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PHYSIOLOGICAL RESPONSE OF SORGHUM PLANT (*SORGHUM VULGARE*) TO PHOSPHORUS TREATMENTS UNDER CALCAREOUS SOIL

By

HATEM MOHAMED ASHOUR ABD EL-SALAM

B.Sc. Agric. Sc. (Horticulture), Ain Shams University, 1995

M.Sc. Agric. Sc. (Plant Physiology), Ain Shams University, 2002

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الاستجابة الفسيولوجية لنبات سورجم العلف لمعاملات الفوسفور تحت ظروف الأرض الجيرية

رسالة مقدمة من

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ABSTRACT

Hatem Mohamed Ashour: Physiological Response of Sorghum Plant (*Sorghum vulgare*) to Phosphorus Treatments under Calcareous Soil. Unpublished Ph.D. Thesis, Department of Agricultural Botany, Faculty of Agriculture, Ain Shams University, 2009.

Two field experiments were carried out at King Maryot, North Western Coastal region of Egypt during summer seasons of 2004 and 2005. This study was conducted to evaluate the effect of phosphorus fertilizers [Super phosphate, MP and rock phosphate either with phosphorine (R+P) or mycorrhiza (R+M)] in the presence or absence of humic acid and magnetic iron on sorghum plants.

The results obtained from the first experiment dealig with intact plants (uncut) illustrated that mycorrhizal rock phosphate was more efficient than other P treatments (R+P, MP and SP). Such increase reached the significant level for leaf area, fresh an dry wights per plant against the rest of other P treatments. Humic acid and magnetic iron applications also stimulated the previous growth characters, since the interaction of mycorrhizal rock phosphate with humic acid and magnetic iron achieved significantly the highest response for growth characters which reflected on grain yield and weigh of 100 grains. Phosphorus dissolving bacterial rock phosphate (R+P) combined with humic acid and magnetic iron also stimulated grain yield and weight of 100 grains. Meanwhile, super phosphate (SP) singly recorded the lowest grain yield production. On the other hand, the treatment of mycorrhizal rock phosphate combined with humic acid in present or absence of magnetic iron reduced pH value of soil from 7.9 to 6.9 which reflected on increasing the availability of soil nutrients in particulary P. Since this treatment stimulated P uptake to reach 12.5% in the first season and extended to reach 25% in the second one above those obtained from super phosphate. However, phosphorin also with rock phosphate increased P uptake to record 10.3% in both seasons respectively. Furthermore, the mycorrhizal rock hosphate treatment combined with humic acid and magnetic iron obviously stimulated the N, S, Mn, Zn, B and Cu uptake and decreased Na uptake. However K, Ca, Mg and Fe contents in plant shoot did not differ with different P treatments.

With respect to the second expriment deeling with sorghum as fodder crop, results revealed that magnetic iron when combined with mycorrhizal rock phosphate and humic acid significantly stimulated plant high, number of leaves, leaf area and number of tillers to surpass the other interactions which reflected clearly on yield cuttings at the three different dates and their plant dry weights. The nutrient content of cutting plants under differet treatments almost behaved as that previously observed for the whole plant. P, N and S nutrients as well Zn, Mn, B and Cu, content positively responded with mycorrhizal rock phosphate + humic acid and magnetic iron. On the other hand K, Ca and Mg, as well Fe content did not clearly differ with different interactions.

Key words: Phosphorus fertilizers, Rock phosphate, Mycorrhizae, Magnetic iron, Humic acid.

I. INTRODUCTION

One of the main problems in Egypt is the insufficient production of forage crops, especially in summer. Total cultivated area was 261.351 fed. in season 2005. Therefore, great attention has been paid to summer forage crops during the last few years. The cultivated area of sorghum as fodder crop is increasing yearly due to improved breeding for different stress conditions and new varieties to meet the increasing needs of animal feed (total area 13.112 fed. in season, 2005*).

Sorghum is grown in the United States, Australia, and other developed nations essentially for animal feed. However, in Africa and Asia the grain is used both for human nutrition and animal feed. It is estimated that more than 300 millions people from developing countries essentially rely on sorghum as source of energy **(Godwin and Gray, 2000).** However, starch is the main component of sorghum grain, followed by proteins, non-starch polysaccharides (NSP) and fat. The average energetic value of whole sorghum grain flour is 356 kcal/100 g **(BSTID-NRC, 1996).** Sorghum has a macromolecular composition similar to that of maize and wheat **(BSTID-NRC, 1996).**

Sorghum grain yield constitute 12% the total summer grain yield (in season 2005*).

However, sorghum is adapted to a wide range of environmental conditions particularly to drought. On the other hand mycorrhizal plants often have greater tolerance to drought than non-mycorrhizal plants **(Ghazi Al-Karaki *et al*., 2004)**. It can be successfully grown on a wide range of soil types. It tolerates a range of soil pH from 5.0 – 8.5 and is more tolerant to salinity than maize.

Phosphorus (P) is an essential macronutrient, being required by plants for normal growth and development in relatively large

* Minisstry of Agric. (summer green fodder crops and grain yield, 2005).

quantities (~0.2 to 0.8%) **(Mengel and Kirkby, 1987; Mills and Jones, 1996).** The availability of P to plants for uptake and utilization is impaired in alkaline and calcareous soils due to the formation of poorly soluble calcium phosphate minerals, therefore, they have very low levels of natural available phosphorus. P-fertilizer applications are essential for the establishment and maintenance of most crops. Adding P fertilizer at "normal" rates and with conventional methods may not result optimal yield and crop quality in these soils common in arid and semi-arid regions. **Gouda *et al*. (1990)** stated that increasing levels to triple super phosphate in calcareous soil causes a highly significant increase in groundnut pod yield and yield components. The response of plants to the concentration of phosphate in the root environment has important implications in both soil chemistry and plant physiology.

Calcareous soils contain relatively large amounts of inorganic P, but because of P-fixation, relatively little is available for crop use. This is also true of water soluble phosphorus added to the soil in the form of super phosphate fertilizer. Many investigators have shown that a wide range of microorganisms can solubilize insoluble phosphate, thereby increasing the availability of P to plant roots **(Barthakur, 1978 and Venkateswarlu *et al*., 1984).** *Bacillus megaterium* var. phosphaticum has been used as microbial fertilizer (Phosphobacterin) to millions of hectares in Europe to increase P availability to a variety of crops **(Cooper, 1959)**. Moreover, several investigators have reported increases in yields of different crops as a result of phosphobacterin application to calcareous soils **(Osman *et al*., 1974; Kabesh *et al*., 1975 and Saber *et al*., 1975).** The mycorrhizae are symbiotic associations, formed between plants and soil that play an essential role in plant growth, plant protection, and soil quality, particularly evident with soil nutrients that are more immobile such as phosphorus, zinc, copper **(Dalpe and Monreal, 2004).** More attention has apparently given to the role of phosphate-dissolving bacteria (PDB) than that of phosphate-dissolving fungi **(Barthakur, 1978).** Meanwhile,, **Venkateswarlu *et al*. (1984)** reported that fungi were more efficient than bacteria in solubilizing insoluble phosphate.

Enhancing the availability of soil inorganic P to plant uptake is an important research subject as well as with practical aspects. Reactive rock phosphate can provide a less expensive alternative to manufactured P fertilizers but they are slowly soluble in most soils. Hence, there is a need to increase the effectiveness of low reactive phosphate rocks. In general, the availability of nutrients depends on many factors, some of which are soil reaction (pH) **(Barak *et al*., 1997),** plant species**, (Habib *et al*. 1999)** soil solution composition **(Nakamaru *et al*, 2000),** and types & ratios of microorganisms **(Leyval and Joner, 2001),** soil type**, (Patterson, 2002).**

Sharif *et al*. (2004), suggested that the addition of humic acid have great potential to improve maize yield and the physiochemical and biological properties of the silty clay loam soil. In addition, **(Aydn *et al*., 1999),** found that K-Humate increased dry matter and N,P,K,Ca, Mg, Fe, Mn, Zn and Cu contents of maize and sunflowers and increased nutrient uptake by the plants, so more with the soil than foliar application. Humic acid increased resistance to drought, cold and diseases, prevented early senescence, increased yield, increased activities of superoxide dismutase and nitrate reductase, and increased plant uptake and translocation of nutrients **(Xue *et al*., 1994).**

Wilson (1992), prepared paramagnetic iron sulphate hydrate salts containing iron in both the di- and trivalent states from black magnetic iron oxides of high iron content. These products have fertilizing and soil conditioning properties superior to non-magnetic iron compounds containing iron only in either the di-or trivalent state.

Therefore, the objective of the present study was to asses the physiological response of sorghum plants as a summer forage crop to three main forms of P fertilizers (super phosphate, mono phosphate and rock phosphate) in the presence or absence of humic acid and/or magnetic iron. On the other hand, some phosphate-dissolving organisms were used for increasing P availability from the raw material (rock phosphate) as well as the agronomic effectiveness of this material along with phosphate dissolving bacteria and mycorrhiza. Furthermore, the effect of these treatments on growth, grain yield and phosphorus contents of sorghum plants grown on calcareous soil at Maryot was studied.

Table (4): Effect of different phosphorus treatments, humic and magnetic iron applications on plant height cm/plant of sorghum plant during the three sampling dates of the two seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	60.7 e	73.3 cde	81.33 e	83.3 e	84 d	87.3 d	71 i	84g h	90 i	95 hi	100 e	107 de
Super + humic	70.7 de	79.3 cde	82.3 e	92.7 cd	85 d	91.7 d	82 h	86 gh	93 hi	98 ghi	104 de	110 de
Monophos	74.7 cde	91 bcde	84 e	96.7 cde	84 d	96.7 cd	88 gh	103 f	100 fghi	110 fg	115 cd	111 de
Monophos + humic	77.3 cde	95.7 abcde	86 e	98.7 abcd	90 d	101.7 bcd	90 g	106 f	103 fgh	112 ef	108 de	114 cd
Rock + Phose	96.7 abcde	112 abc	112 abcde	127.7 abcde	107.3 abcd	126 abcd	107 f	118 de	123 de	134 bcd	122 c	137 b
Rock + Phose + humic	102.67abcd	129.7 ab	114.3 abcde	143 ab	120 abcd	145.3 ab	115 e	140 ab	127 cd	155 a	134 b	160 a
Rock + Myco	106.7 abcd	120 ab	122 abcde	133.7 abcd	122 abcd	138 abc	123 d	138 b	138 bc	152 a	141 b	155 a
Rock + Myco + humic	127.7 ab	133.7 a	140.3 abc	155 a	141.3 abc	148 a	131.3 c	145 a	144 ab	156 a	154 a	164 a

* Duncine within each date.

* Means with the same letter are not significantly different.

Table (5): Effect of different phosphorus treatments, humic and magnetic iron applications on leave number/plant of sorghum plant during the three sampling dates of the two season

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phosphate (control)	4 c	4 c	5 d	5 d	6 d	6 d	6 e	7 de	7 g	8 gf	8 f	8 f
Super + humic	4 c	5 bc	5 d	6 cd	6 d	6.7 d	7 de	8 cd	8 gf	9 ef	8 f	8 f
Monophos	5 bc	6.7 ab	6 cd	7.7 bcd	6.7 d	7.7 cd	8 cd	10 ab	9 ef	10 de	9 ef	10 e
Monophos + humic	5 bc	6.7 ab	6 cd	7.7 bcd	6.7 d	8.7 bcd	9 bc	10 ab	9 ef	10 de	9 ef	10 e
Rock + Phose	6.7 ab	7.7 a	7.7 bcd	10 ab	8.7 bcd	10.7 abc	8 cd	9 bc	10 de	12 bc	10 e	12 d
Rock + Phose + humic	7.7 a	7.7 a	8.7 abc	10.7 ab	10.7 abc	13.7 a	9 bc	11 a	11 cd	15 a	12 d	15 ab
Rock + Myco	7.7 a	8.7 a	10 ab	10 ab	10.7 abc	11.7 ab	9 bc	10 ab	12 bc	15 a	13 cd	14 bc
Rock + Myco + humic	7.7 a	8.7 a	10 ab	11.7 a	12.7 a	14.3 a	10 ab	11 a	13 b	16 a	13 cd	16 a

* Duncine within each date.

* Means with the same letter are not significantly different.

Table (6): Effect of different phosphorus treatments, humic and magnetic iron applications on leave area of sorghum plant during the three ampling dates of the two seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	48.8 g	57.3 g	58.5 h	79.5 gh	91.4 i	176.7 ghi	60 i	70 hi	69 j	91 i	150 j	188 i
Super + humic	53.6 g	85.7 fg	76.6 gh	168.8 defg	173.2 ghi	264.7 defg	65 hi	76 gh	88 i	120 h	180 i	215 h
Monophos	64.2 fg	95.4 efg	106.9 fgh	187 cdef	203.7 fghi	283 cdefg	87 fg	115 e	130 h	198 f	226 h	270 f
Monophos + humic	76.8 fg	99.2 defg	121.5 efgh	191.7 cdef	218.1 efghi	142.6 hi	97 f	119 e	175 g	201 f	250 g	281 f
Rock + Phose	110.9 cbef	154.9 bc	207.5 bcde	270.5 bc	302 cdefg	357.3 bcd	121 e	156 cd	220 e	261 c	313 e	352 cd
Rock + Phose + humic	140.7 bcde	184.5 ab	264.1 bcd	300.2 b	326.2 bcdef	435.7 b	149 d	196 b	241 d	299 ab	338 d	400 b
Rock + Myco	145.4 bcd	173.7 ab	249.2 bcd	278.7 bc	344.5 bcde	392.4 bcd	166 c	191 b	282 b	298 ab	360 c	399 b
Rock + Myco + humic	179.6 ab	208.3 a	290.7 b	387.2 a	406.1 bc	644 a	185 b	220 a	290 b	311 a	380 b	550 a

* Duncine within each date.

* Means with the same letter are not significantly different.

Table (7): Effect of different phosphorus treatments, humic and magnetic iron applications on fresh weight gm/plant of sorghum plant during the three sampling dates of two seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	116 h	135.3 fgh	174 c	191.4 c	251.3 e	275.5 de	127 i	147 gh	185 i	201 ghi	260 l	286 kl
Super + humic	125.7 gh	212.7 cdefg	188.5 c	232 c	264.9 de	319 de	136 hi	156 g	190 hi	210 gh	210 gh	291 kl
Monophos	145 efgh	214.6 cdefg	193.c	251.3 c	280.3 de	340.3 de	161 g	226 ef	223 fg	280 e	315 jk	351 ghi
Monophos + humic	152 defgh	222.3 cdef	211.7 c	262 bc	330 de	351.9 de	221 f	234 ef	244 f	274.7 e	330 ij	365 fgh
Rock + Phose	227.2 bcdef	299.7 abc	270.7 bc	372.2 ab	357.7 de	406 cde	253 d	252 d	281 e	294 e	334.7 hij	388 ef
Rock + Phose + humic	232 bcde	319 ab	275.5 bc	435 a	367.3 cde	580 ab	242 de	328 b	286 e	449 b	376 fg	595 b
Rock + Myco	241.7 bcd	304.5 abc	285.2 bc	377 ab	377 cde	415.7 cd	310 c	320 bc	384 d	420 c	420 de	520 c
Rock + Myco + humic	309.3 abc	386.7 a	406 a	483.3 a	512.3 bc	657.3 a	315 bc	398 a	389 d	489 a	430 d	669 a

* Duncine within each date.

* Means with the same letter are not significantly different.

Table (8): Effect of different phosphorus treatments, humic and magnetic iron applications on dry weight g/plant of sorghum plant during the three sampling dates of two seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phosphate (control)	91.87 f	102.5 ef	130.5 e	154.7 cde	145 e	178.9 cde	96 k	107 jk	135 k	159 ij	150 k	184 ij
Super + humic	96.7 f	116 def	145 de	169.2 bcde	169.2 de	192.4 cde	101 jk	110 j	151 j	165 hi	175 j	188 hi
Monophos	104.4 ef	120 cdef	159 cde	171.1 bcde	183.7 cde	193.3 cde	112 ij	126 gh	173 gh	177 gh	194 ghi	200 fgh
Monophos + humic	106.3 ef	130.5 cdef	168.2 bcde	174 bcde	188.5 cde	195.3 cde	122 hi	136 fg	175 gh	179 g	198 fgh	205 fg
Rock + Phose	135.3 bcdef	164.3 abcd	178.9 bcde	207.9 abcde	198.2 cde	217.5 cde	140 ef	159 cd	184 fg	198 e	203 fg	211 ef
Rock + Phose + humic	145 abcdef	188.5 ab	188.5 abcde	241.7 ab	202.1 cde	309.3 ab	150 de	193 a	193 ef	247 b	208 f	315 b
Rock + Myco	154.7 abcde	169.1 abcd	193.3 abcde	222.3 abcd	203 cde	241.7 bcd	169 bc	179 b	213 d	238 bc	222 e	271 c
Rock + Myco + humic	174 abc	193.3 a	232 abc	261 a	265.9 abc	338.3 a	174 b	198.3 a	228 c	266 a	246 d	341 a

* Duncine within each date.

* Means with the same letter are not significantly different.

Table (9) : Effect of different phosphorus treatments, humic and magnetic Iron applications on sorghum plant grains yield kg/feddan in the two seasons

Treatments	1st season		2nd season	
	Without magnetic iron	With magnetic iron	Without magnetic iron	With magnetic iron
Super phosphate (control)	376 c	504.6 abc	390 de	410. de
Super + humic	386.7 bc	531.7 abc	395 cde	425 cde
Monophos.	517.2 abc	540.2 abc	450 cde	520 bcd
Monophos + humic	522 abc	541.3 abc	500 bcd	530 bcd
Rock + Phosph	547.1 abc	560.7 abc	560 bcd	570 bcd
(Rock + Phosph) + humic	551 abc	604.1 ab	565 bcd	615 ab
Rock + Myco	555.8 abc	571.3 abc	590 bc	580 bc
(Rock + Myco) + humic	580 abc	707.1 a	595 bc	680 a

Table (30): Effect of different phosphorus treatments, humic and magnetic iron applications on plant height cm/plant of sorghum plant during the three cutting dates of the 2nd season

Treatments	2nd season					
	Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phosphate (control)	71	84	60	65	55	60
	i	gh	l	kl	m	kl
Super + humic	82	86	63	68	57	62
	h	gh	kl	jk	lm	k
Monophos	88	103	72	77	64	70
	gh	f	ij	hi	jk	hi
Monophos + humic	90	106	75	80	67	74
	g	f	hi	gh	ij	gh
rock + Phose	107	118	85	93	76	82
	f	de	fg	de	g	ef
rock + Phose + humic	115	140	89	106	78	94
	e	ab	ef	ab	fg	b
Rock + Myco	123	138	100	104	88	91
	d	b	bc	ab	cd	bc
Rock + Myco + humic	131.3	145	97	110	85	100
	c	a	cd	a	de	a

* Duncine within each date.

* Means with the same letter are not significantly different.

Table (31): Effect of different phosphorus treatments, humic and magnetic iron applications on leaf number/plant of sorghum plant during the three cutting dates of the 2nd season

Treatments	2nd season					
	Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phosphate (control)	6	7	15	20	11	13
	e	de	l	k	k	jk
Super + humic	7	8	17	22	12	15
	de	cd	l	jk	jk	ij
Monophos	8	10	24	28	17	22
	cd	ab	j	hi	i	h
Monophos + humic	9	10	27	30	20	25
	bc	ab	i	gh	h	g
Rock + Phose	8	9	31	34	28	31
	cd	bc	g	ef	f	def
Rock + Phose + humic	9	11	32	42	29	38
	bc	a	fg	b	ef	ab
Rock + Myco	9	10	38	40	34	36
	bc	ab	cd	bc	cd	bc
Rock + Myco + humic	10	11	36	45	32	40
	ab	a	de	a	de	a

* Duncine within each date.
* Means with the same letter are not significantly different.

Table (32) : Effect of different phosphorus treatments, humic and magnetic iron applications on all leave area/plant of sorghum plant during the three cutting dates of the 2nd season

Treatments	2nd season					
	Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phosphate (control)	395.2 i	429.2 g	1080 i	1800 g	1600 k	1730 ij
Super + humic	414.4 hi	628.9 f	1992 h	2210 f	1699 j	1809 i
Monophos	521 f	839.18 e	2298 f	2409 e	1903 h	2015 gf
Monophos + humic	584 f	864.64 de	2303 f	2506 d	1990 gh	2050 fg
rock + Phose	943.03 cd	1192.73 bc	2560 cd	2630 bc	2101 f	2309 d
Rock + Phose + humic	1083.3 cd	1420.65 b	2590 cd	2801 a	2210 e	2500 b
Rock + Myco	1119 bc	1511.19 ab	2700 b	2709 b	2400 cd	2430 bc
Rock + Myco + humic	1382.9 b	1812.21 a	2690 b	2850 a	2350 cd	2600 a

* Duncine within each date.
* Means with the same letter are not significantly different.

Table (35): Effect of different phosphorus treatments, humic and magnetic iron applications on sorghum cutting plant yield in the two seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phosphate (control)	4.8 k	5.2 ijk	3 m	3.4 klm	1.5 l	1.8 jkl	5.5 j	5.7 hi	3.5 j	3.9 i	1.99 i	2.2 gi
Super + humic	5.0 jk	5.4 hij	3.2 ml	3.6 jkl	1.6 lk	2.0 ijk	5.6 ij	5.8 h	3.9 i	4.5 h	2.1 hi	2.3 gh
Monophos	5.6 ghi	5.9 fg	3.6 ijk	4.1 ghi	2.1 hij	2.3 ghi	6.2 g	6.5 f	4.6 g	4.8 f	2.5 fg	2.6 ef
Monophos + humic	5.8 fgh	6.1 ef	3.9 hij	4.2 fghi	2.2 hij	2.5 fgh	6.3 g	6.6 ef	4.7 fg	5.1 e	2.5 fg	2.7 ef
Rock +Phose	6.4 de	6.8 bcd	3.4 fgh	4.6 def	2.7 defg	2.6 efgh	6.7 de	7.2 c	5.3 d	5.5 c	2.6 e	3.1 d
Rock+ Phose + humic	6.6 cd	6.9 b	4.4 efg	4.8 cde	2.8 def	3.0 cde	6.6 d	7.3 c	5.3 d	5.6 bc	3.1 d	3.2 cd
Rock+ Myco	7.1 ab	7.4 a	4.9 bcd	5.3 ab	3.1 bcd	3.5 ab	7.6 b	7.9 a	5.7 b	5.7 b	3.3 bcd	3.5 b
Rock + Myco + humic	7.2 ab	7.5 a	5.1 abc	5.5 a	3.3 abc	3.7 a	7.6 b	7.9 a	5.6 bc	6.1 a	3.4 bc	3.9 a

* Duncine within each date.

* Means with the same letter are not significantly different.

Table (34) : Effect of different phosphorus treatments, humic and magnetic iron applications on dry weight gm/plant of sorghum plant during the three cutting dates of the 2nd season

Treatments	2nd season					
	Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phosphate (control)	96 k	107 jk	60 m	68 kl	50 m	56 l
Super + humic	101 jk	110 j	65 l	71 jk	53 lm	61 k
Monophos	112 ij	126 gh	72 jk	80 hi	63 jk	70 i
Monophos + humic	122 hi	136 fg	76 ij	83 gh	65 j	75 h
Rock + Phose	140 ef	159 cd	87 fg	96 e	80 g	90 e
rock + Phose + humic	150 de	193 a	91 f	120 b	85 f	106 b
Rock + Myco	169 bc	179 b	106 d	112 c	99 c	102 c
Rock + Myco + humic	174 b	198.3 a	100 e	130 a	94 d	117 a

* Duncine within each date.
* Means with the same letter are not significantly different.

Table (33): Effect of different phosphorus treatments, humic and magnetic Iron applications on sorghum cutting plant of the numberof tillers after cutting

Treatments	1st season				2nd season			
	Cutting dates				Cutting dates			
	90 days		120 days		90 days		120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phosphate (control)	2 d	3 d	3 e	4 e	2 c	2 c	3 d	4 cd
Super + humic	2 d	3 d	3 e	4 e	2 c	3 bc	3 d	5 bcd
Monophos	5 c	6 bc	6 d	8 bc	3 bc	3 bc	5 bcd	5 bcd
Monophos + humic	5 c	6 bc	7 cd	8 bc	3 bc	4 ab	5 bcd	6 abc
Rock + Phose	6 bc	7 ab	8 bc	9 ab	3 bc	4 ab	5 bcd	6 abc
Rock + Phose + humic	7 ab	7 ab	9 ab	9 ab	4 ab	5 a	5 bcd	6 abc
Rock + Myco	7 ab	8 a	9 ab	10 a	5 a	5 a	7 a	8 a
Rock + Myco + humic	8 a	8 a	10 a	10 a	5 a	5 a	8 a	8 a

* Duncine within each date.
* Means with the same letter are not significantly different.

Table (11): Effect of different phosphorus treatments, humic and magnetic iron applications on total phosphorus content of sorghum plant g/100 g dry weight during 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	0.589	0.621	0.766	0.807	0.295	0.311	0.60	0.632	0.801	0.823	0.31	0.33
Super + humic	0.618	0.629	0.803	0.818	0.309	0.315	0.62	0.641	0.821	0.833	0.32	0.34
Monophos	0.632	0.641	0.822	0.833	0.316	0.321	0.651	0.659	0.844	0.852	0.35	0.37
Monophos + humic	0.638	0.643	0.829	0.836	0.319	0.322	0.655	0.661	0.851	0.853	0.36	0.38
Rock + Phose	0.649	0.657	0.844	0.854	0.325	0.329	0.681	0.72	0.854	0.875	0.39	.0.41
Rock + Phose + humic	0.651	0.659	0.846	0.857	0.326	0.33	0.71	0.73	0.865	0.886	0.40	0.42
Rock + Myco	0.663	0.667	0.862	0.867	0.332	0.334	0.75	0.77	0.859	0.923	0.43	0.46
Rock + Myco + humic	0.664	0.666	0.863	0.866	0.332	0.333	0.76	0.79	0.911	0.941	0.44	0.48

Table (12): Effect of different phosphorus treatments, humic and magnetic iron applications on total soluble [hosphorus content of sorghum plant g/100 g dry weight during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	0.501	0.528	0.651	0.686	0.25	0.264	0.51	0.537	0.681	0.699	0.264	0.281
Super + humic	0.525	0.535	0.683	0.695	0.263	0.267	0.527	0.545	0.698	0.708	0.272	0.289
Monophos	0.537	0.545	0.698	0.708	0.269	0.272	0.553	0.56	0.717	0.724	0.298	0.315
Monophos + humic	0.542	0.547	0.705	0.711	0.271	0.273	0.557	0.562	0.723	0.725	0.306	0.323
Rock + Phose	0.552	0.558	0.717	0.726	0.276	0.279	0.579	0.612	0.730	0.744	0.332	0.349
Rock + Phose + humic	0.553	0.56	0.719	0.728	0.277	0.28	0.604	0.621	0.735	0.753	0.34	0.357
Rock + Myco	0.564	0.567	0.733	0.737	0.282	0.28	0.638	0.655	0.761	0.785	0.366	0.391
Rock + Myco + humic	0.564	0.566	0.734	0.736	0.282	0.283	0.646	0.672	0.774	0.80	0.374	0.408

Table (13): Effect of different phosphorus treatments, humic and magnetic iron applications on total soluble organic content of sorghum plant g/100 g dry weight during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	0.088	0.093	0.115	0.121	0.044	0.047	0.09	0.095	0.12	0.123	0.043	0.05
Super + humic	0.093	0.094	0.121	0.123	0.046	0.047	0.093	0.096	0.123	0.125	0.048	0.051
Monophos	0.095	0.096	0.123	0.125	0.047	0.048	0.098	0.099	0.127	0.128	0.053	0.056
Monophos + humic	0.096	0.096	0.124	0.125	0.048	0.048	0.098	0.099	0.128	0.128	0.054	0.057
Rock + Phose	0.097	0.099	0.127	0.128	0.049	0.049	0.102	0.108	0.128	0.131	0.059	0.062
Rock + Phose + humic	0.098	0.099	0.127	0.129	0.049	0.049	0.107	0.11	0.130	0.133	0.060	0.063
Rock + Myco	0.099	0.1	0.129	0.13	0.05	0.05	0.113	0.116	0.134	0.139	0.065	0.069
Rock + Myco + humic	0.1	0.1	0.129	0.13	0.05	0.05	0.114	0.119	0.137	0.141	0.066	0.072

Table (14): Effect of different phosphorus treatments, humic and magnetic iron applications on inorganic phosphorus content of sorghum plant g/100 g dry weight during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	0.406	0.428	0.528	0.557	0.203	0.214	0.414	0.436	0.553	0.568	0.214	0.228
Super + humic	0.426	0.434	0.554	0.564	0.213	0.217	0.428	0.442	0.566	0.575	0.221	0.235
Monophos	0.436	0.442	0.567	0.575	0.218	0.221	0.449	0.455	0.582	0.588	0.242	0.255
Monophos + humic	0.44	0.444	0.572	0.577	0.22	0.222	0.452	0.456	0.587	0.589	0.248	0.262
Rock + Phose	0.448	0.453	0.582	0.589	0.224	0.227	0.470	0.497	0.589	0.604	0.269	0.283
Rock + Phose + humic	0.449	0.455	0.584	0.591	0.225	0.227	0.490	0.504	0.597	0.611	0.276	0.290
Rock + Myco	0.457	0.46	0.595	0.598	0.229	0.23	0.518	0.531	0.618	0.637	0.297	0.317
Rock + Myco + humic	0.458	0.46	0.596	0.597	0.229	0.23	0.524	0.545	0.629	0.650	0.304	0.331

Table (15): Effect of different phosphorus treatments, humic and magnetic iron applications on in soluble phosphorus content of sorghum plant g/100 g dry weight during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	0.082	0.087	0.107	0.113	0.041	0.043	0.084	0.088	0.112	0.115	0.043	0.046
Super + humic	0.087	0.088	0.112	0.114	0.043	0.044	0.087	0.090	0.115	0.117	0.045	0.048
Monophos	0.088	0.09	0.115	0.117	0.044	0.045	0.091	0.092	0.118	0.119	0.052	0.049
Monophos + humic	0.089	0.09	0.116	0.117	0.045	0.045	0.092	0.093	0.119	0.119	0.050	0.053
Rock + Phose	0.091	0.092	0.118	0.120	0.045	0.046	0.095	0.101	0.120	0.123	0.055	0.057
Rock + Phose + humic	0.091	0.92	0.118	0.120	0.046	0.046	0.099	0.102	0.121	0.124	0.056	0.059
Rock + Myco	0.093	0.093	0.121	0.121	0.46	0.047	0.105	0.108	0.125	0.129	0.060	0.064
Rock + Myco + humic	0.093	0.093	0.121	0.121	0.046	0.047	0.106	0.111	0.128	0.132	0.62	0.667

Table (16): Effect of different phosphorus treatments, humic and magnetic iron applications on nitrogen content of sorghum plant g/100 g dry weight during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	1.904	1.936	1.424	1.472	0.864	0.912	1.904	1.952	1.728	1.776	1.024	1.056
Super + humic	1.918	1.952	1.456	1.488	0.896	0.928	1.936	1.968	1.744	1.792	1.04	1.104
Monophos	1.984	1.995	1.536	1.616	0.96	0.992	2.096	2.144	1.936	1.984	1.104	1.168
Monophos + humic	1.992	2.001	1.568	1.632	0.976	1.008	2.112	2.16	1.968	2.0	1.152	1.184
Rock + Phose	2.002	2.035	1.664	1.728	1.04	1.088	2.272	2.368	2.016	2.064	1.216	1.248
Rock + Phose + humic	2.019	2.078	1.696	1.744	1.056	1.136	2.336	2.384	2.048	0.112	1.323	1.312
Rock + Myco	2.115	2.185	1.776	1.856	1.152	1.104	2.448	2.512	2.128	2.192	1.328	1.392
Rock + Myco + humic	2.134	2.256	1.792	1.904	1.184	1.20	2.496	2.544	2.16	2.208	1.360	1.424

Table (17): Effect of different phosphorus treatments, humic and magnetic iron applications on crude protein content of sorghum plant g/100 g dry weight during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	11.9	12.1	8.9	9.2	5.4	5.7	11.9	12.2	10.8	11.1	6.4	6.6
Super + humic	11.99	12.2	9.1	9.3	5.6	5.8	12.1	12.3	10.9	11.2	6.5	6.8
Monophos	12.4	12.47	9.6	10.1	6.0	6.2	13.1	13.4	12.1	12.4	6.9	7.3
Monophos + humic	12.45	12.51	9.8	10.2	6.1	6.3	13.2	13.5	12.3	12.5	7.2	7.4
Rock + Phose	12.53	12.72	10.4	10.8	6.5	6.8	14.2	14.8	12.6	12.9	7.6	7.8
Rock + Phose + humic	12.62	12.99	10.6	10.9	6.6	7.1	14.6	14.9	12.8	13.2	7.7	8.2
Rock + Myco	13.22	13.66	11.1	11.6	7.2	6.9	15.3	15.7	13.3	13.7	8.3	8.7
Rock + Myco + humic	13.34	14.1	11.2	11.9	7.4	7.5	15.6	15.9	13.5	13.8	8.5	8.9

Table (18): Effect of different phosphorus treatments, humic and magnetic iron applications on potassium content of sorghum plant ppm during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	630.2	630.5	838.5	838.7	420	423.5	655.41	655.72	863.65	863.86	441	444.68
Super + humic	630.4	630.67	838.6	838.8	422	425.33	655.6	655.89	863.76	863.97	443.1	446.6
Monophos	630.82	631.12	838.9	839.4	427.08	430.58	656.05	656.36	864.07	864.58	448.44	452.11
Monophos + humic	630.97	631.27	839.1	839.5	428.83	432.33	656.2	656.52	864.27	864.69	450.28	453.95
Rock + Phose	631.42	631.72	839.6	839.8	434.08	437.58	656.76	656.99	864.79	864.99	455.79	459.46
Rock + Phose + humic	631.57	631.87	839.7	839.9	435.83	439.33	656.8	657.14	864.89	865.1	457.63	461.3
Rock + Myco	632.02	632.32	840.0	840.3	441.08	444.58	657.3	657.6	865.2	865.51	463.14	466.81
Rock + Myco + humic	632.17	632.47	840.1	840.5	442.83	446.33	657.45	657.77	865.3	865.72	464.98	468.65

Table (19): Effect of different phosphorus treatments, humic and magnetic iron applications on magnesium content of sorghum plant ppm during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	155.2	155.6	177.5	177.8	100	102.5	161.41	161.82	182.83	183.13	105	107.63
Super + humic	155.3	155.77	177.7	177.9	102	104.0	161.51	162.0	183.03	183.24	107.1	109.2
Monophos	155.97	156.37	178.0	178.3	105.25	107.75	162.21	162.62	183.34	183.65	110.51	113.14
Monophos + humic	156.17	156.57	178.4	178.4	106.5	109	162.41	162.83	183.55	183.75	111.83	114.45
Rock + Phose	156.77	157.17	178.5	178.7	110.25	112.75	163.04	163.45	183.86	184.06	115.76	118.39
Rock + Phose + humic	156.97	157.37	178.6	178.9	111.5	114	163.25	163.66	183.96	184.27	117.08	119.7
Rock + Myco	157.57	157.97	179.1	179.4	115.25	117.75	163.87	164.29	184.47	184.78	121.01	123.64
Rock + Myco + humic	157.77	158.17	179.2	179.6	116.5	119	164.08	164.49	184.58	185.0	122.33	124.95

Table (20): Effect of different phosphorus treatments, humic and magnetic iron applications on calcium content of sorghum plant ppm during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	33.7	33.82	43.5	43.7	22.5	22.9	35.05	35.17	44.81	45.01	23.63	24.05
Super + humic	33.81	33.84	43.6	43.8	22.7	23.1	35.15	35.19	44.91	45.11	23.84	24.26
Monophos	33.9	33.99	43.9	44.2	23.3	23.7	35.26	35.35	45.22	45.63	24.47	24.89
Monophos + humic	33.94	34.03	44.1	44.4	12.5	23.9	35.3	35.39	45.42	45.73	24.68	25.1
Rock + Phose	34.08	34.16	44.6	44.8	24.1	24.5	35.44	35.53	45.94	46.23	25.31	25.73
Rock + Phose + humic	34.12	34.21	44.7	44.9	24.3	24.7	35.48	35.58	46.08	46.28	25.52	25.94
Rock + Myco	34.25	34.34	44.93	44.95	24.9	25.3	35.62	35.71	46.30	46.34	26.15	26.57
Rock + Myco + humic	34.30	34.38	44.94	45.01	25.1	25.5	35.67	35.76	46.32	46.36	26.36	26.78

Table (21): Effect of different phosphorus treatments, humic and magnetic iron applications on sulpher content of sorghum plant ppm during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	80.2	82.6	100.3	103.6	40.5	47.4	89.2	93.3	102.1	109.2	50.2	56.3
Super + humic	81.4	84.6	102.4	105.2	45.2	49.3	91.4	95.4	106.6	112.4	55.4	59.1
Monophos	101.3	109.6	110.3	120.6	50.3	59.5	105.3	115.2	116.2	125.0	62.3	70.2
Monophos + humic	103.5	120.5	115.4	125.2	57.2	62.4	109.5	130.3	119.5	130.4	69.5	73.2
Phose + rock	125.4	135.4	130.3	140.4	64.3	68.5	135.4	143.4	134.3	149.2	75.3	79.2
Rock + Phose	130.5	140.5	135.4	149.1	66.3	70.4	139.6	149.3	139.4	157.3	77.5	83.3
Rock + Phose + humic	145.3	155.4	155.4	164.3	72.4	76.6	159.2	167.5	165.7	181.3	89.4	99.3
Rock + Myco	150.4	160.5	159.5	175.3	74.2	79.4	160.4	180.2	177.3	189.2	95.4	101.2

Table (22): Effect of different phosphorus treatments, humic and magnetic iron applications on iron content of sorghum plant ppm during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	64.2	64.5	74.5	74.7	55.5	55.8	66.77	67.08	76.74	76.94	58.28	58.5
Super + humic	64.3	64.63	74.6	74.9	55.6	55.93	66.87	67.22	76.84	77.15	58.38	58.7
Monophos	64.78	65.08	75.1	75.5	56.08	56.38	67.37	67.69	77.35	77.76	58.89	59.2
Monophos + humic	64.93	65.23	75.3	75.7	56.23	56.53	67.53	67.84	77.56	77.97	59.05	59.31
Rock + Phose	65.38	65.68	76.2	76.5	56.68	56.98	68.0	68.31	78.49	78.8	59.52	59.83
Rock + Phose + humic	65.53	65.83	76.4	76.6	56.83	57.13	68.15	68.47	78.69	78.9	59.68	59.99
Rock + Myco	65.98	66.28	76.7	77.1	57.28	57.58	68.26	68.93	79.0	79.41	60.15	60.41
Rock + Myco + humic	66.13	66.43	76.9	77.2	57.43	57.73	68.78	69.09	79.21	79.52	60.31	60.62

Table (23): Effect of different phosphorus treatments, humic and magnetic iron applications on zinc content of sorghum plant zinc ppm during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	6.1	6.3	7.5	7.7	4.11	4.33	6.34	6.55	7.73	7.93	4.32	4.55
Super + humic	6.2	6.4	7.6	7.8	4.22	4.44	6.45	6.66	7.83	3.03	4.43	4.66
Monophos	6.5	6.7	7.9	8.2	4.55	4.77	6.67	6.97	8.14	8.45	4.78	5.01
Monophos + humic	6.6	6.8	8.1	8.3	4.66	4.88	6.86	7.07	8.34	8.55	4.89	5.12
Rock + Phose	6.9	7.1	8.4	8.6	4.99	5.21	7.18	7.83	8.65	8.68	5.24	5.47
Rock + Phose + humic	7.0	7.2	8.5	8.7	5.1	5.32	7.28	7.49	8.76	8.96	5.36	5.59
Rock + Myco	7.3	7.5	8.88	8.93	5.43	5.65	7.59	7.8	9.15	9.20	5.7	5.93
Rock + Myco + humic	7.4	7.6	8.92	8.95	5.54	5.76	7.70	7.9	9.19	9.22	5.82	6.05

Table (24): Effect of different phosphorus treatments, humic and magnetic iron applications on manganise content of sorghum plant ppm during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	3.2	3.5	4.53	4.62	1.55	1.58	3.33	3.64	4.67	4.76	1.63	1.66
Super + humic	3.3	3.67	4.61	4.63	1.57	1.6	3.54	3.81	4.75	4.77	1.65	1.68
Monophos	3.82	4.12	4.71	4.73	1.61	1.64	3.97	4.28	4.82	4.88	1.69	1.72
Monophos + humic	3.97	4.27	4.72	4.75	1.63	1.66	4.13	4.44	4.85	4.91	1.71	1.74
Rock + Phose	4.42	4.72	4.76	4.78	1.67	1.70	4.59	4.91	4.94	5.01	1.76	1.79
Rock + Phose + humic	4.57	4.87	4.77	4.79	1.69	1.72	4.75	5.06	4.98	5.04	1.77	1.8
Rock + Myco	5.02	5.32	4.81	4.83	1.73	1.76	5.22	5.53	5.07	5.13	1.82	1.85
Rock + Myco + humic	5.17	5.47	4.82	4.88	1.75	1.78	5.37	5.69	5.1	5.17	1.83	1.87

Table (26): Effect of different phosphorus treatments, humic and magnetic iron applications on copper contnt of sorghum plant ppm during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	2.0	2.4	2.3	2.76	2.12	2.54	2.76	3.31	3.17	3.81	2.4	2.88
Super + humic	2.3	2.5	2.65	2.88	2.43	2.65	3.17	3.45	3.65	3.97	2.76	3.0
Monophos	2.6	3.0	2.99	3.45	2.75	3.17	3.59	4.14	4.13	4.76	3.12	3.6
Monophos + humic	2.8	3.1	3.22	3.57	2.96	3.28	3.86	4.28	4.44	4.92	3.36	3.72
Rock + Phose	3.3	3.5	3.8	4.03	3.49	3.7	4.55	4.83	5.24	5.55	3.96	4.20
Rock + Phose + humic	3.4	3.6	3.91	4.14	3.6	3.81	4.69	4.97	5.4	5.71	4.08	4.32
Rock + Myco	3.7	3.8	4.26	4.37	3.91	4.02	5.11	5.24	5.87	6.03	4.44	4.56
Rock + Myco + humic	3.75	3.86	4.31	4.44	3.97	4.08	5.18	5.33	5.95	6.13	4.5	4.63

Table (25): Effect of different phosphorus treatments, humic and magnetic iron applications on Boron content of sorghum plant ppm during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	1.9	2.28	2.19	2.62	2.01	2.41	2.62	3.15	3.02	3.62	2.28	2.74
Super + humic	2.19	2.38	2.51	2.73	2.31	2.51	3.02	3.28	3.47	3.77	2.62	2.85
Monophos	2.47	2.85	2.84	3.28	2.61	3.02	3.41	3.93	3.92	4.52	2.96	3.42
Monophos + humic	2.66	2.95	3.06	3.39	2.81	3.12	3.67	4.06	4.22	4.67	3.19	3.53
Rock + Phose	3.14	3.33	3.61	3.82	3.32	3.52	4.34	4.59	4.98	5.28	3.76	3.99
Rock + Phose + humic	3.23	3.42	3.71	3.93	3.42	3.62	4.46	4.72	5.13	5.43	3.88	4.10
Rock + Myco	3.52	3.61	4.04	4.15	3.72	3.82	4.85	4.98	5.58	5.73	4.22	4.33
Rock + Myco + humic	3.56	3.67	4.1	4.22	3.77	3.88	4.92	5.06	5.65	5.82	4.28	4.40

Table (27): Effect of different phosphorus treatments, humic and magnetic iron applications on sodium content of sorghum plant mg/100 g dry weight during ghe 2004/2005 seasons

Treat-ments	1st season						2nd season					
	Sampling dates						Sampling dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	120.5	76.28	130.28	70.72	104.21	60.7	135.9	60.26	156.32	70.05	118.2	60.53
Super + humic	90.68	60.12	99.68	50.19	91.71	44.02	162	50.63	137.56	59.53	90.02	47.55
Monophos	110.07	70.74	120.93	70.6	102.5	50.4	130.52	60.13	150.74	70.6	112.88	54.89
Monophos + humic	82.98	60.25	89.78	50.29	80	42.59	91.73	49.55	130.49	50.88	90.38	48.31
Rock + Phose	110.42	70.43	120.74	60.55	100.48	50.02	118.89	60.86	140.22	60.54	100.57	50.92
Rock + Phose + humic	80.17	50.14	85.85	48.76	80.98	38.54	89.02	48.31	120.47	48.31	85.41	40.97
Rock + Myco	102.24	60.45	119.43	60.92	98.48	40.4	110.32	50.7	140.71	60.11	100.49	50.74
Rock + Myco + humic	70.69	50.48	75.5	47.65	70.78	36.32	86.8	48.98	120.67	38.97	80.43	40.37

Table (28): Effect of different phosphorus treatments, humic and magnetic iron applications on total N, crude protein, albumin, globulin and fitate content of sorghum plant ppm during the 2004/2005 seasons

Treatments	Total N		Crude protein		Albumine		Globuline		Total phytate	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phosphate (control)	1.616	1.696	10.1	10.6	3.2	3.52	1.5	1.7	2.17	2.19
Super + humic	1.632	1.744	10.2	10.9	3.33	3.7	1.6	1.81	2.18	2.2
Monophos	1.792	1.888	11.2	11.8	4.22	4.4	1.91	2.11	2.22	2.24
Monophos + humic	1.808	1.904	11.3	11.9	4.3	4.5	2.0	2.21	2.23	2.25
Rock + Phose	1.936	2.032	12.1	12.7	5.2	5.6	2.33	2.51	2.26	2.28
Rock + Phose + humic	1.968	2.096	12.3	13.1	5.4	5.73	2.44	2.61	2.27	2.29
Rock + Myco	2.112	2.256	13.2	14.1	6.33	6.51	2.72	2.91	2.3	2.34
Rock + Myco + humic	2.144	2.432	13.4	15.2	6.41	6.64	2.82	3.2	2.32	2.36

Table (29): Effect of different phosphorus treatments, humic and magnetic iron applications on total nitrogen crude protein, albumin, globuline and phytate content of grains soghum plant g/100 g durig the second season

Treatments	Total N		Crude protein		Albumine		Globuline		Total phytate	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phosphate (control)	1.792	1.84	11.2	1.5	3.3	3.6	1.61	1.72	3.12	3.15
Super + humic	1.824	1.856	11.4	11.6	3.4	3.7	1.85	1.91	3.16	3.18
Monophos	1.936	1.894	12.1	12.4	4.5	4.8	1.99	2.0	3.21	3.25
Monophos + humic	1.952	2.0	12.2	12.5	4.6	4.9	2.2	2.3	3.56	3.29
Rock + Phose	2.096	2.128	13.1	13.3	5.2	5.6	2.4	2.5	3.32	3.37
Rock + Phose + humic	2.112	2.304	13.2	14.4	5.4	6.2	2.6	2.7	3.39	3.40
Rock + Myco	2.32	2.384	14.5	14.8	6.4	7.3	2.8	2.88	3.42	3.44
Rock + Myco + humic	2.336	2.384	14.6	14.9	6.5	7.4	2.9	3.2	3.48	3.50

Table (36): Effect of different phosphorus treatments, humic and magnetic iron applications on total phosphorus content of sorghum cutting plant g/100 g dry weight during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	0.589	0.621	0.71	0.73	0.60	0.62	0.60	0.632	0.8	0.83	0.7	0.72
Super + humic	0.618	0.629	0.72	0.75	0.61	0.63	0.62	0.641	0.82	0.84	0.713	0.73
Monophos	0.632	0.641	0.76	0.78	0.64	0.67	0.651	0.659	0.85	0.87	0.74	0.76
Monophos + humic	0.638	0.643	0.77	0.79	0.66	0.68	0.655	0.661	0.86	0.88	0.75	0.77
Rock + Phose	0.649	0.657	0.80	0.82	0.69	0.71	0.681	0.720	0.89	0.91	0.78	0.81
Rock + Phose + humic	0.651	0.659	0.81	0.83	0.70	0.72	0.71	0.73	0.90	0.92	0.79	0.82
Rock + Myco	0.663	0.667	0.84	0.86	0.73	0.75	0.75	0.77	0.93	0.95	0.83	0.87
Rock + Myco + humic	0.664	0.666	0.85	0.87	0.74	0.76	0.76	0.79	0.94	0.95	0.85	0.88

Table (37): Effect of different phosphorus treatments, humic and magnetic iron applications on total soluble phosphorus of sorghum cutting plant g/100 g dry weight during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	0.501	0.528	0.604	0.621	0.51	0.527	0.51	0.537	0.68	0.706	0.595	0.612
Super + humic	0.525	0.535	0.612	0.638	0.519	0.536	0.527	0.545	0.697	0.714	0.606	0.621
Monophos	0.537	0.545	0.646	0.663	0.544	0.57	0.553	0.560	0.723	0.74	0.629	0.646
Monophos + humic	0.542	0.547	0.655	0.672	0.561	0.578	0.557	0.562	0.731	0.748	0.638	0.655
Rock + Phose	0.552	0.558	0.68	0.697	0.587	0.604	0.579	0.612	0.757	0.774	0.663	0.689
Rock + Phose + humic	0.553	0.560	0.689	0.706	0.595	0.612	0.604	0.621	0.767	0.782	0.672	0.697
Rock + Myco	0.564	0.567	0.714	0.731	0.621	0.638	0.638	0.655	0.791	0.808	0.706	0.74
Rock + Myco + humic	0.564	0.566	0.723	0.74	0.629	0.646	0.646	0.672	0.799	0.808	0.723	0.748

Table (38): Effect of different phosphorus treatments, humic and magnetic iron applications on total soluble organic phsphorus of sorghum cutting plant g/100 g dry weight during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phosphate (control)	0.088	0.093	0.107	0.110	0.090	0.093	0.09	0.095	0.12	0.125	0.105	0.108
Super + humic	0.093	0.094	0.108	0.113	0.092	0.095	0.093	0.096	0.123	0.126	0.107	0.110
Monophos	0.095	0.096	0.114	0.117	0.096	0.101	0.098	0.099	0.128	0.131	0.111	0.114
Monophos + humic	0.096	0.096	0.116	0.119	0.099	0.102	0.098	0.099	0.129	0.132	0.113	0.116
Rock + Phose	0.097	0.099	0.120	0.123	0.104	0.107	0.102	0.108	0.134	0.137	0.117	0.122
Rock + Phose + humic	0.098	0.099	0.122	0.125	0.105	0.108	0.107	0.110	0.135	0.138	0.119	0.123
Rock + Myco	0.099	0.10	0.126	0.129	0.110	0.113	0.113	0.116	0.14	0.143	0.125	0.131
Rock + Myco + humic	0.10	0.10	0.128	0.131	0.111	0.114	0.114	0.119	0.141	0.143	0.128	0.132

Table (39): Effect of different phosphorus treatments, humic and magnetic iron applications on inorganic phosphrus of sorghum cutting plant g/100 g dry weight during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	0.406	0.428	0.490	0.504	0.414	0.428	0.414	0.436	0.552	0.573	0.483	0.497
Super + humic	0.426	0.434	0.497	0.518	0.421	0.435	0.428	0.442	0.566	0.58	0.492	0.504
Monophos	0.436	0.442	0.524	0.538	0.442	0.462	0.449	0.455	0.587	0.60	0.511	0.524
Monophos + humic	0.44	0.444	0.531	0.545	0.455	0.469	0.452	0.456	0.593	0.607	0.518	0.531
Rock + Phose	0.448	0.453	0.552	0.566	0.476	0.490	0.470	0.497	0.614	0.628	0.538	0.559
Rock + Phose + humic	0.449	0.455	0.559	0.573	0.483	0.497	0.490	0.504	0.621	0.635	0.545	0.566
Rock + Myco	0.457	0.46	0.580	0.593	0.504	0.518	0.518	0.531	0.642	0.656	0.573	0.60
Rock + Myco + humic	0.458	0.460	0.587	0.60	0.511	0.524	0.524	0.545	0.649	0.656	0.587	0.607

Table (40): Effect of different phosphorus treatments, humic and magnetic iron applications on insoluble phosphorus of sorghum cutting plant g/100 g dry weight during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	0.082	0.87	0.099	0.102	0.084	0.087	0.084	0.088	0.112	0.116	0.098	0.101
Super + humic	0.087	0.088	0.101	0.105	0.085	0.088	0.087	0.090	0.115	0.118	0.1	0.102
Monophos	0.088	0.09	0.106	0.109	0.09	0.094	0.091	0.092	0.119	0.122	0.104	0.106
Monophos + humic	0.089	0.09	0.108	0.111	0.092	0.095	0.092	0.093	0.12	0.123	0.105	0.108
Rock + Phose	0.091	0.092	0.112	0.115	0.097	0.099	0.095	0.101	0.125	0.127	0.109	0.113
Rock + Phose + humic	0.091	0.92	0.113	0.116	0.098	0.101	0.099	0.102	0.126	0.129	0.111	0.115
Rock + Myco	0.093	0.093	0.118	0.120	0.102	0.105	0.105	0.108	0.13	0.133	0.116	0.122
Rock + Myco + humic	0.093	0.093	0.119	0.122	0.104	0.106	0.106	0.111	0.132	0.133	0.119	0.123

Table (41): Effect of different phosphorus treatments, humic and magnetic iron applications on nitrogen content of sorghum cutting plant g/100 g dry weight during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	1.82	1.86	1.424	1.472	1.52	1.53	1.85	1.93	1.728	1.776	1.11	1.15
Super + humic	1.85	1.88	1.456	1.488	1.53	1.55	1.92	1.94	1.741	1.972	1.13	1.17
Monophos	1.91	1.94	1.536	1.616	1.54	1.55	1.97	1.99	1.936	1.984	1.19	1.37
Monophos + humic	1.94	1.96	1.568	1.632	1.56	1.57	1.98	2.1	1.968	2.00	1.33	1.44
Rock + Phose	1.92	1.98	1.664	1.728	1.58	1.59	2.2	2.55	2.016	2.064	1.46	1.55
Rock + Phose + humic	1.97	1.99	1.696	1.744	1.59	1.82	2.40	2.65	2.048	2.112	1.48	1.75
Rock + Myco	1.99	2.00	1.776	1.856	1.59	1.62	2.73	2.77	2.128	2.192	1.85	1.93
Rock + Myco + humic	2.00	2.10	1.792	1.904	1.60	1.92	2.75	2.78	2.208	2.75	1.93	1.99

Table (42): Effect of different phosphorus treatments, humic and magnetic iron applications on crude protein content of sorghum cutting plant g/100 g dry weight during 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	11.375	11.63	8.9	9.2	9.5	9.56	11.56	12.06	10.8	11.1	6.94	7.19
Super + humic	11.56	11.75	9.1	6.3	9.56	4.69	12.0	12.13	10.9	11.2	7.06	7.31
Monophos	11.94	12.13	9.6	10.1	9.63	9.69	12.31	12.44	12.1	12.4	7.44	8.56
Monophos + humic	12.13	12.25	9.8	10.2	9.75	9.81	12.38	13.13	12.3	12.5	8.31	9.00
Rock + Phose	12.0	12.38	10.4	10.8	9.88	9.94	13.75	15.94	12.6	12.9	9.13	9.69
Rock + Phose + humic	12.31	12.44	10.6	10.9	9.94	11.38	15.0	16.56	12.8	13.2	9.25	10.94
Rock + Myco	12.45	12.5	11.1	11.6	9.94	10.13	17.06	17.32	13.3	13.7	11.56	12.06
Rock + Myco + humic	12.5	13.13	11.2	11.9	10.0	12.00	17.19	17.38	13.5	13.8	12.06	12.44

Table (43): Effect of different phosphorus treatments, humic and magnetic iron applications on potassium content of sorghum cutting plant potassium ppm during 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	630.2	630.5	855.27	855.47	642.8	643.11	655.41	655.72	880.93	881.14	668.52	668.83
Super + humic	630.4	630.67	855.37	855.57	643.01	643.28	655.6	655.89	881.03	881.24	668.73	669.01
Monophos	630.82	631.12	855.67	856.188	643.43	643.74	656.05	656.36	881.35	881.87	669.2	669.49
Monophos + humic	630.97	631.27	855.88	856.29	643.59	643.89	656.2	656.52	881.56	881.98	669.33	669.65
Rock + Phose	631.42	631.72	856.39	856.59	644.04	644.35	656.76	656.99	882.08	882.29	669.81	670.13
Rock + Phose + humic	631.57	631.87	856.49	856.69	644.198	644.50	656.8	657.14	882.19	882.4	669.97	670.28
Rock + Myco	632.02	632.32	856.8	857.1	644.66	644.96	657.3	657.6	882.5	882.82	670.44	670.76
Rock + Myco + humic	632.17	632.47	856.9	857.31	644.81	645.12	657.45	657.77	882.61	883.03	670.6	679.0

Table (44): Effect of different phosphorus treatments, humic and magnetic iron applications on magnesium content of sorghum cutting plant magnesium ppm during 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	33.7	33.82	44.37	44.57	34.37	34.5	35.05	35.17	45.7	45.91	35.75	35.88
Super + humic	33.81	33.84	44.47	44.68	34.47	34.52	35.15	35.19	45.81	46.02	35.86	35.90
Monophos	33.9	33.99	44.78	45.19	34.58	34.67	35.25	35.35	46.12	46.54	35.96	36.50`
Monophos + humic	33.94	34.03	44.98	45.29	34.62	34.71	35.3	35.39	46.33	46.65	36.01	36.10
Rock + Phose	34.08	34.16	45.49	45.78	34.76	34.85	35.44	35.53	46.86	47.15	36.15	36.24
Rock + Phose + humic	34.12	34.21	45.63	45.83	34.80	34.89	35.48	35.58	47.0	47.20	36.19	36.29
Rock + Myco	34.25	34.34	45.84	45.89	34.94	35.03	35.62	35.71	47.22	47.27	36.34	36.43
Rock + Myco + humic	34.30	34.38	45.87	45.91	34.98	35.07	35.67	35.76	47.25	47.29	36.38	36.48

Table (45): Effect of different phosphorus treatments, humic and magnetic iron applications on calcium content of sorghum cutting plant calcium ppm during 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	155.2	155.6	181.05	181.35	158.3	158.71	161.41	161.82	186.48	186.8	164.64	165.1
Super + humic	155.3	155.77	181.25	181.458	158.4	158.88	161.51	162.0	186.7	186.9	164.74	165.24
Monophos	155.97	156.37	181.56	181.86	159.08	159.49	162.21	162.62	187.01	187.32	165.45	165.87
Monophos + humic	156.17	156.57	181.76	181.968	159.29	159.69	162.41	162.83	187.22	187.43	165.66	166.09
Rock + Phose	156.77	157.17	182.07	182.27	159.9	160.31	163.04	163.45	187.53	187.74	166.3	166.72
Rock + Phose + humic	156.97	157.37	182.17	182.47	160.1	160.51	163.25	163.66	187.64	187.95	166.51	166.94
Rock + Myco	157.57	157.97	182.68	182.98	160.718	161.126	163.87	164.29	188.16	188.48	167.15	167.57
Rock + Myco + humic	157.77	158.17	182.78	183.192	160.922	161.33	164.08	164.49	188.27	188.69	167.36	167.78

Table (46): Effect of different phosphorus treatments, humic and magnetic iron applications on sulpher content of sorghum cutting plant sulfer ppm during 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	80.2	82.6	82.4	87.5	50.5	57.6	89.2	93.3	88.2	92.5	59.4	64.2
Super + humic	81.4	84.6	85.5	91.4	55.2	58.2	91.4	95.4	89.3	96.6	62.4	66.6
Monophos	101.3	109.6	93.3	97.7	60.4	67.6	105.3	115.2	99.3	106.6	70.3	77.3
Monophos + humic	103.5	120.5	95.2	100.3	65.3	69.2	109.5	130.3	102.2	109.4	74.2	79.4
Phose + rock	125.4	135.4	102.3	109.4	72.2	76.4	135.4	143.4	110.3	125.5	80.2	82.5
Phose + rock + humic	130.5	140.5	106.3	110.3	74.4	79.5	139.6	149.3	120.3	129.3	81.5	83.3
Myco +Rock	145.3	155.4	114.4	118.5	84.4	90.3	159.2	167.5	130.4	140.4	95.2	100.5
Myco + Rock + humic	150.4	160.5	116.4	120.3	86.4	95.4	160.4	180.2	135.4	144.2	99.4	109

Table (47): Effect of different phosphorus treatments, humic and magnetic iron applications on iron content of sorghum cutting plant ppm during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	64.2	64.5	75.99	76.194	65.48	65.79	66.77	67.08	78.27	78.48	68.1	68.42
Super + humic	64.3	64.63	76.092	76.398	65.58	65.92	66.87	67.22	78.38	78.69	68.24	68.65
Monophos	64.78	65.23	76.6	77.01	66.079	66.385	67.37	67.69	78.90	79.32	68.72	69.04
Monophos + humic	64.93	65.23	76.8	77.214	66.232	66.538	67.53	67.84	79.11	79.53	68.88	69.2
Rock + Phose	65.38	65.68	77.72	78.03	66.69	66.997	68.0	68.31	80.6	30.37	69.36	69.68
Rock + Phose + humic	65.53	65.83	77.928	78.132	66.844	67.15	68.15	68.47	80.27	80.48	69.52	69.84
Rock + Myco	65.98	66.28	78.234	78.64	67.303	67.609	68.26	68.93	80.59	81.0	69.99	70.31
Rock + Myco + humic	66.13	66.43	78.438	78.74	67.456	67.762	68.78	69.09	80.79	81.12	70.15	70.47

Table (48): Effect of different phosphorus treatments, humic and magnetic iron applications on zinc content of sorghum cutting plant ppm during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	6.1	6.3	7.65	7.85	6.22	6.43	6.34	6.55	7.88	8.09	6.47	6.68
Super + humic	6.2	6.4	7.75	7.96	6.324	6.53	6.45	6.66	7.99	8.20	6.58	7.79
Monophos	6.5	6.7	8.06	8.36	6.63	6.83	6.67	6.97	8.30	8.62	6.90	7.11
Monophos + humic	6.6	6.8	8.26	8.47	6.73	6.94	6.86	7.07	8.51	8.72	7.0	7.21
Rock + Phose	6.9	7.1	8.57	8.77	7.038	7.24	7.18	7.83	8.83	9.04	7.32	7.53
Rock + Phose + humic	7.0	7.2	8.67	8.87	7.14	7.34	7.28	7.49	8.93	9.14	7.43	7.64
Rock + Myco	7.3	7.5	9.06	9.109	7.45	7.65	7.59	7.8	9.33	9.38	7.74	7.96
Rock + Myco + humic	7.4	7.6	9.098	9.129	7.55	7.75	7.70	7.90	9.37	9.40	7.85	8.06

Table (49): Effect of different phosphorus treatments, humic and magnetic iron applications on manganise content of sorghum cutting plant ppm during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	3.2	3.5	4.62	4.71	3.26	3.57	3.33	3.64	4.76	4.85	3.4	3.71
Super + humic	3.3	3.67	4.70	4.72	3.47	3.74	3.54	3.81	4.84	4.9	3.61	3.89
Monophos	3.82	4.12	4.77	4.83	3.89	4.20	3.97	4.28	4.91	4.98	4.05	4.37
Monophos + humic	3.97	4.27	4.8	4.86	4.05	4.35	4.13	4.44	4.94	5.01	4.21	4.53
Rock + Phose	4.42	4.72	4.89	4.96	4.51	4.81	4.59	4.91	5.04	5.11	4.69	5.0
Rock + Phose + humic	4.57	4.87	4.93	4.99	4.67	4.96	4.75	5.06	5.07	5.14	4.84	5.16
Rock + Myco	5.02	5.32	5.02	5.09	5.12	5.42	5.22	5.53	5.17	5.24	5.32	5.64
Rock + Myco + humic	5.17	5.47	5.05	5.12	5.27	5.58	5.37	5.69	5.21	5.27	5.48	5.8

Table (51): Effect of different phosphorus treatments, humic and magnetic iron applications on copper content of sorghum cutting plant ppm during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	2.0	2.4	2.41	2.85	2.24	2.42	2.76	3.31	3.13	3.55	1.84	2.21
Super + humic	2.3	2.5	2.7	2.9	2.26	2.4	3.17	3.45	3.44	3.66	2.12	2.30
Monophos	2.6	3.0	3.1	3.5	2.63	2.92	3.59	4.14	3.76	4.19	2.39	2.76
Monophos + humic	2.8	3.1	3.4	3.6	2.87	3.01	3.86	4.28	3.98	4.89	2.58	2.85
Rock + Phose	3.3	3.5	3.4	4.1	3.32	3.61	4.55	4.83	4.58	4.92	3.04	3.22
Rock + Phose + humic	3.4	3.6	4.1	4.2	3.52	3.62	4.69	4.97	4.89	5.00	3.13	3.31
Rock + Myco	3.7	3.8	4.3	4.5	3.52	3.7	5.11	5.24	5.93	5.98	3.41	3.50
Rock + Myco + humic	3.75	3.86	4.4	4.6	3.66	3.88	5.18	5.33	5.98	5.99	3.45	3.55

Table (50): Effect of different phosphorus treatments, humic and magnetic iron applications on Boron content of sorghum cutting plant ppm during 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	1.9	2.28	2.2	2.7	1.9	2.31	2.62	3.15	2.28	2.74	1.75	2.1
Super + humic	2.19	2.38	2.6	2.9	2.21	2.41	3.02	3.28	2.62	2.85	2.01	2.19
Monophos	2.47	2.85	2.9	3.3	2.51	2.9	3.41	3.93	2.96	3.42	2.27	2.62
Monophos + humic	2.66	2.95	3.2	3.5	2.71	2.9	3.67	4.06	3.19	3.53	2.45	2.71
Rock + Phose	3.14	3.33	3.7	3.9	3.21	3.4	4.34	4.59	3.76	3.99	2.89	3.06
Rock + Phose + humic	3.23	3.42	3.8	3.99	3.34	3.51	4.46	4.72	3.88	4.10	2.97	3.15
Rock + Myco	3.52	3.61	4.2	4.2	3.51	3.71	4.85	4.98	4.22	4.33	3.24	3.32
Rock + Myco + humic	3.56	3.67	4.2	4.55	3.67	3.77	4.92	5.06	4.28	4.40	3.28	3.38

Table (52):Effect of different phosphorus treatments, humic and magnetic iron applications on sodium content of sorghum cutting plant mg/100 g during the 2004/2005 seasons

Treatments	1st season						2nd season					
	Cutting dates						Cutting dates					
	1st 60 days		2nd 90 days		3rd 120 days		1st 60 days		2nd 90 days		3rd 120 days	
	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magneti c Iron	Without magnetic Iron	With magnetic Iron	Without magnetic Iron	With magnetic Iron
Super phos-phate (control)	120.5	76.28	133.5	71.9	100.3	59.99	135.9	60.26	120.67	66.44	100.33	60.66
Super + humic	90.68	60.12	100.4	63.7	80.4	44.66	162.0	50.63	98.34	49.33	80.4	49.3
Monophos	110.07	70.74	125.9	66.5	98.4	58.88	130.52	60.13	120.52	65.4	99.4	59.5
Monophos + humic	82.98	60.25	100.5	50.3	80.3	40.99	91.73	49.55	90.22	48.34	80.9	48.83
Rock + Phose	110.42	70.43	124.3	65.9	95.6	57.44	118.89	60.86	110.92	60.3	92.55	58.6
Rock + Phose + humic	80.17	50.14	99.5	50.3	75.5	40.88	89.02	48.31	86.44	46.5	70.6	40.44
Rock + Myco	102.24	60.45	120.2	63.8	90.7	44.5	110.32	50.7	100.93	50.97	90.66	57.5
Rock + Myco + humic	70.69	50.48	92.3	44.5	70.99	39.85	86.8	48.98	80.94	46.5	70.6	40.45

II. REVIEW OF LITERATURE

The available review concerning the effect of phosphorus treatments on physiological response of sorghum plant under calcareous soil, could be classified as follows :

I. Growth characters and yield:

I.1. Effect of phosphorus treatments:

Calcareous sand, which are widely used in construction of putting green, can increase the problems with nutrient deficiencies, particularly phosphorus (P), **Kruse *et al*. (2005)** indicated that P deficiencies of creeping bent grass can be detected through the use of remote sensing. P deficiencies were corrected with a single foliar application of P at the rate above 1.5 g/m^2.

I.1.1. Super phosphate:

Patil *et al*. (1984) studied the response of sorghum to various combinations of water and citrate soluble forms of phosphorus in black soil and calcareous soil. They found that application of P to sorghum grown on two types of soil increased grain yield and nutrient uptake; yields on non-calcareous soil were higher than on calcareous soil. Sorghum showed most response to water soluble P and least to citrate soluble P. Reduction in yield with citrate soluble P (dicalcium phosphate) can be arrested by combining it with at least 40 and 20% water soluble P (single superphosphate) for calcareous and non-calcareous soils, respectively.

Tomar *et al*. (1984), found that after incubation with fresh cattle dung for 15 weeks, a mixture of Mussoorie rock phosphate (MRP) and triple superphosphate (TSP) in the ratio of 80:20 was as effective as incubated TSP and more effective than unincubated TSP for wheat yields and P uptake on a calcareous soil. An unincubated mixture of MRP and TSP at 20:80 was similar in effectiveness to unincubated TSP.

Menon *et al*. (1991) compared the Olsen and Pi tests for their effectiveness in evaluating P availability to maize on calcareous soils. Phosphate rock, partially acidulated with H_2SO_4 at 50% acidulation level (PAPR 50% H_2SO_4) and single super phosphate (SSP) were applied at different rates to calcareous clay soil. In soil treated with SSP, dry matter yield of maize correlated equally well with Pi-P and with Olsen-P.P uptake correlated significantly with Pi-P as well as Olsen-P. Similarly in soils fertilized with PAPR, significant correlations were found between dry matter yield and Pi-P and between dry matter yield and Olsen-P. When all the data were pooled, Pi-P and Olsen-P correlated equally well with both dry matter weight and P uptake. Phosphorus extracted by the Pi test correlated significantly with P extracted by the Olsen test.

Jakobsen (1993) found that high activity ratio between P and Ca induced Ca deficiency resulting in restricted maize root functioning indicated by periodic decreases of nutrient uptake rates and plant growth rate. P deficiency also restricted root growth. Superphosphate application gave the highest DM yield and utilization of P, Mg and Ca.

Kayombo (2003) studied the effect of tillage and fertilizers on the yield of sorghum. The treatment (1) zero tillage, (2) flat cultivation (3) plus mulch tied riding strip catchment tillage and tractor tillage plus mulch. Fertilizer treatments consisted of no fertilizers (control), farmyard manure (FYM) at 10 t/ha, triple superphosphate (TSP) at 100 kg/ha and FYM plus TSP at 5 t/ha. Crop performance expressed as grain yield of sorghum, was better under deep tractor tillage.

Khalid *et al.* (2003) studied the effect of nitrogen and phosphorus on the fodder yield and quality of two sorghum cultivars (Hegari and JS 263) were grown with different doses of nitrogen and phosphorus fertilizers in the form of urea and single superphosphate. There was a gradual increase in plant height, stem diameter, number of leaves per plant, leaf area per plant and fodder yield with the increase in nitrogen and phosphorus. The variety Hegari is better as compared to JS 263 grown for fodder purpose.

Silva *et al*. (2004) used two types of phosphate fertilizer: FOSMAG 300 mg and triple superphosphate (TSP; 0, 50, 100, 200, 300 and 500 mg) for potted sorghum plants grown in red-yellow or red latosols under green-house conditions. Differences were observed in dry matter production of sorghum grown in red latosol and supplied with TSP and FOSMAG. Sorghum response was influenced by soil characteristics (availability of nutrients such as Mg and S), nutrient interaction (P X Ca and P X Zn) and type of phosphate fertilizer (FOSMAG or TSP).

Ghodpage and Datke (2005) studied the effects of inorganic and organic fertilizers on the performance of sorghum. The treatments consisted of 80:40:40 kg N (urea), P (superphosphate) and K (muriate of potash)/ha + PSB (phosphate solubilizing bacteria) 25 g/kg seed. The highest grain and fodder yields were obtained with 60:30:30 NPK + 5t farmyard manure (FYM)/ha + seed inoculation (PSB).

Parasuraman (2005) determined the efficacy of sources single superphosphate (SSP) diammonium phosphate (DAP) and rock phosphate (RP) and levels (20 and 40 kg/ha) of P on the growth, grain yield, nutrient (N, P and K) uptake and residual soil fertility of sorghum under rain fed conditions on red soil in India. He found that total dry matter production, plant height, leaf area index and 100 grain weight were favourably affected by the sources and levels of P. Diammonium phosphate (DAP) at both levels proved effective and the 40 kg P/ha as DAP recorded significantly the highest grain yield, SSP rated the next, followed by RP. The nutrient uptake and soil available nutrient status were favourably influenced by DAP application at 20 and 40 Kg/ha.

Wafaa *et al*. (2006) showed that the mineral fertilizers treatment (ammonium sulfate 20% N, superphosphate 15% P and potassium sulphate 48%K at rates of 100, 30 and 48 kg/fed N, P and K respectively) positively affected the dry matter of both shoots and roots of wheat along with contents of nitrogen and potassium in both shoots, roots and shoot-root ratio.

I.1.2. Monoammonium phosphate :

Jakobsen (1993) found that high activity ratio between P and Ca induced Ca deficiency resulting in restricted root functioning indicated by periodic decreases of nutrient uptake rates and plant growth rate. P deficiency also restricted root growth. The application of ammonium phosphate was the most effective to increase soil P and P uptake by maize.

Wang *et al*. (1999) commenced a study in 1994 using maize on the effect of sowing only 1-2 days before wheat harvest in rows 0.5 m apart. Watering was done 2-3 days after sowing. They indicated that a compound fertilizer containing 300 kg/ha ammonium phosphate, 150 kg/ha potassium sulphate, 15 kg/ha zinc sulphate and 75 kg/ha urea was added at the 5-leaf stage. With this method mean yield was 9300 kg/ha, 15.78% higher than the traditional method. Since, 1993 the organic matter content of the soil increased from 12.3 g/kg to 16.5 g/kg and available N,P and K also increased.

El-Dewiny *et al*. (2005) studied the impact of different phosphatic fertilizers sources and rates on availability of N,P and K nutrients and some heavy metals in soil and their uptake by sorghum plants. Data revealed that phosphatic fertilizers positively affected the dry matter of sorghum plant grown on clay loam soil and the response was dependent on P-fertilizer sources and rates. The results indicated that the highest values for dry matter content were obtained when Diammonium phosphate (DAP) was applied at either lower or higher rates of application. Meanwhile the lowest values of plant growth were found with single superphosphate (SSP) fertilizers and increase with plant age.

I.1.3. Rock phosphate :

Abdel-Latif and Abdel-Fattah (1983) compared the effect of different organic residues and inorganic phosphatic fertilizers on growth of barley in calcareous soil. Application of orange residues + superphosphate or rock phosphate increased DM yield to 6.37 and 5.92 g respectively, compared with 4.42 g for control treatments. Sugarcane or clover residues applied alone or with phosphate decreased barley DM yield.

Rabindra *et al*. (1986) evaluated rock phosphate as an alternative source of P in a P-deficient calcareous vertisol. They found that application of rock phosphate/pyrite mixture (1:3) gave paddy and straw yield of rice comparable to those with single superphosphate.

Xiong *et al*. (1994) suggested that, although partial acidulation could substantially improved the effectiveness of rock phosphate and the immediate effect of the fertilizer was competitive with monocalcium phosphate (MCP), application of partially acidulated rock phosphates (PARP) to calcareous soils is only of short term benefit, in the long run this fertilizer is not a desirable source of P in calcareous soils since the unacidulated part in the fertilizer was not solubilized in the alkaline conditions.

Casanova (2003) worked in Venezuela on sorghum, maize, rice and many crops. His investigation focused on finding a process for the production of low-cost phosphate fertilizers from partial acidulation of indigenous phosphate rock (PAPR). He found that agronomic effectiveness of partial acidulation of indigenous phosphate rock (PAPRs) (20-30%) concentrations and acidulation grades of 40% and above was assessed on various crops. They yielded excellent results in comparison with traditional fertilizers. Increase in yields of 29-100% over the national average yields in sorghum and maize.

I.2. Effect of biofertilizer (mycorrhyza and pohosphate bacteria solubilizing bacteria treatments):

Shinde and Patil (1985) indicated that inoculation of wheat seed with *Pseudomonas striata* or *Bacillus polymyxa* culture resulted in grain yields similar to those obtained with 5o kg P_2O_5/ha as superphosphate, also application of rock phosphate and seed inoculation with *B. polymyxa* gave a higher yield than rock phosphate alone.

Salih *et al*. (1989) studied the effect of different phosphate dissolving fungi on the availability of P in calcareous soil treated with rock phosphate or superphosphate and its subsequent uptake by sorghum. They found that dry matter and P uptake responses to inoculation with fungi were better in the soil treated with rock phosphate (RP) than in soil treated with triple superphosphate (TSP). Positive and significant correlation coefficients among available P, P uptake and dry matter production at different periods of the growing season were observed following inoculation. However, none of these variables were found to be significantly correlated with the fungal population.

El-Demerdash *et al*. (1992) showed that lentils cv. G9 or G370 were grown in a pot experiment in Autoclaved clay loam or calcareous soil without inoculation, or inoculated with each of 4 strains of *R. leguminosarum* and/or vesicular-arbuscular mycorrhizal fungi (VAM). The soil was unamended or amended with 0.4 g rock phosphate or 0.7 g superphosphate/kg soil. Plant growth, percentage VAM infection and nodulation were greater in G370 than in G9 and greater in clay loam than calcareous soil. Plant DW was highest in G370 grown on clay loam soil with rock phosphate and soil inoculated with VAM+ *R. leguminosarum* strain ARC-202 L (local).

Hashem (1996) performed field trial at the Ras-Sudr Station, wheat cv. Sakha 8 was given different combinations of sulfur, municipal refuse, and seed inoculation with a mixture of N-fixing and phosphate- solubilizing bacteria. All treatments increased grain yield compared with the control. A combination of municipal refuse and bacterial inoculation gave the highest yield of 2.53 t/feddan. Soil EC and ESP were generally decreased by treatments.

El-Sersawy *et al*. (1997) studied the interaction between organic manure mixtures, N fertilizer and biofertilizers on calcareous soil properties and wheat production in Wadi Sudr, South Sinai. A study showed the role of organic manure mixtures supported by N fertilizers and biofertilizers in improving new desert soil properties, also these treatments show corresponding improvements in NPK uptake which were reflected on high grain and straw yields.

Neweigy *et al*. (1997) found that the treatment with mycorrhizal inoculation also gave higher values of plant height, leaf area per plant, fresh and dry weights of root and shoot system/plant than parallel treatments which included phosphate solubilizing bacteria.

Abd El-Ghany (1999) performed a field experiment at Maryut, Alexandria Governorate to study the effect of using some biofertilizers on maize crop production either alone or combined with organic manures. The best results were generally given by combinations of manure with biofertilizers. The best improvement for both soil and plant factors were mainly with (composted garbage + sheep manure) + (*Pseudomonas fluorescens*). The lowest improvement for both soil and plant parameters was generally recorded with natural yeast + sheep manure. Relationships between soil microbiology and crop production were detected.

El-Ghany *et al*. (1999) evaluated the effect of biofertilization as *Rhizobium leguminosarum*), sheep dung, two levels of P-fertilization (15 and 30 kg/fed) on the yield of fenugreek in saline calcareous soil (52% $CaCO_3$) irrigated with saline groundwater (6400 ppm). The results indicated that the fenugreek yield were increased by 237% over the control.

Hashem (1999) found that the calcareous soil treated with non-symbiotic nitrogen fixing bacteria (Nb) or phosphate dissolving bacteria (Pb) individually or combined with soil conditioners led to significant increase in berseem dry matter and the uptake of N,P and K by plants.

Patidar and Mali (2001) indicated that in experiment conducted in India to determine the most appropriate combination of organic manure, fertilizers and biofertilizers for sorghum and assess their residual effect on succeeding wheat. The application of 10 tones farmyard manure/ha increased grain and fodder yields of sorghum by 18.52 and 9.42% respectively, compared with the control. Significant improvement in grain and fodder yields of sorghum was observed up to 75% recommended rate of fertilizer. The inoculation of *Azospirillum* alone and in combination with phosphate-solubilizing bacteria (*Bacillus megaterium*) significantly increased grain and fodder yields of sorghum. Grain and straw yields of wheat increased by 8.8 and 6.6%, owing to the residual effect of farmyard manure.

Subbiah and Thenmozhi (2001) showed that application of 35 Kg P_2O_2 /ha as mussooriephos in association with dual inoculatio of vesicular arbuscular mycorrhizal (VAM) fungi at 100 g/m^2 as soil application and phosphobacterin at 2 kg/ha as seed treatment and soil application in calcareous soil had beneficial effect not only on enhancing the fruit yield and P use efficiency but also on improving the quality of fruit in bhendi plant besides saving the cost of 15 kg P_2O_5.

Ghodpage and Datke (2005) studied the effect of inorganic and organic fertilizers on the sorghum. The treatments consisted of 80:40:40 kg N (urea), P (super phosphate) and K (muriate of potash)/ha + PSB (phosphate solubilizing bacteria 25 g/kg seed. The highest grain and fodder yields were obtined with 60:30:30 NPK - 51 farmyard manure (FYM)/ha + seed inoculation (PSB).

I.3. Effect of humic acid treatments:

Ahmad and Tan (1991) found that maize seedlings were grown for 30 days in pots containing 1 kg of a Cecil sandy clay loam mixed with 0, 25, 50 or 100 mg P, 0 or 50 mg Al and 0 or 100 mg humic acid/pot. Shoot and root dry weight (DW) increased with P and humic acid application.

Xue *et al*. (1994) applied a new humic acid (HA) compound fertilizer to maize, wheat, cotton, rape and sesame. Humic acid (HA) fertilizer performed better than the equivalent diammonium phosphate and chemical fertilizers. It increased resistance to drought, cold and diseases prevented early senescence, increased yield.

Aydn *et al*. (1999) studied the effects of K-Humate (0, 1.5, 3.0 or 4.5 kg/ha) applied to the soil or foliage on the dry matter content in maize and sunflowers. They found that increasing K-Humate application rates generally increased dry matter of both plants.

Santhy *et al*. (2001) studied the status and content of humic and fulvic acid fractions of soil organic matter and their effect on crop yield, availability and uptake of nutrients by crops in the long term fertilizer experiment in India. They found that humic acid content was higher than fulvic acid and the content of both increased with depth, they contributed significantly in predicting the yield. N, P and K uptake by all the three crops (finger millet, maize and cowpea) of the sequence.

Sharif *et al*. (2002) sprayed humic acid (HA) on soil at the rate of 0, 50, 100, 150, 200, 250 and 300 mg/kg soil along with uniform rate of NPK 120, 90, 60 kg/ha. They found that the addition of HA increased soil N concentration and plant N accumulation significantly over control with no significant differences within the treatments of different levels of HA applied. Soil P concentration improved significantly by the addition of 200 mg/kg HA whereas plant P accumulation was not significantly affected by the application of different levels of HA. Micronutrients (Zn, Fe, Mn and Cu) concentrations of soil and their accumulations by maize plants increased nonsignificantly over control by the application of HA.

Sharif *et al*. (2003) studied the residual effect of humic acid and chemical fertilizers on maize yield. The residual effect of humic acid caused significant increase in grain, total dry matter and stalk yield of maize.

Sharif *et al*. (2004) compared the efficiency of organic and inorganic fertilizers applied alone or in combination, on the yield and yield components of maize. They found that the highest grain yield, total dry matter yield and 1000 grain weight was obtained by the addition of humic acid (HA) in combination with farmyard manure (FYM) and NPK. HA applied in combination with 120-90-60 kg NPK/ha may be considered as an optimum rate to achieve the optimum grain yield, dry matter yield and 1000 grain weight. They suggested that the addition of HA have great potential to improve maize yield and physicochemical and biological properties of the soil.

Chen *et al*. (2007) indicated that humic acid added in urea can evidently increase grain yield and N utilizing rate of maize. According to the yield and N utilizing rate of maize, 10% humic acid added in urea is better than other treatments in comprehensive effects.

Schmidt and Gleixner (2005) indicated that soils and sediments contain only small amounts of organic matter, and large concentrations of paramagnetic metals can give poor solid-state nuclear magnetic resonance (NMR) spectra of organic matter. Pretreatment of samples with hydrofluoric acid (HF) dissolves significant proportions of the mineral matrix and extracts paramagnetic elements. They concluded that hydrofluoric acid (Hf) treatment released fresh, soluble, probably microbial, biomass in addition to carbohydrates. Net changes of the bulk chemical composition of organic matter were small for most soils, size fractions and plant material, but not for samples containing little organic matter, or those rich in easily soluble organic matter associated with iron oxides such as Podzol B horizons.

Wafaa *et al*. (2006) indicated that applied farmyard manure (FYM) at the rate of 2% with high rate (0.07%) of each of the used natural minerals (magnetic iron oxide, basic slag and manganese dust) and FYM at the rate of 3% in combination with moderate rate (0.05%) of such minerals recorded high values of both shoots and roots dry matter of wheat as well as their content of N,P and K.

II. Chemical constituents

II.1. Effect of phosphorus treatments

II.1.1. Super phosphate

Lytton and McCaslin (1983) found that there was a significant P% sewage interaction in the 1st harvest of greenhouse grown sorghum for P uptake. All other possible interactions were not statistically significant. P uptake from the sludge treatments which supplied 472-944 kg P /ha was similar to that from applications of 1.299 and 2.598 t P/ha as triple super phosphate.

Patidar and Mali (2001) found that the application of 10 tones farmyard manure/ha increased nutrient uptake (N, P and K) 15.4, 14.2 and 16.0% respectively by sorghum. Successive increase in fertility levels, either 75% or 100% of the recommended fertilizer rate, significantly enhanced the N (157.0 kg/ha), P (47 kg/ha) and K (247 kg/ha) uptake by sorghum.

Khalid *et al*. (2003) found that when the nitrogen and phosphorus fertilizers were added in the form of urea and single superphosphate, increased a progressive increase in crude protein, crude fiber, ash content and stem thickness of sorghum was observed.

Noufal (2006) found that in field experiments, in sorghum plant P-fertilizer application increased the concentrations of Ca, Mg, Fe, Mn in vegetative plant parts and sometimes in grains.

II.1.2. Monoammonium phosphate :

Albornoz *et al*. (1993) showed that in field trials on an alkaline calcareous Pullman soil for sorghum at a density of 160,000 plants/ha following a wheat crop and given 16.33 or 67 kg P_2O_5/ha either as the acid 10-20-0-4 NPKS, urea/phosphoric acid formulation or as the neutral 32-0-0 NPK urea/ammonium nitrate formulation mixed with 10-34-0 mono ammonium phosphate applied in bands beside the seed. N was maintained at 67 kg/ha throughout the treatments. Type of fertilizer had no effect on grain yield, yield components or nutrient and trace element contents of soil, leaves or grain. Rate of applied P generally had little effect on the parameters measured since availability of P in the Pullman soil was high. Both fertilizers significantly increased grain yields and yield components, through the effect of N-Grain yield increased from 5.34 t and 1.20 t to 6.59 t and 3.60 t/ha in response to N in 1988 and 1989, respectively.

Duangpatra *et al*. (1993) reported in field trial on loamy soil in Thailand of maize plant was given different combinations and rates of N,P and K fertilizers. P was generally applied as diammonium phosphate, grain yield was 1.09 t/ha without NPK 1.49 t/ha with 75 kg/N + 37.5 kg k/ha and 1.75-2.52 t/ha with NPK. The highest yield was given by 75 kg N + 97 kg P 47 kg with N and P applied as ammonium phosphate sulfate.

El-Dewiny *et al*. (2005) studied the impact of different phosphatic fertilizers, sources and rates, on availability of N, P and K nutrients and some heavy metals in soil and their uptake by sorghum plant. They found that the analytical analysis of the soil samples after each cut showed that, increasing rates of P-fertilizers increased the availability of N,P and K nutrients and Cd and Pb in the extraction solutions. Data representing the uptake of NPK and Cd or Pb metals by sorghum as affected by different applications of sources and rates of P-fertilizers showed positive response compared to control. Values being higher for Cd and Pb in the highest rate of single superphosphate (SSP) fertilizers compared to triple superphosphate (TSP) and diammonium phosphate (DAP) fertilizers.

II.1.3. Rock phosphate

Abdel-Latif and Abdel-Fattah (1983) studied the effect of different organic residues and inorganic phosphatic fertilizers on nutrients of barley in calcareous soil. They indicated that N content was increased from 7.65 mg/g in the control to 10.31 and 10.8 mg/g with orange residues and orange residues + rock phosphate, respectively. Application of clover residues and clover residues + rock phosphate increased N content to 8.03 and 13.30 mg/g, respectively. There were no significant effects on P, Ca, Mg or Fe contents while effects on K and Zn contents were variable.

Avnimelech and Hagin (1985) tested several phosphate solubility and availability parameters for calcareous soil samples fertilized with superphosphate, partially acidulated phosphate rock and a mixture of the two. Plant response to the fertilizer application was studied in a greenhouse experiment. The ionic product of calcium carbonate phosphate [Ca_3 (HCO_3) $3PO_4$] correlated best with the plant response parameters. The correlations of the plant response parameters with the other solubility parameters ($CaPO_4$, H_2PO_4 or HPO_4 potentials) were higher than that obtained with conventionally determined available soil phosphorus.

Rabindra *et al.* (1986) evaluated rock phosphate as an alternative source of P in a P-deficient calcareous vertisol. They noticed that the application of rock phosphate/pyrite mixture (1:3) gave a better residual response than single superphosphate. Incubation study revealed that pyrite effectively solubilized P present in rock phosphate.

Dash *et al.* (1990) studied the transformation and availability of P from partially acidulated phosphate rock in an acid lateritic soil and a black calcareous soil under stimulated wheat-rice or rice-wheat soil water conditions. Under wheat-rice conditions the formation of

Al-P and Fe-P increased leading to increases in available P upon flooding. Under rice-wheat conditions however, there was a continuous decrease in Al-P, Fe-P and available P.

Liu *et al*. (1990) indicated that the pH in the rhizosphere of rice and wheat growing on soil plates was much lower in P-deficient albic soil than in P-fertilized soil (1.2 pH units difference). The zone of acidification was approximately 4 cm behind the root tips. Isolation of organic acids from the rice rhizosphere showed that 37.61% more citric acid was exuded under P stress, and this led to 52-103% greater dissolution of rock phosphate. In wheat rhizosphere of calcareous soil, more extractable Fe (DTPA-Fe and Tamm's Fe) was found than in non-rhizosphere soil. The enhancement of Fe availability was related to the accumulation of mugineic acid in the soil within 1 mm of the root surface. Exudation of mugineic acid was higher in chlorotic plants than in green plants, and higher in an iron insensitive variety than in an iron-sensitive variety. The ability of mugineic acid to dissolve iron from pure minerals was in the order amorphous iron hydroxide > crystalline strengite > goethite.

Morel and Plenchette (1992) found that the P derived from fertilizer (Pff values) in several luvisols and a calcareous soil were 13.7% for the cumulative application of Gafsa rock phosphate applied at 100 kg P/ha for 15 years, and 81% for the 310 mg P/kg applied to mycorrhizal soybeans. There was a close linear regression between Pdff and JCF (PO_4 ions remaining in soil solution), Resuperscript 2= 0.89. This relation was very useful for the accurate, rapid and economic comparison of P fertilizers.

Singh *et al*. (1993) found that an oxalic acid: rock phosphate ratio of 1:2 was comparable with SSP with respect to P availability in soil, oxalic acid was a better solubilizer of rock phosphate than mineral acids in calcareous soils because it complexes and stabilized Ca.

Zhu *et al*. (2002) investigated the phosphorus (P) uptake efficiency of *Fagopyrum esculentum* Moench (buck wheat) and *Triticum aestivum* (spring wheat), from a Ca-bound form. The first experiment was based on a sand-culture system with either rock phosphate (RP) or $CaHPO_4$ as the P source and nitrate or ammonium nitrate as N source. A highly calcareous soil was used in the second experiment. When plants were supplied with nitrate, the total P uptake by buckwheat from RP was nearly 10- fold higher than that of spring wheat (20.1 compared with 2.1 mg P pot-1). High P uptake efficiency of buckwheat was also demonstrated using the field soil but to a lesser extent, which may be related to the difference in Zn supply between sand culture and field soil. It is suggested that buckwheat may be included in intercropping or crop rotation systems to activate P sources in calcareous soil.

Vaidya *et al*. (2003) found that the use of rock phosphate (RP) acidulated with sulfuric acid (SA) as source of these elements in short term crops (sorghum, wheat) in possible. The use of ammonium thiosulfate (ATS) for RP acidulation combined with sulfuric acid (SA) is feasible. An acidic soil low in P and Ca was used to test the efficiency of RP acidulated with SA and ATS. Fertilizer treatments were RP acidulated with SA (RA). RP acidulated with 70% SA + 30% ATS (R30T), RP acidulated with ATS (R 100T), Triple super phosphate (SP) and control with out P. The P dosis applied to the soil was 400 mg/kg. Released P in SSEP with RA and (R30T) was higher than with RP and (R10T) but P released from R30T in SE was lower than that RA. Maize P uptake was higher when RA and R30T were used, while in SE, P uptake was higher in R30T. A significant negative relationship was found between root length and P uptake in SE.

II.2. Effect of Biofertilizer (mycorrhyzal and phosphate solubilizing bacteria) treatments

Shinde and Patil (1985) used P solubilising cultures and rock phosphate on P availability to wheat in black calcareous soil. They found that inoculation of wheat seed with *Pseudomonas striata* or *Bacillus polymyxa* culture increased the availability of soil P, whereas inoculation with *Aspergillus awamori* was not effective.

Salih *et al*. (1989) tested availability of phosphorus and its subsequent uptake by sorghum in a calcareous soil treated with rock phosphate (RP) or superphosphate as affected by phosphate-dissolving fungi. They showed that *Penicillium* sp. and two *Aspergillus foetidus* isolates significantly increased the availability of P in soil treated with RP or triple superphosphate (TSP) during the growing season. *Penicillium* sp. isolate was more effective in increasing available P in the soil treated with RP or TSP than were *Aspergillus* isolates. P uptake responses to inoculation with these fungi were better in the soil treated with RP than in soil treated with TSP. In the TSP treated soil, the fungi achieved their maximum P releasing capacity two weeks earlier than in soil treated with RP.

Neweigy *et al*. (1997) found that *Azospirillum* inoculum + ammonium sulfate (50 kg N/fed) combined with *Glomus mosseae* gave the highest values of NPK and crude protein in shoot of sorghum plants. Treatments with *G. mosseae* gave higher values of chlorophyll pigments and carotenoids than parallel treatments which included phosphate solubilizing bacteria.

II.3. Effect of humic acid treatments

Ahmad and Tan (1991) found that maize seedlings were grown for 30 days in pots containing 1 kg of a Cecil sandy clay loam mixed with 0, 25, 50 or 100 mg P, O or 50 mg Al and 0 or 100 mg humic acid/pot. In the absence of Al, shoot P concentration was increased by P and unaffected by humic acid, while with 50 mg Al/pot applied P did not increase, the P concentration except when applied with humic acid. Shoot Al concentration was decreased by P application.

Xue *et al*. (1994) applied a new humic acid (HA) compound fertilizer to maize, wheat, cotton rape and sesame. HA increased activities of superoxide dismutase and nitrate reductase, and increased plant uptake and translocation of nutrients.

Aydn *et al*. (1999) studied the effects of K-Humate (0, 1.5, 3.0 or 4.5 kg/ha) applied to the soil or foliage on the elemental composition and uptake of plant nutrients in maize and sunflowers. They found that increasing K-humate application rates generally increased N, P, K, Ca, Mg, Fe, Mn, Zn and Cu contents of both plants. K-Humate application generally increased nutrient uptake by the plants, so more with the soil than foliar application method.

Sharif *et al*. (2002) studied the effect of different levels of humic acid (HA) on the growth of maize. HA was sprayed on soil at the rate of 0, 50, 100, 150, 200, 250 and 300 mg/kg soil along with uniform rate of NPK 120, 90, 60 kg/ha. The addition of 50 and 100 mg/kg HA caused significant increase of 20 and 23% in shoot and 39 and 32% in root dry weight of maize plants compared to control. The increasing levels of HA above 50 and 100 mg/kg produced no significant effect on maize yield. They suggested that increases in growth of maize due to HA addition may be associated with the improved biochemical environment of the soil.

Sharif *et* al. (2003) studied the residual effect of humic acid (HA) and chemical fertilizers on nutrient accumulation by maize plants. They found that residual effect of the addition of NPK levels showed significant response for total N accumulation by maize plants whereas HA levels increased N accumulation non-significantly over control.

Sharif *et al*. (2004) compared the efficiency of organic and inorganic fertilizers applied alone or in combination, on the yield and yield components of maize. Soil analysis showed that both organic sources of fertilizers (HA, FYM), when combined with NPK, increased the P and total N concentrations of maize leaves.

Chen *et al*. (2007) indicated that the humic acid can obviously promote the absorption of nitrogen, phosphorus and potassium by maize plants with an obvious increase of the contents of nitrogen and potassium oxide in the stem and leaves of maize plants.

III. The role of magnetic iron in soil

Wilson (1992) indicated that the formation of paramagnetic iron sulfate hydrate salts containing iron in the di and trivalent states from black magnetic iron oxides of high iron content and their use as fertilizers effective in both acid and alkaline soils in disclosed. Such oxides are comminuted, wetted with a specified amount of water, reacted with concentrated sulfuric acid, and dried. The resultant products are paramagnetic and contain iron in both the di-and trivalent states. These products have fertilizing and soil conditioning properties superior to non-magnetic iron compounds containing iron only in either the di-or trivalent states.

Vodyanitski and Rogovneva (1994) studied vertic solonetzic chernozems in the Stavropol area of Russia. These soils had a high proportion of free iron oxides which were partially inherited from the parent Maykopian clays but were largely attributed to their high salinity which caused the rapid formation of iron oxides. Mineral salts break down the silicoaluminate lattice and promote the liberation of iron. The synthesis of ordered highly magnetic iron oxides was hindered by the heavy particle size composition of the vertic soils and by the presence of exchange Na but was promoted by the presence of exchange Ca. Lepidocrocite which was present in small amounts (<4% iron oxides) was formed directly from corroded Fe silicates.

Dearing *et al*. (1995) made a comparison of the magnetic properties of acid gleyed soils under two UK Woodland stands, Oak (*Quercus robur*) and Corsican Pine (*Pinus laricio*). Twenty five soil profiles under each type were sampled and analysed in three layers within designated horizons. The results show that in the surface (organic) horizon the main magnetic components is probably derived from fly-ash and that the concentration is up to 4 times higher under pine. This is attributed to a combination of more efficient scavenging properties of conifers and relatively low rates of organic turnover. In subsurface horizons the magnetic properties indicate that the higher acidity under pine has resulted in reduced concentrations of ferroma gnetic and antiferromagnetic iron oxides. These significant changes in mineralogy have taken place in 50-60 years.

Vodyanitskii *et al.* (1997) showed that soil concretions in the southern part of the taiga zone are characterized by a low magnetic susceptibility, except for concretions of moderate magnetic susceptibility that are found in soils developed on varied clay. Magnetic susceptibility values in soil concretions are almost independent soil hydromorphic development. The low-magnetic iron oxides-feroxyhite, goethite and ferrihydrite-predominate in these concretions. Unlike thermodyna-mically stable goethite, which may be formed chemically, thermodynamically unstable hydroxides (feroxyhite and ferrihydrite) are formed in concretions by iron-oxidizing microorganisms. This process is facilitated by a low content of bivalent iron and humus, which is typical for non-gleyed soils.

Jong *et al*. (2000) indicated that the magnetic susceptibility (chi) of soils varies with the slop position due to some factors, such as texture and drainage class. The chi of the sand and silt fractions was positively correlated with that of the bulk soil, whereas the chi of the clay fraction did not vary with the chi of the bulk soil. Stable sand sized magnetic grains are believed to be rare in these soils.
The magnetic susceptibility (chi) of soils varies with the slope position due to some factors, such as texture and trainage class.

Pizarro *et al*. (2001) studied the magnetic separates from the sand fraction of three Chilean soils forming on volcanic materials. Soil samples were collected from the β-horizon of pedons from native and cultivated areas. Results reveal relatively complex magnetic mineral assemblages in all samples. Results on the iron oxide spinels, reveal a large variability not only of chemical composition, but also of crystalline structure and magnetic properties of these magnetic minerals. The effect of agricultural practices, particularly the continuous chemical fertilizer application and soil acidity correction over several years, on the iron oxide mineralogy could not be unequivocally established, but the present data provide a relatively detailed description of the magnetic iron oxide assemblages of these Chilean volcanic soils.

III. MATERIALS AND METHODS

Two field experiments were conducted, at Desert Research Center (DRC) Experimental Farm at Maryot, North Western Coastal Region of Egypt during two summer seasons 2004 and 2005 respectively to *Sorghum vulgar* var. Dorado, to evaluate the effect of magnetic iron, humic acid and their combinations with four different phosphorus fertilizer sources on growth characters chemical composition and grain yield production or as fodder plant.

The experimental calcareous soil was tilled three overlapped times, and 20 m^3/fed of balady organic manure was added during soil preparation. The experimental area was divided into 16 plots 12 m^2 for each, with four rows of 4 m in length and 60 cm in width. Physical and Chemical properties of the experimental soil are presented in Tables (1 and 2).

Table 1. Mechanical properties of Maryot experimental soil (mean of 2004 and 2005 seasons)

O.M	Particle size distribution (mm)				
	Course sand	Fine sand	Silt	Clay	Class texture
0.33	28.18	39.25	18.27	14.18	Sandy

Table 2. Chemical properties of Maryot experimental soil (mean of 2004 and 2005 seasons)

pH	$CaCO_3$	E.C dsm^{-1}	Saturation soluble extract							
			Soluble aions (meq/L.)				Soluble cations (meq/L.)			
			CO^{-3}	HCO^{-3}	SO^{-4}	Cl^{-}	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
7.9	17.28	0.94	-	3.18	2.75	4.32	3.1	1.77	4.22	0.19

Sorghum vulgare var. Dorado grains were kindly obtained from the Agricultural Research Center (ARC), Ministry of Agriculure, Dokki, Cairo, Egypt in both seasons. Two grains per hill were sown on the 1st of June in both seasons. Plants were thinned 25 days after sowing to leave one plant/hill.

Nitrogen fertilization (as ammonium sulphate 20.5% N) were added at 250 kg/feddan (100 kg) after thinning as well 150 kg at two equal parts at 61 and 91 days after sowing. Potassium fertilization (as potassium sulphate 48% K_2O at the rate of 100 kg K_2O/fed.), were divided in two equal parts ten days after thinning and just before the second irrigation, twenty five days latter.

Sixteen treatments were arranged in Split split design with six replicates, where magnetic iron treatments occupied the main plots, the humic acid treatments arranged in the sub-main, and different phosphorus fertilization sources accombained along with the super phosphate, mono ammonium phosphate and phosphorin biofertilizers or Mycorrhiza combined with rock phosphate occupied the sub-sub ones.

I. Treatments:

1. Magnetic iron:

*Magnetic iron (99% Fe_2O_3) treatment was applied broadcasting at the rate of 100 kg/fed. to the treated plots during soil preparation, (8 treatments) while the control plots were left without any addition.

2. Humic acid :

*Humic acid was sprayed, directly after thinning and then every 15 days at the rate of 2000 ppm/feddan, while the control plants were sprayed wih water. Plants were sprayed three times till the first cut (or sampling dates) 60 days after sowing.

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* Commercial product contained (99% Fe_2O_3) produced by **Alahram Company.**

* Commercial fertilizer contained (48% humic acid) produced by technogreen Company.

3. Phosphorus treatments:

Phosphorus fertilization sources were as follows:

3.1. Super-phosphate at the rate of 200 kg/fed. was added durig soil preparation.

3.2. Mono ammonium phosphate was sprayed three times at the rate of 2000 ppm/feddan, commensing 25 days after sowing, while the control plants were sprayed with water. The application was repeated every 15 days till the first cut or (first sampling date) at 60 days after sowing.

3.3. [**]Rock phosphate (P_2O_5 25.06, SO_3 4%) was added at the rate of 150 kg/fed. during soil preparation accompanied with the bacterial bio-fertilizer “Phosphorine” as seed treatment just before sowing at 200 gm/fed, mixed with arabic gum to form seed-coat. Phosphorine biofertilizer (*Bacillus megatherium* var. *phosphaticum*) as commercial product was kindly provided from microbial research center (Cairo MIRCEN), the unit of Biofertilizer, Fac. of Agric., Ain Shams Univ.

3.4. Rock phosphate at (150 kg/fed) accompanied with Mycorrhiza was added to the soil just before sowing at the rate of 1 g/hill (containing 10^8 mycorrhiza spores) was kindly provided from microbial research center (Cairo MIRCEN), Fac. of Agric., Ain Shams Univ.

These treatments could be summerized as follow:

1) Super phosphate as a control (SP).

2) Super phosphate + humic acid (SP + H).

3) Mono amonium phosphate (MP).

4) Mono ammonium phosphate + humic (MP + H).

5) Rock phosphate + phosphorine (R+P).

6) Rock phosphate + phosphorine + humic (R+P + H).

7) Rock phosphate + Mycorrhiza (R+M).

[**] Commercial product contained (P_2O_5% - SO_3 4%) produced by Alahram Company.

8) Rock phosphate + Mycorrhiza + humic (R+M + H).

The previous treatments (8 treatment) were repeated in presence of magnetic iron as follow :

9) Super phosphate + magnetic iron.

10) Super phosphate + humic acid + magnetic iron.

11) Mono phosphate + magnetic iron.

12) Mono phosphate + humic + magnetic iron.

13) Rock phosphate + phosphorine + magnetic iron.

14) Rock phosphae + phosphorine + humic + magnetic iron.

15) Rock phosphate + Mycorrhiza + magnetic iron.

16) Rock phosphate + Mycorrhiza + humic + magnetic iron.

Two main experiments were established with sorghum plant either to grain production or as fodder plant. For this purpose, three replicates out of the six were used to determinate the growth characters and chemical composition in the three following cutting dates at 60, 90 and 120 days after sowing, while the rest of replicates were kept to determine the growth characters as well chemical determination from the uncut plants at three sampling dates concomitant to that of cutting dates (60, 90 and 120 days). Grain yield and its components were studied at the end of the two growth seasons.

II. Studied parameters:

1. Growth characters:

Three plants were sampled randomly from each treatment at 60, 90 and 120 days after sowing. The followig growth characters of whole plant (shoot) and cutting plant were determined.

Plant height (cm/plant), number of leave per plant; area of fifth leaf/plant (in case of intact plant) and area of total leave per plant (in case of cutting plants); leaf area in (cm^2) using II. 3000 portable area meter (Lin Coin, Nebraska 68504 USA) and grain yield of uncut plant, fresh and dry weight (g) per plant. In addition weight of 100 grains. Whereas, number of branchs per cutting plant and fresh yield of each cut (ton/ faddan) were studied.

Statistical analysis of the previous characters was made as described by **Steal and Torrie (1960)** and Duncan's new multiple range test was used to differentiate between means as described by **Duncan (1955).**

III. Chemical determinations:

For chemical analysis, sorghum shoots sampled either from the intact plant or cutting ones for each treatment (60, 90 and 120 days after sowing) of both seasons were oven dried at 70ºC for 48 hr ground and kept to chemical determinations.

1. **Determination of total nitrogen and calculated crude protein:**

Total nitrogen was determined by the usual Kjeldahl method according to **AOAC (1995).** The crude protein was calculated by multiplying the total nitrogen by 6.25.

Protein fractions were estimated in grain yield of both seasons.

2. Determination of protein fractions :

Two protein fractions (albumin and globulin) was extracted by using a modified Osborne method of stepwise extraction based on protein solubility in different solvents. **Pattis and Hamaker (1994).**

A colorimetric determination of protein in the water extract or NaCl extract, at 595 nm against the blank. Protein concentration was calculated from the standard curve were carried out by using the method of **Bradford (1976).**

3. Phosphorus Determinations:

Total phosphorus and different phosphorus fractions were estimated in the different samples collected during the two seasons. The methods used could be summarized as follow :

Extraction:

A weight of 0.5 – 1 g finely powdered dry sample was extracted with 20 ml of a mixture of equal volumes of 30% TCA and

2% phenol water, for 24 hr. at 0ºC, then filtered and washed several times with distilled water. The filtrate was made up to 50 ml while the residue was discarded **(Naguib, 1962).**

a) For inorganic phoshorus determination, 5 ml of the extract were neutralized with NaOH (3 N) using phenolphthalin as indicator. One millilitre freshly prepared 2.5% ammonium molybdate and ½ ml of 10 N H_2SO_4 were added to the neutralized sample and the mixture was kept for 10 minutes before addition of ½ ml Fiske reagent. The solution was mixed throughly, made up to 25 ml and kept for 15 minutes before being estimated colorimetrically using a red filter **(Fiske & Subbarrow, 1925).**

b) Soluble organic phosphorus: Two ml of 50% H_2SO_4 were mixed with 10 ml of the TCA extract. The mixture was gently heated till charring, without evolution of fumes, was apparent. Two ml of 30% $HClO_4$ were added to the cold digest and the flasks were further heated till fuming stopped and the contents were clear. After cooling, the digest was volumetrically transferred to a 50 ml flask before being analysed for its total soluble phosphorus.

Following the same procedure mentioned for inorganic phosphorus; the total P content of extract was estimated in the digest. By substracting the inorganic P from the values obtained after digestion, the soluble organic phosphorus content was evaluated.

c) Total phosphorus, an accurate weight of 0.02-0.04g of representative sample was transferred to a dry digestion bulb and rinsed with few mls of distilled water. H_2SO_4 – $HClO_4$ digestion was carried as previously mentoned. Phosphorus was estimated in the digest after completion to volume, following the previously recorded procedures.

The storage P-form as phytate were determined in grain yield of both seasons.

4. Determination of phytate in grains:

Phytate was extracted according to the procedure descried by **Camira and Clydesdale (1982)** and modified by **Mohamed *et al*. (1986).** The defatted sample (1 g) was extracted with trichloroacetic acid (3%, W/V) at 37ºC for 30 min with simple shaking. Series of small columns were fitted with a glass wool and packed with anion exchange (Dowex 1) and covered with small piece of filter paper. The tubes were washed with distilled water using vacuum pump followed by NaCl solution (0. 2M). The extracted phytate (0.2 ml) was transferred into a test tube, chromogenic solution (0.2 ml) was added and the volume made up to 5 ml using distilled water. The tubes were heated in a water bath for 30 min, then cooled down and read at DU 7400 spectrophotometer at 830 nm. The results were expressed as mg phytate/100 g sample.

5. Determination of minerals in sorghum plant:

The minerals content in sorghum plant were determined according to **AOAC (1995)** official method, general recommendations for emission spectrographic methods, applicable to K, Ca, Mg, Fe, Zn, Mn, Cu, B and Na by Atomic absorption spectrometer (SOLAAR-UNICAM 989).

At the end of the experiment of 2nd season sixteen soil samples were taken from the experimental plots for chemical analysis (physical propeties, organic matter, soil pH, total carbonate, electrical conductivity, soluble cations and anions), were determined.

- Particle size distribution by the pipette method as described by **Piper (1950).**
- Organic matter content was determined according to the methods of Walkely and Black outlined by **Jackson (1973).**
- Soil pH was determined in (1:2.5) soil: water suspension using a glass electrode pH meter according to **Richards (1954).**

- Total carbonate content was measured using Collin's calcimeter according to **Liper (1950).** While active $CaCO_3$ was estimated as described by **Yaalon (1957).**
- Electrical conductivity value was measured in soil paste extract as described by **Jackson (1973).**
- Soluble cations and anions were analysed in the soil extract according to **Jackson (1973).** Calcium and magnesium were determined volumetrically with versinate method, **Jackson (1973),** while sodium and potassium were determined using flamephotometer. Soluble anions, was determined colorimetrically using barium chromate method according to **Dewis and Freitas (1970).**
- Chemically extractable elements, in the available form were extracted from soil and determined as follows:

  Nitrogen was extracted by 2M KCl and determined using microkjeldahl method outlined by **Chapman and Pratt (1961).** Phosphorus was extracted by NH_4HCO_3-DTPA extract, **Soltanpour and Schwab (1977)** and determined using ascorbic acid and ammonium molybdate according to **Holman and Eilliot (1983).** Potassium was extracted by NH_4HCO_3-DTPA extract and determined using flamephotometer.
- Available micronutrients Fe, Mn, Zn and Cu were extracted by DTPA according to **Lindsay and Norvell (1978)** and determined using atomic absorption spectrophotometer.
- Total micronutrients Fe, Mn, Zn and Cu were determined according to **Jackson (1973).**
- Micronutrients were determined by atomic absorption spectrophotometer according to **Chapman and Pratt (1961).**

IV. RESULTS

I. Intact plant:

A. Morphological characters of the shoot:

1. Plant height:

Seasonal changes of plant height of the sorghum plant during three successive sampling dates 60, 90, 120 days under different phosphorus treatments, show that different fertilizers applied as will as humic or magnetic iron increased plant height during the 1^{st} season till 90 days (second sample). In the third one (120 days) such increase did not differ greatly than that detected in the second one of the first season, yet in the second season such increase was more recorded for the previous sample when compared with second sample (Table 4-A,B and C).

As for the effect of phosphorus treatments applied it is clear that R+M treatment significantly gave taller plants in both seasons against the rest of P-fertilizers except for R+P treatment of the 1^{st} season, whereas surpass phosphate application was almost significantly less than the different phosphate applications particularly in the 2^{nd} season.

On the other hand, humic acid as well as magnetic iron treatments stimulated plant height above the control of each, this almost true in both seasons as well as the treatments without humic of the first one only which reached the same level of significance.

The second order interaction of phosphate fertilizers either with humic or magnetic iron induced plants taller than those untreated with humic or magnetic in both seasons (Table 4-D).

(R+M) + humic acid when combined with magnetic iron significantly induced the tallest plants in both seasons as well R+M without humic when combined with magnetic iron of the first season.

Table (4-A):

Treatment \ Days	60		90		120	
	First	Second	First	Second	First	second
Super phosphate	71.0 b	80.8 d	84.9 b	94.0 d	87.0 b	105.3 d
Mono phosphate	84.7 b	96.8 c	91.3 b	106.3 c	94.3 b	112.0 c
Rock + phosphoine	110.3 a	120.0 b	124.3 a	134.8 b	124.7 a	138.3 b
Rock + Mycorrhiza	122 a	134.3 a	137.8 a	147.5 a	137.3 a	153.5 a

Table (4-B):

Treatment \ Days	60		90		120	
	First	Second	First	Second	First	second
Without humic acid (-) hum.	91.9 a	104.0 b	105.1 a	117.8 b	106.29 a	123.5 b
With humic acid (+) hum.	102.1 a	111.9 a	114.04 a	123.5 a	115.37 a	131.0 a

Table (4-C):

Treatment \ Days	60		90		120	
	First	Second	First	Second	First	second
Without magnetic Iron (-) Fe	89.6 b	100.9 b	102.79 b	114.75 b	104.83 a	122.3 b
With magnetic Iron (+) Fe	104.33 a	115 a	116.33 a	126.6 a	116.83 a	132.3 a

Duncine within each date and each season.

Table (4-D):

Treatments	First season		Second season	
	Without magnetic iron	With magnetic iron	Without magnetic iron	With magnetic iron
Super phosphate (control)	75.3 c	81.3 bc	87 k	95.3 id
Super + humic	79.3 bc	87.9 bc	93 j	98 hij
Monophos.	82.6 bc	94.8 bc	101 h	108 g
Monophos + humic	84.4 bc	98.7 bc	100.3 hi	110.7 g
(Rock + Phosph)	105.3 ab	121.9 ab	117.3 f	129.7 be
(Rock + Phosph + humic)	112.3 ab	139.3 a	125.3 e	151.7 ab
(Rock + Myco)	116.9 ab	130.6 a	134 d	148.3 bc
(Rock + Myco + humic)	136.4 a	145.6 a	143.1 c	155 a

Duncine within each season.

As previously mentioned with the second order interaction (R+M) + humic when combined with magnetic application significantly recorded the highest plants allover the different treatments in both seasons as well as (R+M) treatment with magnetic iron without humic application of the second and third samples in the second season (Table, 1).

2. Number of leaves:

The seasonal changes of leaves number during 1st and 2nd seasons show that number of leaves per plant generally increased with advancement of plant age (60, 90 and 120 days) (Table 5A, B and C).

Table (5-A):

Treatment \ Days	60		90		120	
	First	Second	First	Second	First	second
Super phosphate	4.3	7.0	5.3	8.0	6.2	8.0
	c	b	c	d	b	d
Mono phosphate	5.8	9.3	6.8	9.5	7.4	9.5
	b	a	b	c	b	c
Rock + phosphoine	7.4	9.3	9.25	12.0	10.91	12.3
	a	a	a	b	a	b
Rock + Mycorrhiza	8.2	10.0	10.42	14.0	12.3	14.0
	a	a	a	a	a	a

Table (5-B):

Treatment \ Days	60		90		120	
	First	Second	First	Second	First	second
Without humic acid	6.2	8.4	7.7	10.4	8.5	10.5
(-) hum.	a	b	a	b	b	b
With humic acid	6.5	9.38	8.21	11.38	9.9	11.38
(+) hum.	a	a	a	a	a	a

Table (5-C):

Treatment \ Days	60		90		120	
	First	Second	First	Second	First	second
Without magnetic	5.96	8.3	7.3	9.9	8.50	10.3
Iron (-) Fe	b	b	b	b	b	b
With magnetic Iron	6.9	9.5	8.6	11.9	9.92	11.62
(+) Fe	a	a	a	a	a	a

Duncine within each date and each season.

Table (5-D):

Treatments	1st season		2nd season	
	Without magnetic iron	With magnetic iron	Without magnetic iron	With magnetic iron
Super phosphate (control)	5 bc	5 bc	7 h	7.7 h
Super + humic	5 bc	5.9 bc	7.7 h	8.3 gh
Monophos.	5.9 bc	7.4 b	8.7 fg	10 e
Monophos + humic	5.9 bc	7.7 b	9 fg	10 e
(Rock + Phosph)	7.7 b	9.5 ab	4.3 ef	11 d
(Rock + Phosph) + humic	9 b	10.7 a	10.7 de	13.7 ab
(Rock + Myco)	9.5 ab	10.1 a	11.3 cd	13 b
(Rock + Myco) + humic	10.1 a	11.6 a	12 c	14.3 a

Duncine within each season.

The first order interaction of the main applications of phosphorus fertilizers, humic acid and magnetic iron during the two successive seasons 2004 & 2005 are presented in Table (5-A). It is evident that R+M significantly increased number of leaves against SP treatment in both seasons, such increase reached 90.6, 42.8, 96.6 and 75.0% 98.0, 75.0% for the three sampling dates respectively above the control of both seasons. R+M significantly followed R+P treatment yet with less values.

Apart from the increase detected in first and second samples in the first season for treatments without humic acid, it is clear that foliar application of humic acid stimulated number of leaves during the three sampling dates particularly in the 2nd season (Table 5-B).

Also magnetic iron application gained significant leaf number in both seasons compared to untreated plants (Table 5-C).

As previously mentioned with the first order interaction, R+M either with humic only at the 2nd season or with magnetic iron in the first one stimulated leaf number significantly on the rest of treatments except for R+P with humic when combined with magnetic iron application (Table 5-D).

Here again (R+M) + humic treatment particularly with magnetic iron achieved significant increase of the leaf numbers during the three sampling dates in both seasons. Such behaviour was detected with R+P + humic treatment in the 1st season at the early and late sampling dates (60 & 120) to reach the same level of significance when combined with magnetic iron application in 1st and 3rd samples of the 1st season as well 1st and 2nd samples of the 2nd season (Table 5).

3. Leaf area:

The seasonal changes of leaf area during the 1st and 2nd seasons show that the leaf area per plant increased with advancement of plant age (60, 90 and 120 dasys) (Table 6-A, B, C).

It is evident that the first order interaction of the main applications of phosphorus fertilizers, humic acid and magnetic iron during the two successive seasons 2004 and 2005 show that R+M significantly increased leaf area against the other P applications followed with R+P, MP and SP treatments disdendingly with significant differences Table (6-A).

Table (6-A):

Days / Treatment	60		90		120	
	First	Second	First	Second	First	second
Super phosphate	61.35 d	67.8 d	95.85 d	92.0 d	189.3 c	183.3 d
Mono phosphate	83.91 c	104.5 c	151.78 c	176.0 c	199.03 c	256.8 c
Rock + phosphoine	147.8 b	155.5 b	260.6 b	258.3 b	355.3 b	350.8 b
Rock + Mycorrhiza	176.8 a	190.5 a	301.4 a	292.3 a	446.8 a	422.3 a

Table (6-B):

Days / Treatment	60		90		120	
	First	Second	First	Second	First	second
Without humic acid (-) hum.	106.3 b	120.8 b	179.73 b	193.8 b	275 b	282.3 b
With humic acid (+) hum.	128.6 a	138.4 a	225.1 a	215.5 a	319.92 a	324.3 a

Table (6-C): Magnetic iron:

Days / Treatment	60		90		120	
	First	Second	First	Second	First	second
Without magnetic Iron (-) Fe	102.5 b	116.3 b	171.87 b	186.9 b	264.55 b	274.6 b
With magnetic Iron (+) Fe	132.4 a	142.9 a	232.93 a	222.4 a	330.64 a	331.9 a

Duncine within each date and each season.

Table (6-D):

Treatments	1st season		2nd season	
	Without magnetic iron	With magnetic iron	Without magnetic iron	With magnetic iron
Super phosphate (control)	66.9	104.5	93	116.3
	ef	e	m	l
Super + humic	101	173.1	111	137
	e	d	l	k
Monophos.	124.9	191.8	147.7	194.3
	de	d	j	h
Monophos + humic	138.8	144.5	174	200.3
	de	de	i	h
(Rock + Phosph)	206.8	260.9	218	256.3
	cd	bc	g	e
(Rock + Phosph) humic	243.7	306.8	242.7	298.3
	c	b	f	ab
(Rock + Myco)	246.4	281.6	269.3	296
	bc	bc	d	b
(Rock + Myco) + humic	292.1	413.2	285.5	360.3
	bc	a	c	a

As for humic application, it is clear that foliar application stimulated leaf area during the three sampling dates of both seasons to reach the level of significance against untreated plants (Table 6-B).

Also magnetic iron application (Table 6-C) gained significant leaf area in both seasons compared with untreated plants.

As previously mentioned in the first order interaction (R+M) + humic only when combined with magnetic iron achieved significant leaf area in both seasons than the rest of other interactions (Table 6-D).

As for the third order interaction (Table 6). (R+M) + humic treatment particularly with magnetic iron achieved significant increase of the leaf area above the rest of treatments (Table 6).

4. Shoot fresh weight:

Shoot fresh weight of sorghum plants tended to increase with advancement of age in both seasons under different P-applications, humic acid or magnetic treatments (Table 7A, B, C).

Concerning the first order interaction, R+M application significantly increased plant fresh weight during the three samples in both seasons, as well R+P of the first one at the last two samples against the other P treatments (Table 7-A).

Humic acid or magnetic applications surpass the untreated ones during the different sampling dates of both seasons (Table 7-B, C).

As for (R+M) + humic stimulated significantly fresh weight of sorghum plant when combined with magnetic iron above the rest of interactions during the two seasons. In this respect (R+P) + humic followed the previous treatment with magnetic iron interaction (Table 7-D).

The third order interaction of (R+M) + humic acid and magnetic significantly recorded the highest fresh weight during the three sampling dates of both seasons (Table 7).

Table (7-A):

Days / Treatment	60		90		120	
	First	Second	First	Second	First	second
Super phosphate	147.4 c	141.5 d	196.5 b	196.5 d	277.7 b	278.3 d
Mono phosphate	183.7 c	210.5 c	229.6 b	255.4 c	325.6 b	340.3 c
Rock + phosphoine	269.5 b	268.8 b	338.4 a	327.5 b	427.8 a	423.4 b
Rock + Mycorrhiza	310.55 a	335.8 a	387.9 a	420.5 a	490.6 a	509.8 a

Table (7-B):

Days / Treatment	60		90		120	
	First	Second	First	Second	First	second
Without humic acid (-) hum.	210.5 b	224.5 b	264.4 b	283.5 b	337.98 b	359.3 b
With humic acid (+) hum.	245.1 a	253.8 a	311.77 a	316.5 a	422.8 a	416.5 a

Table (7-C):

Days / Treatment	60		90		120	
	First	Second	First	Second	First	second
Without magnetic Iron (-) Fe	193.7 b	220.6 b	250.6 b	277.8 b	342.61 b	342.7 b
With magnetic Iron (+) Fe	261.85 a	257.6 a	325.53 a	327.2 a	418.21 a	433.13 a

Duncine within each date and each season.

Table (7-D) :

Treatments	1st season		2nd season	
	Without magnetic iron	With magnetic iron	Without magnetic iron	With magnetic iron
Super phosphate (control)	180.4 de	200.7 cd	190.7 j	211.3 ij
Super + humic	193 de	254.6 c	200.7 j	219 i
Monophos.	206 cd	268.7 c	233 h	285.7 f
Monophos + humic	231.5 c	278.7 c	265 g	291.2 f
(Rock + Phosph)	285.2 c	359.3 bc	289.6 f	311.3 e
(Rock + Phosph) + humic	291.6 c	444.7 b	301.3 ef	457.3 b
(Rock + Myco)	301.3 c	365.7 b	371.3 d	420 c
(Rock + Myco) + humic	409.2 b	509.1 a	378 d	518.7 a

Duncine within each season.

5. Shoot dry weight:

Dry matter production of the shoot of sorghum plant (Table 8 A, B, C) tended to increase with advancement of age during both seasons under P-fertilizers, humic acid and magnetic iron applications. As for P fertilizers R+M recorded significant increase above the rest of treatments except for R+P in the 1st season which was significantly the same yet with low values.

Table (8-A):

Treatment \ Days	60		90		120	
	First	Second	First	Second	First	second
Super phosphate	101.8 b	103.5 d	149.9 B	152.5 d	171.4 b	174.3 d
Mono phosphate	115.5 b	124.0 c	168.22 b	176.0 c	190.2 b	199.3 c
Rock + phosphoine	158.3 a	160.5 b	204.23 a	205.5 b	231.78 a	234.3 b
Rock + Mycorrhiza	172.8 a	180.1 a	227.2 a	236.3 a	262.22 a	270.0 a

Table (8-B):

Treatment \ Days	60		90		120	
	First	Second	First	Second	First	second
Without humic acid (-) hum.	130.4 a	136.0 b	177.3 a	184.6 b	195.2 b	204.4 b
With humic acid (+) hum.	143.8 a	148.04 a	197.5 a	200.5 a	232.63 a	234.5 a

Table (8-C):

Treatment \ Days	60		90		120	
	First	Second	First	Second	First	second
Without magnetic Iron (-) Fe	126.03 b	133.0 b	174.5 b	181.5 b	194.44 b	199.5 b
With magnetic Iron (+) Fe	148.15 a	151.04 a	200.23 a	203.6 a	233.34 a	239.4 a

Duncine within each date and each season.

Table (8-D):

Treatments	1st season		2nd season	
	Without magnetic iron	With magnetic iron	Without magnetic iron	With magnetic iron
Super phosphate (control)	122.5 c	145.4 bc	127 m	150 k
Super + humic	137 c	159.2 bc	142.3 l	154.3 ij
Monophos.	149.2 bc	161.8 bc	159.7 hi	167.7 h
Monophos + humic	154.3 bc	166.6 bc	165 h	173.3 gh
(Rock + Phosph)	170.8 bc	196.6 ab	175.7 g	189.3 f
(Rock + Phosph) + humic	178.5 b	246.5 ab	183.7 f	251.7 b
(Rock + Myco)	183.7 b	211 b	201.3 e	229.3 c
(Rock + Myco) + humic	223.9 b	264.2 a	216 d	268.4 a

Duncine within each season.

The magnetic iron addition promoted grain yield production than the control (without magnetic iron) (Table 8-C). Humic acid addition achieved grain yield production to be significantly higher than untreated ones in the second season Table (8-B).

Table (8) illustrate that (R+M) + humic when combined with magnetic iron significantly achieved maximum grain yield production in both seasons above the other interactions. (R+P) + humic acid with magnetic iron followed that obtained with (R+M) + humic when combined with magnetic iron in both seasons.

Also the differences between P-applications of the first season were less than that of second one, since the magnitudes of the second season surpass that of the first one (Table 8A).

Apart from the treatment without humic of the 1st season at the early two samples, the second season as well the last sample of the first one significantly reduced dry matter accumulation below the addition of humic acid (Table 8-B).

Magnetic iron application promoted dry matter accumulation during the three successive samples of both seasons against the untreated plants (Table 8-C).

The second order interaction reveal that (R+M) + humic when combined with magnetic iron significantly stimulated dry matter production allover the other interactions in both seasons.

The dry matter production of sorghum plant during both seasons run parallel to that detected in fresh weight with the same level of significance in the three sampling dates (Table 8).

6. Grain yield:

Regarding P-fertilizers (Table 9-A), R+M treatment stimulated grain yield production in both seasons, whereas the other three P-applications recorded significantly less grain yields. The percentage of increase recorded were 134.2, 125.8, 118.0 and 150.9, 142.4, 123.4 for R+M, R+P and MP treatments respectively against the control for the two successive seasons. Such behaviour was almost the same for dry matter production in the last sample (120 days) of both seasons Table (9-A).

Table (9-A):

Treatment \ Season	First season	Second season
Super phosphate	449.7 b	405.0 d
Mono phosphate	530.2 ab	500.0 c
Rock + phosphoine	565.7 a	577.5 b
Rock + Mycorrhiza	603.6 a	611.3 a

Table (9-B):

Treatment \ Days	First season	Second season
Without humic acid (-) hum.	521.64 a	508.8 b
With humic acid (+) hum.	552.99 a	538.1 a

Table (9-C):

Treatment \ Days	First season	Second season
Without magnetic Iron (-) Fe	504.48 b	505.6 b
With magnetic Iron (+) Fe	570.15 a	541.3 a

Table (10): Effect of different phosphorus treatments, humic and magnetic iron applications on 100 grains weight in the two seasons.

Treatments	First season		Second season	
	Without magnetic iron	With magnetic iron	Without magnetic iron	With magnetic iron
Super phosphate (control)	1.4	1.6	1.3	1.5
	e	de	k	jk
Super + humic	1.5	2.2	1.4	1.6
	e	bcde	jk	fg
Monophos.	1.8	2.2	1.8	2
	cde	bcde	hi	de
Monophos + humic	1.98	2.3	1.9	2.2
	bcde	bcde	gh	cd
(Rock + Phosph)	2.3	2.6	2.1	2.3
	abcde	abc	efg	Id
(Rock + Phosph) + humic	2.3	2.9	2.2	2.9
	abcde	ab	ef	b
(Rock + Myco)	2.5	2.7	2.6	2.8
	abcd	abc	c	b
(Rock + Myco) + humic	2.7	3.1	2.7	3.2
	abc	a	bc	a

Duncine within each season.

Table (10-A):

Treatment	First season	Second season
Super phosphate	1.66 c	1.46 d
Mono phosphate	2.03 b	1.98 c
Rock + phosphoine	2.53 a	2.38 b
Rock + Mycorrhiza	2.74 a	2.75 a

Table (10-B):

Treatment	First season	Second season
Without humic acid (-) hum.	2.12 a	2.0 b
With humic acid (+) hum.	2.35 a	2.3 a

Table (10-C):

Treatment	First season	Second season
Without magnetic Iron (-) Fe	2.05 b	2.0 b
With magnetic Iron (+) Fe	2.43 a	2.3 a

Duncine within each season.

Super phosphate SP singly or with humic recorded least grain yield production particularly without magnetic iron application (Table 9).

The previous response of grain yield detected with P-treatments or humic, as well magnetic applications was the resultant of that recorded with the weight of 100 grains with almost the same level of significance (Table 9, 10-A,B,C).

B. Chemical constituents of shoot:

B.1. Macronutrient contents:

a. Phosphorus:

The effects of different P-fertilizers, humic and magnetic iron on the total P and its fractions in the plant shoot of different sampling dates are presented in Tables (11, 12, 13, 14 & 15) and Figures (1-20). It is evident that the percentage of total P and other P fractions tended to increase by age to reach their maximum at the second date, then shaprly declined at third one. Such increase reached 30% until 90 days whereas, the reduction recorded 61% at last age. This trend was almost true for various P fractions under different treatments in the first seasons. However, similar trend was observed in the second season for super phosphate and monoammonium phosphate treatments. Meanwhile, rock phosphate applicaton either with humic acid or magnetic iron achieved less reduction in last age to be ~50% instead of 61% in the first season., different treatments almost gave high much magnitudes above that detected for each treatment in first season.

The main constituent of total P of the different treatments was the soluble form which reached ~85% of total P within different applications and the inorganic fraction constitute the main form of total soluble P to be about 81% of total soluble P.

As for the additional applications of humic acid and/or magnetic iron, data presented in Table (11-15) clearly show that the foliar application of humic acid had only a positive effect on super phosphate treatment in both seasons, since the addition of humic acid stimulated total P and its fractons to be ~4.9% & 3.3% in both seasons respectively against SP without humic. In addition super phosphate treatment responded also with magnetic iron application to reach about ~5.4% higher than those untreated with magnetic iron in both seasons.

Concerning the effect of different phosphorus treatments on the total P and its fractions at sampling dates seasons, Tables (11-15) and Figs. (1-18) data indicate that Mycorrhiza application with rock phosphate stimulated P uptake to reach ~12% in the first season and extended to reach ~25% in the second one above those obtained from super phosphate (control). Also, phosphorin application with rock phosphate stimulated P uptake to record 10.3% & 13.5% in the two seasons respectively. Other P fractionts for these treatments ran almost parallel to that obtaied with total P.

b. Nitrogen content & Crude protein :

Data presented in Tables (16 & 17) and illustrated in Figs. (21 - 28) show that total N of sorghum plant during the three successive samples indicate that N persentage and crude protein in shoot decreased with advancement of age gradually in the first season. On the other hand, the second season also reduced nitrogen percentage yet less than that detected in the first one at 90 days after sowing. Meanwhile the reduction at the last one (120 days after sowing) was much severe in comparison to that of the first one.

The Mycorrhizal rock phosphate treatment combined with h.a & magnetic iron achieved the highest N content above all other P treatments in all sampling dates of both seasons.

c. Potassium:

Concerning the seasonal changes of shoot potassium content in the two successive seasons Table (18) and Figs. (29-32), reveal that the accumulation of K increased with the advancement of age from 60 to 90 days to record ~33% in the first season and 31.7% in the second one. The differences within P-treatments followed nearly the same trend in both seasons. However, the shoot Potassium content was sharply decreased at third sampling age (120 days after sowing). Such decrease was ~49.8% and 48.7% with super phosphate treatments. However, R+M treatment lessened this reduction in the content about 3% against control (SP) at the last sampling date in the first and second season respectively.

The response of shoot Potassium content to different P sources are given in Table (18), it is evident that the MR + humic acid when combined with magnetic iron initiated an increase (~6.0%) above superphosphate application (control with magnetic iron) at last sampling date in both seasons.

d. Magnesium:

Data in Table (19) and Figures (33, 34, 35, 36) show the Magnesium content in shoot gained the maximum values at the second sampling date then declined at the next sample (120 days after sowing). This pattern was almost the same detected with Potassium content with difference in magnitudes which reached 20 folds for Potassium content against Magnesium content.

R+M with or without humic acid or magnetic iron tended to stimulate Magnesium content commencing from 90 days compared with SP applications. As for the effect of different P treatments on Mg content, it is clear that the first and second sampling dates in both seasons showed almost no differences among all P fertilizer sources. Meanwhile at the third sample the R+M treatment obviously increased Magnesium content in plant shoot to reach around 11% above SP treatment. R+P plus magnetic iron also with or without humic acid followed that obtained with previous treatment to reach about 7% above SP treatment in both seasons.

e. Calcium:

Data presented in Table (20) and illustrated in Figs. (37, 38, 39 & 40) show an increase in Calcium content of shoot with advancement in age up to 90 days then decreased at 120 days. Such increase at the second sample date, recorded ~14%. On the other hand, at the third sample, the reduction of Calcium content reached ~43.5% and 42.5% for SP treatment, while it was 35% and 34% for R+M treatment without magnetic iron for first and second seasons respectively. Magnetic iron application almost gained the same increase detected during the second sampling date which ranged between 14% & 13.6% in 1st season to be 13.2% & 12.8% in the second one for SP and (R+M) + humic acid respectively in both seasons. However, the reduction recorded for Calcium content at the last sampling date ranged between 42.3% & 41.5% for SP treatment in both seasons respectively. However, such reduction detected for (R+M) + magnetic iron either with humic acid or without humic was almost less, since it was 33.5% & 32.9% and 34.6% & 33.1 for both treatments during the two seasons respectively.

f. Sulfur:

The seasonal changes of Sulfur content in shoot is presented in Table (21) and Figs. (41, 42, 43 & 44). Generally the second sampling date revealed the highest Sulfur content in shoot. Such increase with R+P either with or without humic acid or magnetic iron gave almost stable content during the first two samples in both seasons, then decreased at the last one. Moreover, the increase recorded with SP + humic acid either with or without magnetic iron reached about 25% in the first season and about 17% & 15% in the second season respectively. Generally such reduction at the third sample recorded almost 53% in the first season and 46% in the second one.

(R+M) + humic acid promoted greatly sulfur content of sorghum plant to reach ~94% with magnetic iron at the first sampling date in both seasons against control for each date, and nearly about 72% in other two samples of both seasons. Other treatments (R+M, R+P) + humic acid, R+P, mono ammonium phosphate + humic acid, mono ammonium phosphate) came descendingly below (R+M) + humic acid either with or without magnetic iron during the three sampling dates of both seasons.

B.2. Micronutrient content:

a. Iron:

Data presented in Table (22) and illustrated in Fig. (45, 46, 47, 48) show that the seasonal changes of iron content in shoot at the three sampling dates in both seasons. gained their maximum at the second sampling date. Thereafter iron content decreased at the third one. R+P either with Mycorrhiza or phosphorine in rock phosphate presence or absence of humic acid as well magntic iron stimulated iron content during the three successive samples in both seasons above SP or mono ammonium phosphate applications Table (22). R+M application combined

with humic acid and magnetic iron increased iron content in plant shoot at the three successive sampling dates to reach ~3.4%, 3.6% and 4.0% above those obtained under control treatment in both seasons.

b. Zinc:

Data in Table (23) and Figs. (49, 50, 51 & 52) show Zn content of sorghum plant during three sampling dates in both seasons as affected by different phosphorus, humic acid & magnetic iron treatments. The Zinc content tended to increase by age to achieve its maximum value at second sampling date then sharply decreased at the last one.

Rock phosphate application either with mycorrhiza or phosphorine with or without humic acid or magnetic iron surpass that recorded with SP or monoammonium phosphate applications during the three sampling dates, of both seasons to be much superior with rock phosphate + mycorrhiza to reach about 20% in the first two samples and 35% in the last one, in both seasons.

c. Manganese:

Data presented in Table (24) and illustrated in Figs. (53, 54, 55 & 56) show that Mn uptake for different treatments applied tended to increase till 90 days after sowing except for R+M with or without humic acid and magnetic iron as well R+P with humic acid in presence with magnetic iron at the first season, or the first two treatments (R+M with or without humic acid and magnetic iron) also slightly decreased in this date (90 days after sowing) in the second season. Despite of the increase detected with SP at the 2nd sampling date concomitant with the reduction obtained from R+M treatments in the same sample, it is still higher than Mn content of SP treatments to be ~5.5% in the first season and 8.5% in the second one, either with or without magnetic iron. However, the increase recorded for (R+M) with humic acid and magnetic iron reached ~57% above SP at the first sampling date in both seasons.

d. Copper:

Data presented in Table (25) and illustrated in Figs. (57, 58, 59 & 60) show that the seasonal changes of Cu content in shoot exhibited an increase at the second sample, then decreased at the third one. Such increase at the 2nd sample, reached almost 15.0% for different applications in both seasons. However, the reduction in the second season was higher than that of the first one, since the values recorded in the second sample of second season was higher than of first one.

Humic acid or magnetic iron altered Copper content according to P application, since it achieved its maximum with SP application to reach ~15% with humic acid and 20% with magnetic iron against untreated plants. Whereas Mono amonium phosphate gained 8% with humic acid and 15% with magnetic iron above the untreated mono ammonium phospahate. Also R+P achieved 3% with humic acid and 6.0% with magnetic iron Meanwhile Mycorrhiza with rock phosphate responded at least percentage since it reached only 1.0% with humic acid and 2.5% with magnetic iron. This was almost true during all sampling dates in both seasons. However, the last application of Mycorrhiza either with or without humic acid and mgnetic iron recorded maximum Cu content above the other applications. This increase was 87.8% at all sampling dates in both seasons.

e. Boron:

Data presented in Table (26) and illustrated in Fig. (61, 62, 63, 64) show the seasonal changes of Boron content in plant shoot in two successive seasons. The Boron content in the 1st season, increased at 90 days to record ~15% above those sampled at 60 days. However the reduction detected in the third sample was more pronounced in the second season which almost the same detected with Cu content of sorghum plant. Also magnetic iron and humic acid applications gained the same response detected with Copper, since SP treatment responded greatly with these additions. However, rock phosphate application either with phosphorin

or mycorrhiza stimulated Boron content above the other phosphorus sources. Since, the application (R+P) without humic acid achieved ~65% above the SP treatment in the first sample which reached 85% with micorrhiza + rock phosphate without humic acid and magnetic iron.This was almost true during the next two sampling dates.

B.3. Beneficial element:

Sodium content in shoot:

Data presented in Table (27) and illustrated in Figs. (65, 66, 67, 68) clearly show that, opposite to that recorded with macro and micro nutrient contents of sorghum plant treated with P applications, humic and magnetic iron, sodium content of whole plant recorded reversable response with P applicaton, since mycorrhizal rock phosphate + humic acid absorb the least sodium content below the other P applications to be the least with magnetic iron at the three sanpling dates in both seasons. On the contrary, super phosphate achieved much sodium content above rest of P applications in particular when applied without humic acid or magnetic iron. Since magnetic iron application tended to reduce sodium uptake below those untreated (without magnetic iron) in the different sampling dates of both seasons.

Moreover humic acid application altered sodium content to be below than untreated phosphorus sources in both seasons.

B.4. Grains content:

Data presented in Table (28 & 29) and illustrated in Figs. (69-72) indicate that total nitrogen content, crude protein as well albumin and globuline behavied almost similalry to grain yield production. Mychorrhiza + Rock phosphate, phosphorin + Rock phosphate, mono ammonium phosphate and super phosphate treatments, came in dessending manner when combined with humic or magnetic iron.

The albumin constitute (double content) against globulin.

Phytic acid followed that obtained with total N and different protein forms yet with less differences.

II. Cutting plant:

A. Morphological characters of cutting plants:

1. Plant height:

The cutting of sorghum plant in three different dates 60, 90 and 120 days indicate that plants gained their maximum height at the first cut, then decreased descendingly at the two other dates, such decrease almost reached about 22% in the second cut and 10% in the last one either with phosphorus applications or when humic or magnetic were applied (Table 30 A, B, C).

Mycorrhizal application (R+M) significantly promoted plant height allover the rest of P-applications, also rock phosphate + phosphorin, Monophosphate , super phosphate gave significantly descending response for plant height during the three cutting dates (Table 30-A).

Table (30-A):

Treatment \ Days	60	90	120
Super phosphate	80.75 d	64 d	58.5 d
Mono phosphate	96.75 c	76 c	68.75 c
Rock + phosphoine	120 b	93.25 b	82.5 b
Rock + Mycorrhiza	134.32 a	102.75 a	91 a

Table (30-B):

Treatment \ Days	60	90	120
Without humic acid (-) hum.	100.9 b	80.12 b	71.25 b
With humic acid (+) hum.	115 a	87.87 a	79.125 a

Table (30-C):

Treatment \ Days	60	90	120
Without magnetic Iron (-) Fe	104 b	82 b	73.25 b
With magnetic Iron (+) Fe	111.9 a	86 a	77.125 a

Table (30-D) :

Treatments	Second season	
	Without magnetic iron	With magnetic iron
Super phosphate (control)	62 g	69.7 f
Super + humic	67.3 ef	72 e
Monophos.	74.7 e	83.3 de
Monophos + humic	77.3 e	86.7 d
(Rock + Phosph)	89.3 d	97.7 c
(Rock + Phosph) + humic	94 c	113.3 a
(Rock + Myco)	103.7 b	111 a
(Rock + Myco) + humic	104.4 b	118.3 a

Humic application or magnetic iron treatments significantly stimulated plant height above the untreated ones during the three cutting dates (Table 30 B,C).

As for magnetic iron treatment either with (R+M) + humic or with phosphorin + Rock + humic significantly promoted the height of cutting plants above the other interactions except for Mycorrhiza + Rock without humic when combined with magnetic iron since it gave the same behaviour.

Here again as previously mentioned with Mycorrhiza + Rock when combined with humic and magnetic iron achieved significantly the tallest plants above the other different interactions in the three cutting dates, also phosphorin + Rock + humic combined with magnetic iron or Mycorrhiza + Rock without humic with magnetic iron followed that detected by Mycorrhiza with the previous treatments during the three cutting dates (Table 30).

2. Number of leaves:

Number of leaves of sorghum plant tended to increase to reach their maximum during the second cutting date for different treatments either for phosphorus applications or humic and magnetic iron then tended to decrease in the third cutting date. Such increase ranged between 264% to 397.5% for super phosphate and R+M treatments respectively, whereas the reduction recorded for super phosphate treatment was 31%. Meanwhile such reduction was almost 10% for R+M in the last cutting (Table 31-A).

The increase or decrease for humic application on those untreated with humic did not differ greatly. Whereas, magnetic iron gave almost the same number in the second cutting date, yet the reduction at the last cutting was less than the second cutting for the untreated plants (without magnetic iron) (Table 31 B,C).

Table (31-A):

Treatment \ Days	60	90	120
Super phosphate	7 d	18.5 d	12.75 d
Mono phosphate	9.25 c	27.25 c	21 c
Rock + phosphoine	9.75 b	34.75 b	31.5 b
Rock + Mycorrhiza	10 a	39.75 a	35.5 a

Table (31-B):

Treatment \ Days	60	90	120
Without humic acid (-) hum	8.5 a	28.75 b	24.0 b
With humic acid (+) hum	9.3 a	31.37 a	26.37 a

Table (31-C):

Treatment \ Days	60	90	120
Without magnetic Iron (-) Fa	8.25 b	32.25 a	22.87 b
With magnetic Iron (+) Fa	9.5 a	32.62 a	27.5 a

Table (31-D):

Treatments	Second season	
	Without magnetic iron	With magnetic iron
Super phosphate (control)	10.7 g	13.3 f
Super + humic	12 f	15 e
Monophos.	16.3 e	20 d
Monophos + humic	18.7 de	21.7 d
(Rock + Phosph)	22.3 d	24.7 c
(Rock + Phosph) + humic	23.3 c	30.3 ab
(Rock + Myco)	27 be	28.7 b
Rock + Myco) + humic	26 b	32 a

Regarding the first order interaction, R+M significantly recorded the highest leaf numbers during the three cutting dates followed by R+P, MP and SP respectively. Also humic acid applications significantly stimulated leaf numbers above the untreated ones during the last two cutting dates. Magnetic iron application also recorded significant stimulation of leaf number than untreated (without magnetic iron during the first and last cutting dates) yet this number of leaves did not differ during the second cutting date. Humic and magnetic application also reduced leaf number in the last cutting date to be approximately around 15%.

The second order interaction R+M or R+P with humic significantly stimulated number of leaves when combined with magnetic iron against the other interactions (Table 31-D).

Table (31), illustrate that R+P or R+M treatments when combined with humic as well magnetic iron recorded significant increase of leaf number per plant in the three cutting dates above the other interactions.

3. Leaf area:

Leaf area of sorghum plant increased sharply to reach, its maximum at the second cutting date, then tended to decrease slightly at the last one (120 days) this was almost true either with P-applications or humic or magnetic additions (Table 32-A, B, C).

The differences between P-applications during the 1st cutting date (60 days) was 312%, 248% and 150% for R+M, R+P and MP treatments when compared with control (SP). Moreover R+M application recorded highly significant increase for leaf area during the three cutting dates followed by R+P, MP and finally the control (SP). Also, addition either humic or magnetic iron stimulated leaf area of sorghum plant during the three cutting dates when compared with control of each treatments (Table 32-A, B, C).

Here again as previously mentioned with the number of leaves R+M and R+P with humic when combined with magnetic iron application significantly reflected itself with leaf area, to be highly significant when combined with magnetic iron.

With respect to the three order interactions. It's evident that the same trend previously obtained with P-applications was detected with leaf area except for the increase recorded with SP when applied without magnetic iron which tended to increase leave area till the last cutting dates, which may be the resultant of the increase detected with number of tillers at the same age with the same treatment (Table 32-D).

Table (32-A):

Treatment / Days	60	90	120
Super phosphate	466.92 d	2027.5 d	1709.5 d
Mono phosphate	702.20 c	2129.25 c	1989.5 c
Rock + phosphoine	1159.92 b	2645.25 b	2280 b
Rock + Mycorrhiza	1456.32 a	2737.25 a	2445 a

Table (32-B):

Treatment / Days	60	90	120
Without humic acid (-) hum	868.8 b	2401.75 b	2061 b
With humic acid (+) hum	910.1 a	2492.75 a	2151 a

Table (32-C):

Treatment / Days	60	90	120
Without magnetic Iron (-) Fe	805.35 b	2366.62 b	1805.88 b
With magnetic Iron (+) Fe	1112.24 a	2527.87 a	2180.375 a

Table (32-D):

Treatments	2nd season	
	Without magnetic iron	With magnetic iron
Super phosphate (control)	1025.07 g	1319.73 f
Super + humic	1368.47 f	1549.30 e
Monophos.	1574.0 e	1754.40 d
Monophos + humic	1625.70 d	1806.90 cd
(Rock + Phosph +)	1868.01 c	2043.91 b
(Rock + Phosph) + humic	1961.10 c	2240.55 a
(Rock + Myco)	2073.00 b	1883.40 b
Rock + Myco) + humic	2140.97 b	2420.74 a

On the other hand (R+M) + humic when combined with magnetic iron significantly stimulated leaf area of sorghum plant above the other combinations during the three cutting dates followed by R+P + humic when combined with magnetic iron particularly in the second and last cutting dates (Table 32).

4. Number of tillers :

Number of tillers recorded in the second and third cutting dates indicate that R+M treatment significantly gave large number of tillers above the other P-applications which descendingly ran parallel to that recorded with the leaf number (Table 33-A).

Also humic acid applications gave the same as that of leaf number, whereas the level of significance differed for magnetic iron applications when compared with number of leaves since the increase of tiller’s number due to magnetic application recorded significant values only at the second cutting dates whereas the last cutting of the 2nd season was almost the same for magnetic (Table 33-B,C).

Table (33-A):

Treatment \ Days	Branch number cut one		Branch number cut two	
	First	Second	First	Second
Super phosphate	2.5d	2.25d	3.5d	3.75d
Mono phosphate	5.5c	3.25c	7.2c	5.25c
Rock + phosphoine	6.75b	4.0b	8.75b	5.5b
Rock + Mycorrhiza	8.00a	5.0a	9.7a	7.75a

Table (33-B):

Treatment \ Days	Branch number cut one		Branch number cut two	
	First	Second	First	Second
Without humic acid (-) hum.	3.87a	3.87a	6.0a	6.0a
With humic acid (+) hum.	3.375b	3.375b	5.125b	5.125b

Table (33-C):

Treatment \ Days	Branch number cut one		Branch number cut two	
	First	Second	First	Second
Without humic acid (-) hum	4.86b	3.37b	7.12b	5.5a
With humic acid (+) hum	5.75a	3.87a	7.5s	5.75a

The second order interaction reveale that R+M either with or without humic significantly stimulated number of tillers when combined with magnetic iron (Table 33-D).

Also, (R+M) + humic without magnetic iron significantly stimulated number of tillers above the other combinations at both cutting dates (90 & 120 days). R+M treatment singly or with humic when each combined with or without magnetic iron significantly promoted number of tillers above the rest of interactions particularly in the second season. Since (R+M) + humic + magnetic or without magnetic achieved significant number of tillers as well R+M without humic when combined with magnetic iron application (Table 33-D).

5. Plant dry weight:

Dry matter accumulation of sorghum plant during three successive cuttings, tended to decrease with ageing of plant, such reduction was about 37.5% for R+M at the second cutting date whereas at the last one the reduction recorded was about 42.5%. On the other hand, the reduction were about 38.5%, 44% and 37%, 45% for R+P and monoammonium phosphate treatments at the second and third cutting dates respectively (Table, 34-A).

Dry matter accumulation achieved significantly higher magnitudes with R+M treatment followed by R+P, MP and SP respectively in the three cutting dates (Table 34-A).

Humic application almost gave the same pattern obtained with P-treatments with significant increase for humic addition against the untreated ones at the three cutting dates (Table 34-B).

Table (33-D):

Treatments	1st season		2nd season	
	Without magnetic iron	With magnetic iron	Without magnetic iron	With magnetic iron
Super phosphate (control)	2.5 d	3.5 c	2.5 e	3 e
Super + humic	2.5 d	3.5 c	2.5 e	4 d
Monophos.	5.5 c	7 b	4 d	4 d
Monophos + humic	6 c	7 b	4 d	5 c
(Rock + Phosph)	7 bc	8 ab	4 d	5 c
(Rock + Phosph) + humic	8 b	8 ab	4.5 c	5.5 b
(Rock + Myco)	8 b	9 a	6 b	6.5 a
(Rock + Myco) + humic	9 a	9 a	6.5 a	6.5 a

On the other hand magnetic iron applications negligibly affected dry matter accumulation with the last two cutting dates since it was the same. Meanwhile the plants untreated with magnetic iron ran parallel to the previous P- and humic treatments (Table 34-C).

Table (34-A):

Treatment \ Days	60	90	120
Super phosphate	103.5 d	66 d	55 d
Mono phosphate	124 c	77.75 c	68.25 c
Rock + phosphoine	160.5 b	98.5 b	90.25 b
Rock + Mycorrhiza	180.075 a	112 a	103.0 a

Table (34-B):

Treatment \ Days	60	90	120
Without humic acid (-) hum	136 b	85.12 b	77.5 b
With humic acid (+) hum	148.03 a	93.25 a	83.25 a

Table (34-C):

Treatment \ Days	60	90	120
Without magnetic Iron (-) Fe	133 b	82.12 a	73.6 b
With magnetic Iron (+) Fe	151.03 a	84.4 a	84.63 a

Table (34-D):

Treatments	2nd season	
	Without magnetic iron	With magnetic iron
Super phosphate (control)	68.7f	77ef
Super + humic	73f	80.7e
Monophos.	82.3e	92de
Monophos + humic	87.7e	98d
(Rock + Phosph)	102.3d	115c
(Rock + Phosph) + humic	108.7d	139.7ab
(Rock + Myco)	124.7b	131ab
(Rock + Myco) + humic	122.7b	148.4a

The second order interaction of (R+M) + humic when combined with magnetic iron stimulated significantly dry matter production above the rest of the interactions. Meanwhile (R+P) + humic or R+M when combined with magnetic iron were almost the same and came directly after the previous treatment (Table, 34-D).

On the other hand, R+M either with or without humic and without magnetic iron gave also the same effect on dry matter accumulation to be significantly higher than the rest of other treatments (Table, 34-D).

R+M or R+P when combined with humic and magnetic iron applications accumulated dry matter production during the three cutting dates to record significantly an increase above the other interactions. In the first cutting date (R+M) + humic with magnetic iron application surpass that of R+P + humic with magnetic to reach the level of significance at the last two cuttings (Table, 34).

R+M treatment either with or without magnetic promoted dry matter production to follow the first two treatments when combined with magnetic iron. Moreover, R+M when combined with magnetic iron increased dry matter production than those untreated with magnetic to reach 6% in the first two cutting dates and 3% at the last one (Table 34).

6. Cutting yield (ton/fedan):

Cutting yield of sorghum plants during the three cutting dates indicate that the yield decreased with advancement of cutting date which varied within P-treatments applied since it was about 35% and 48% for super phosphate application for the second and third cuttings respectively of the first season (Table 35-A).

Whereas the reduction for R+M application at the same cutting dates were 29%, 35% respectively in the 1st season. Such reduction, were approximately 30%, 45% and 25%, 39% respectively for the same treatments in the second season (Table 35-A).

R+M with or without humic significantly increased cutting yield when combined with magnetic iron than the other interactions in both seasons as well those untreated with magnetic in the first one (Table 35-D).

R+P also with or without humic attained the same level of significance for cutting yield as R+P without magnetic in the second season.

Third order interaction reveale that (R+M) + humic and magnetic iron significantly increased cutting yield at the different dates as well R+M with magnetic at the first cutting date of both seasons above the rest of the interactions. The last treatment extended to produce high cutting yield at 90, 120 days of both seasons than the other interactions (Table 35).

Table (35-A):

Treatment \ Days	60		90		120	
	First	Second	First	Second	First	second
Super phosphate	5.1 d	5.65d	3.3 d	3.95d	1.725d	2.147d
Mono phosphate	5.85 c	6.4c	3.95 c	4.82c	2.275c	2.575c
Rock + phosphoine	6.7 b	6.95b	4.52 b	5.42b	2.775b	3.275b
Rock + Mycorrhiza	7.3 a	7.75a	5.2 a	5.77a	3.4a	3.525a

Table (35-B):

Treatment \ Days	60		90		120	
	First	Second	First	Second	First	second
Without humic acid (-) hum	6.15b	5.92b	4.15b	4.3b	2.45b	2.72b
With humic acid (+) hum	6.325a	6.71a	4.33a	4.5a	2.63a	2.9a

Table (35-C):

Treatment \ Days	60		90		120	
	First	Second	First	Second	First	second
Without magnetic Iron (-) Fe	6.08b	6.51b	4.05b	4.28b	2.425b	2.38b
With magnetic Iron (+) Fe	6.418a	6.86a	4.43a	4.5a	2.675a	2.93a

Duncine within each date and each season.

Table (35-D):

Treatments	First season		Second season	
	Without magnetic iron	With magnetic iron	Without magnetic iron	With magnetic iron
Super phosphate (control)	3.1f	3.5e	3.7e	3.9de
Super + humic	3.3e	3.7d	3.9de	4.2cd
Monophos.	3.8d	4.1c	4.4c	4.6c
Monophos + humic	4.0c	4.3cd	4.5c	4.8cb
(Rock + Phosph +)	4.2b	7.7ab	4.9b	5.3ab
(Rock + Phosph) + humic	4.6b	4.9ab	5.0b	5.4ab
(Rock + Myco)	5.0a	5.4a	4.9b	5.7a
(Rock + Myco) + humic	5.2a	5.6a	5.5ab	6.0a

Duncine within each season.

B. Chemical constituent in cutting plant:

B.2.1. Macronutrient contents:

a. Phosphorus:

The total P content and its fractions in shoot of sorghum plants at three cutting dates in two successive seasons are presented in Tables (36, 37, 38, 39 & 40) and illustrated in Figures (73-84). The total P content as well its fractions were greater at the second cutting date than those found at the first or third cutting dates. In contrary to that obtained in intact

plant which gained less content at the last sampling date (120 days after sowing), the last cutting gained almost tantamount content at those of the first cut or slightly increased. The reduction recorded at the last cutting against the second one, with rock phosphate application either with phosphorin or mycorrhiza in presence or absence of humic acid when combined with magnetic iron reached about 13.5% & 11% for the first P application in both seasons, where it reached 12.7% & 8.0% for the second treatment (R+M with or without humic acid) in both seasons respectively.

Concerning the main fraction of total P in plant shoot, it is evident that the total soluble P is the main form which occupied ~85% of total P within different applications and inorganic P formed the main fraction of total soluble P to record 81% of total soluble P. to be similar to that found for intact plants in both seasons.

Concerning the effect of different P fertilizers on total P content and its fractions in plant shoot at all cutting dates in both seasons, it is clear that mycorrhizal rock phosphate combined with humic acid and magnetic iron achieved the highest P contents in shoot above all other applications. This was true at the three cutting dates in both seasons. However, in case of cutting plants, the beneficial effect of R+M was increased by advancing the cutting dates against super phosphate treatment. Since the R+M application stimulated P content to be around 12.7 at the 1st cutting date which reached 23% at the last one, in both seasons. Meanwhile, such increase did not exceed 12.7% for intact plant for the same treatment at the three sampling dates of both seasons. However, SP treatments responded clearly to humic acid or magnetic iron applications compared with other P treatments, at different sampling dates in both seasons.

b. Nitrogen content and crude protein:

Total N and crude protein contents of sorghum plant during the two seasons recorded the highest values of N or crude protein at the first cutting date then decreased in the two successive cutting dates to reach the lowest content at the third cutting date. However, super phosphate treatment presented a slight increase of N content at the 3rd cutting date compared with the second one, in the first season, Tables (41 & 42) and Figs. (93-100).

As for the fertilizers effect on the N content, it is clear that MR combined with or without humic acid promoted total nitrogen content either with or without magnetic iron compared with SP treatments, in the second season above those of the first one, during the three cutting dates. Such behavior was detected with PR treatments when combined with or without magnetic iron to extend only till the second cutting date.

c. Potassium:

Data in Table (43) and Figs. (101-104) clearly show that the Potassium content in shoot recorded the maximum accumulation at the second cutting date then decreased at the last one, yet it was slightly higher than that recorded in the first cut. Such increase and decrease reached between 35% and 24% in both seasons respectively. Different P applications either with humic acid or magnetic iron negligibly affected K content at different cutting dates of both seasons.

d. Magnesium:

Magnesium content ran parallel with that obtained with K content at the different cutting dates, since the peak was achieved at the second cutting date, Table (44) and Figs. (105 - 108). However, first and last cuttings almost contain the same. Rock phosphate applications either with phosphorine or mycorrhiza stimulated Mg content above control (SP) to be within 2.5-3.3% respectively in the second cutting date in both seasons.

e. Calcium:

Data presented in Table (45) and Figs. (109-112) show that the Ca content in cutting plants almost achieved similar behavior for Potassium & Calcium since, second cutting date recorded the highest Ca content above the other two cutting dates. On the other hand, the first and last cuttings were almost the same with slight increase for the last one. However, the differences within P applications did not record clear effects.

f. Sulfer:

Apart from the increase recorded with SP singly or when combined either with humic acid or magnetic iron in the second cutting date of the first season, generally the other treatments of both seasons tended to decrease Sulfer content with advancement of cutting date. R+M either with humic acid or magnetic iron stimulated Sulfer content at different cutting dates above the other treatments during the two growth seasons, Tables (46) and Figs. (113-116). The other P applications of different cutting dates ran parallel to that recorded with intact plants, since rock phosphate + phosphorine, monoammonium phosphate and SP followed the same descending manner observed with intact plants.

B.2.2. Micronutrient content:

a. Iron:

Data in Table (47) and Figs. (117-120) illustrate that sorghum plant at the second cutting date promoted much higher iron content above first and last cutting dates in both seasons, such increase was 18.4% & 17.2% in both seasons. While the reduction at the last cutting date was below the next one by ~13.8% and 13.0% in both seasons respectively.

R+M treatment combined with humic acid either with or without magnetic iron increased iron content at the three successive cutting dates to be about 3.0% above those found with SP treatment (control), in both seasons.

b. Zinc:

Zinc content of sorghum plant recorded highest values during the second cutting date. On the other hand, the last cutting date slightly stimulated Zinc content in comparison to that of the first cutting of both seasons. R+M with humic acid recorded the highest Zinc content above the rest of treatments. This increase reached ~21% either with or without magnetic iron in the first and last cutting dates in both seasons against their controls. Whereas, it recorded 19% & 16% for the same treatment either without or with magnetic iron in the second cutting date in both seasons, respectively Table (48) and Figs. (121-128).

c. Manganese:

Data presented in Table (49) and Figs. (125-128) illustrate that Mn uptake of sorghum plant within different cutting dates gained much Mn in the second cutting date above the other two cutting dates except for R+M either with humic acid or magnetic iron. Since the cutting dates negligibly affected greatly Mn content to be almost the same or with slight less magnitude in the second cutting date. Since, the differences of the last treatment above SP treatment reached 61%, 56% in absence or presence of magnetic iron in the first and last cutting dates in both seasons. Whereas, such increase reached only about 9% in the second cutting date either with magnetic iron or without magnetic iron in both seasons.

d. Boron:

Data presented in Table (50) and illustrated in Figs. (133-136) show that Maximum B content was detected at the second cutting date of the first season, whereas, the repetition of these treatments in the same plots altered such behavior in the second one to reach its maximum content early at the first cutting date. On the other hand, magnetic iron application stimulated B content in particular with SP to reach about 20% above the untreated ones of both seasons, in the second cutting date, such differences with magnetic iron was less when combined with (R+M) + humic acid to reach 8.0% and 3.0% in both seasons in the same cutting date. So, for this reason the increase recorded for R+M against SP deferred in the presence than in absence of magnetic iron to be 69% or 61% & 91% or 88% in both seasons respectively. The same behavior was recorded in the last cutting date. The differences were 93% or 87% and 63% or 61% for absence and presence of magnetic iron when combined with (R+M) + humic acid in last cutting date of both seasons.

e. Copper:

The second cutting date of the different treatments stimulated Cu content of the sorghum plants in both seasons, , the first and last cutting dates almost had less content below the second one of both seasons Table (51) and Figs. (129-132). However, the reduction recorded at the second season was much announced than that detected of the first season. R+M treatments (with or without humic acid and magnetic iron) almost stimulated Copper content above the rest of treatments. The response of SP with magnetic iron application reflected self also as that obtained with boron. This, effect started early with the beginning of the first cut, which reached 61% for (R+M) + humic acid during the three cutting dates without magnetic iron application in the first season as well almost the second one. Meanwhile such increase recorded 88%, 82% and 63% for the three cutting dates in the 1st season and 88%, 91% & 87% of the second season.

B.2.3. Beneficial element:

Sodium:

Data presented in Table (52) and illustrated in Figs. (137-140) show that the trend obtained of intact plant was almost the same for cutting ones, since rock phosphate application with humic acid reduced sodium content at different cutting dates of both seasons, whereas super phosphate application singly accumulated much sodium above the rest of P applications. Also magnetic iron and humic acid treatments reduced sodium content for each P treatments. Moreover, the effect of magnetic iron was most effective in the second season, since the treatments were repeated in the same areas.

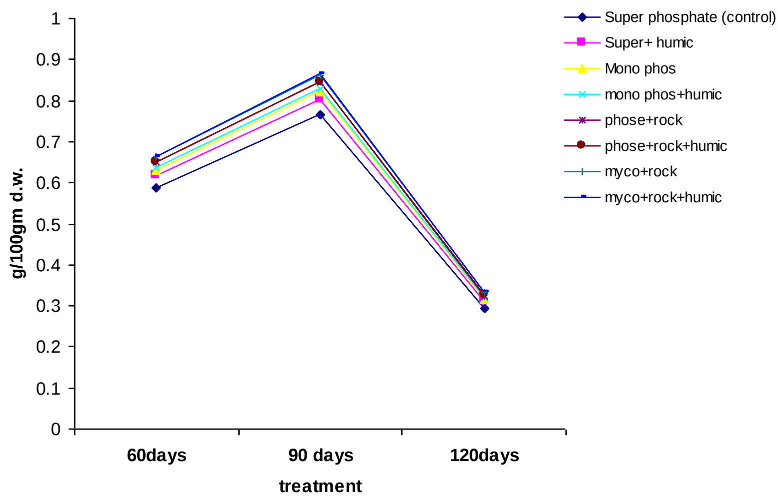

Fig.(1): Total phosphorus in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

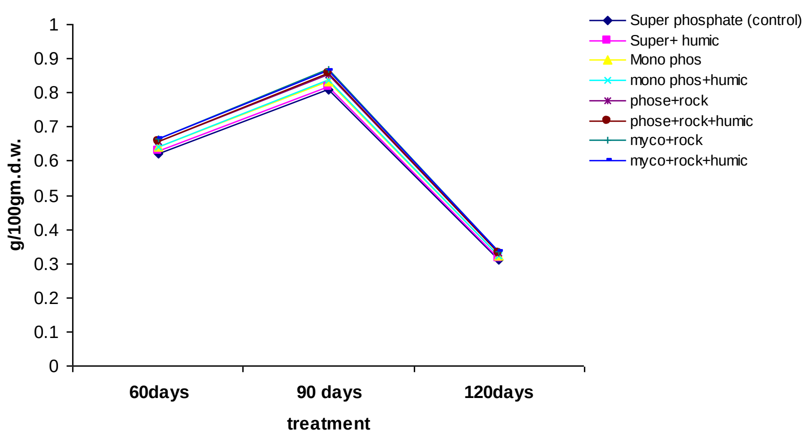

Fig.(2): Total phosphorus in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

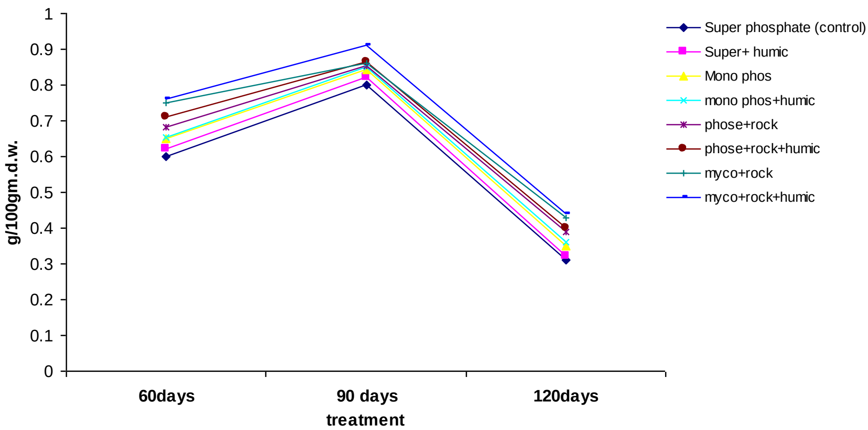

Fig.(3): Total phosphorus in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

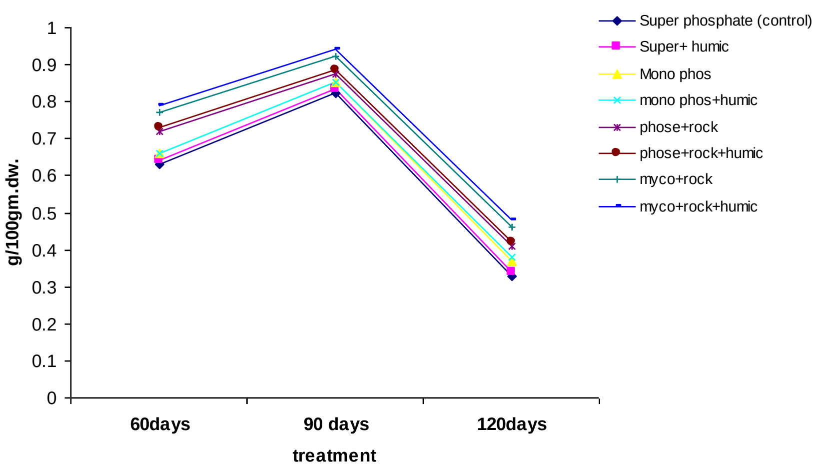

Fig.(4): Total phosphorus in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

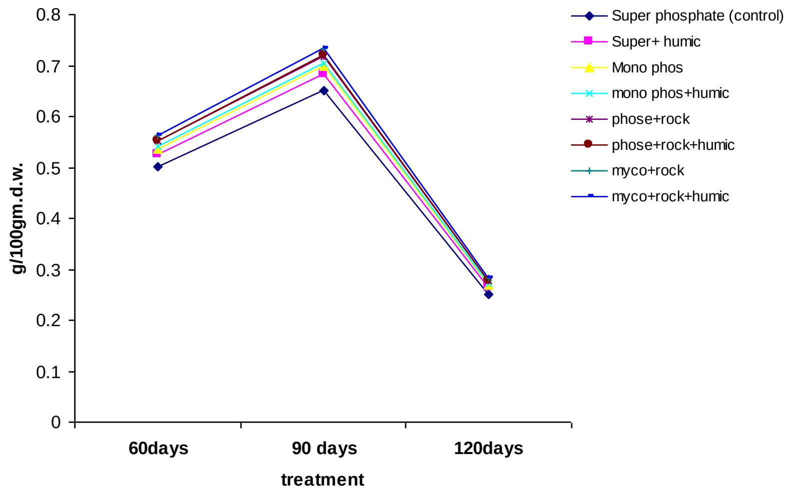

Fig.(5): Total soluble (p) in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

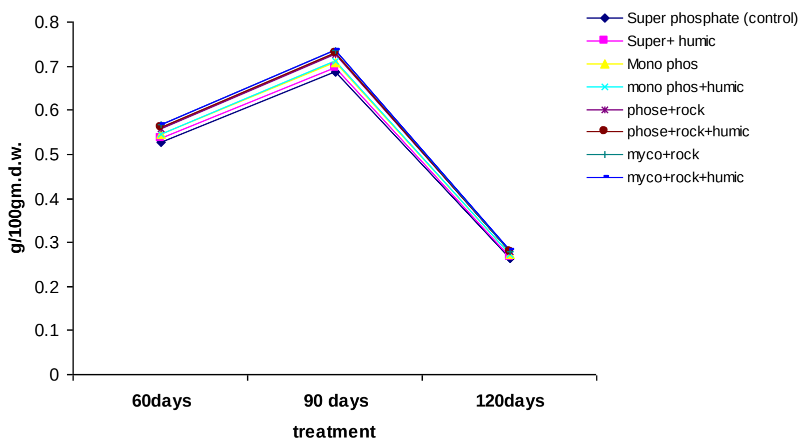

Fig.(6): Total soluble (p) in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

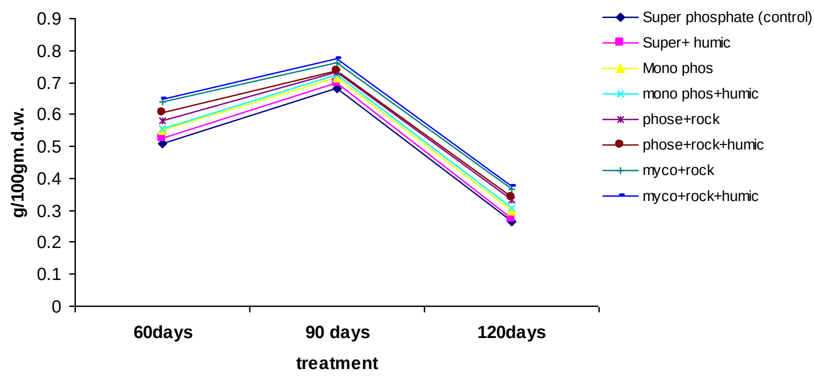

Fig.(7): Total soluble (p) in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

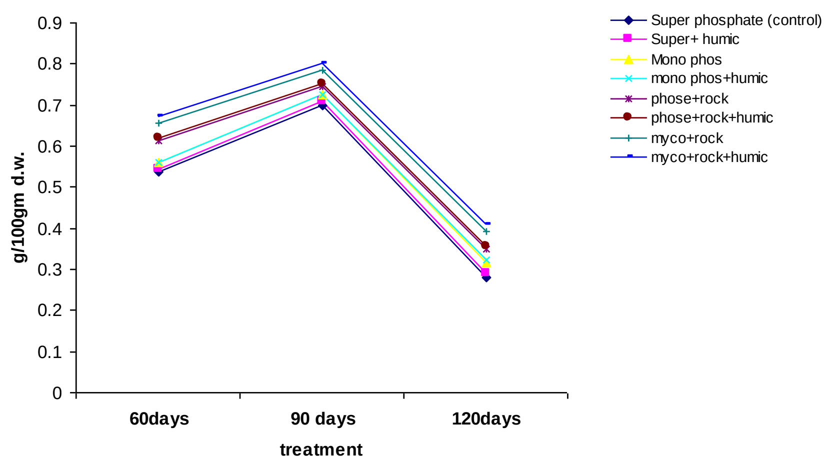

Fig.(8): Total soluble (p) in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

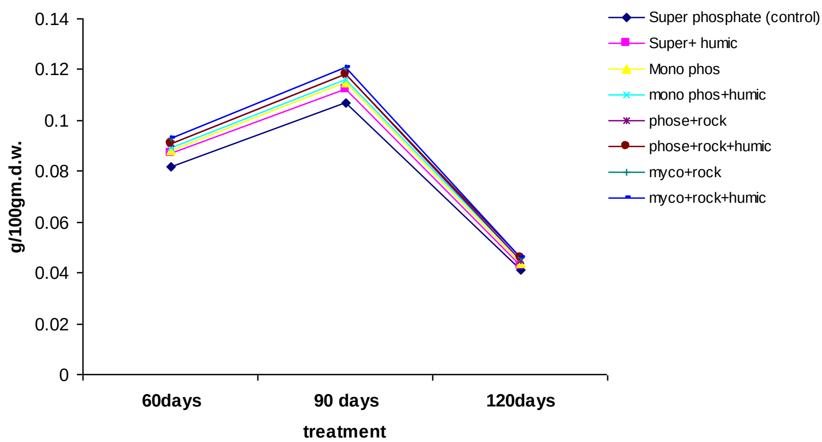

Fig.(9):Total insoluble (p) in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

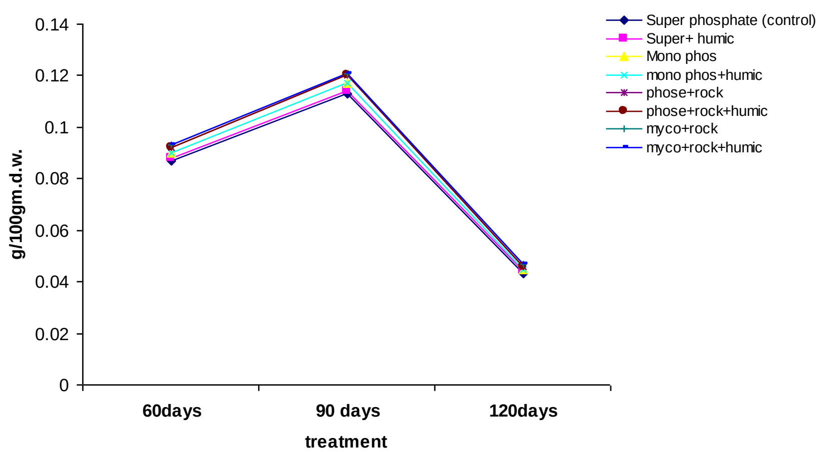

Fig.(10): Total insoluble (p) in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

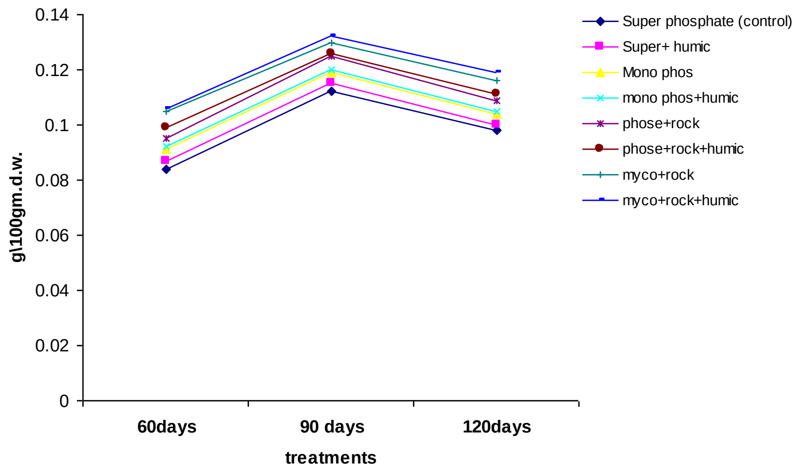

Fig.(11): Total insoluble (p) in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

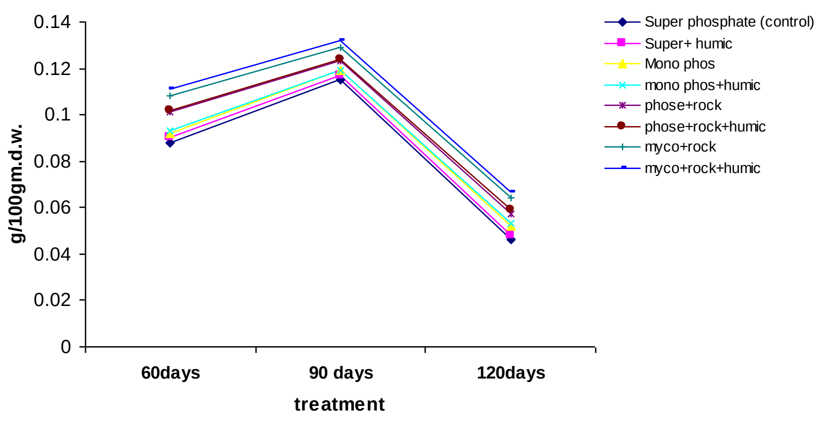

Fig.(12): Total insoluble (p) in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

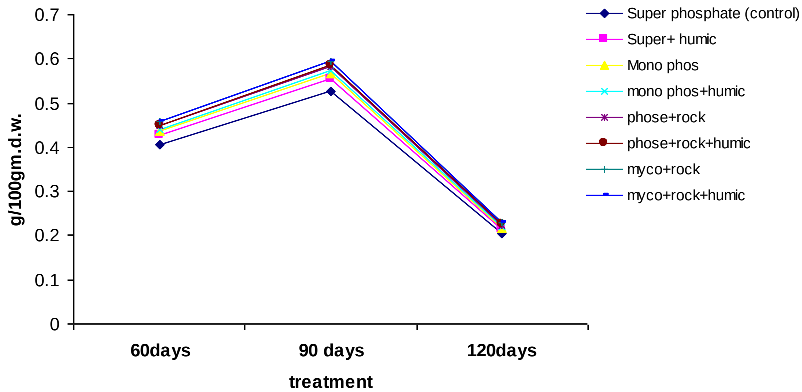

Fig.(13): Inorganic phosphorus in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

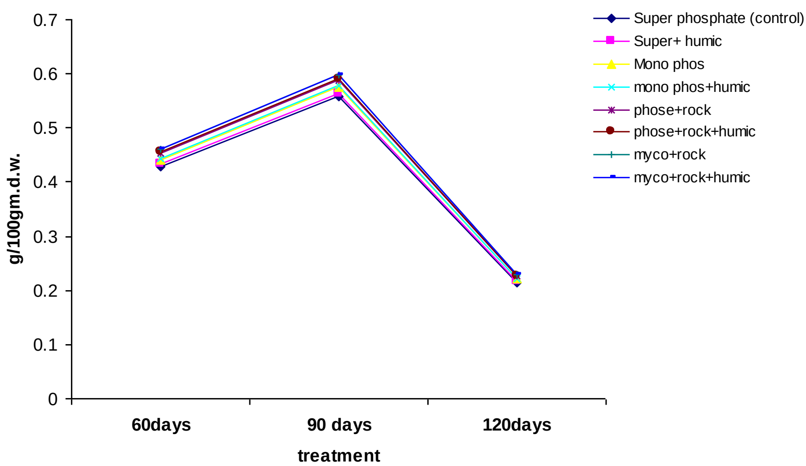

Fig.(14): Inorganic phosphorus in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

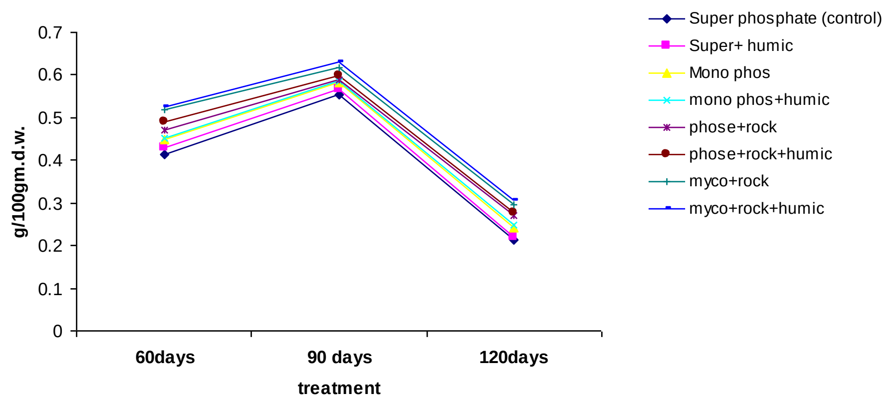

Fig.(15): inorganic phosphorus in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

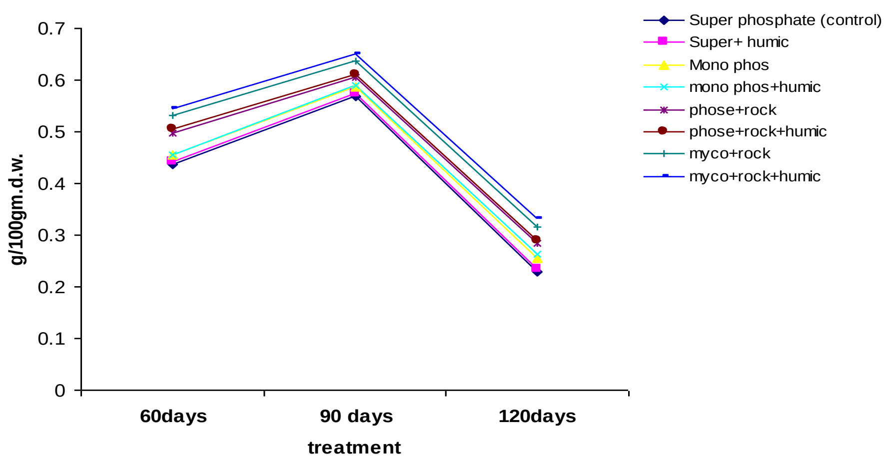

Fig.(16): Inorganic phosphorus in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

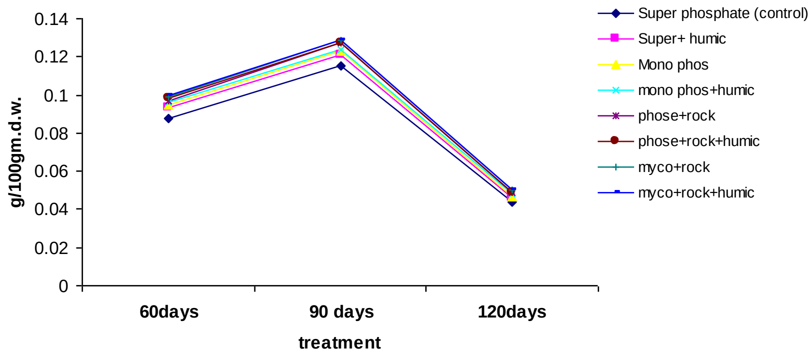

Fig.(17): Total soluble organic (p) in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

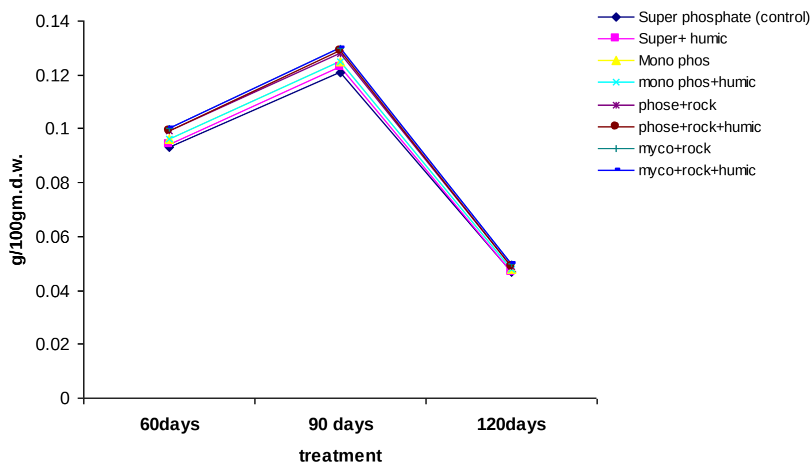

Fig.(18): Total soluble organic (p) in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

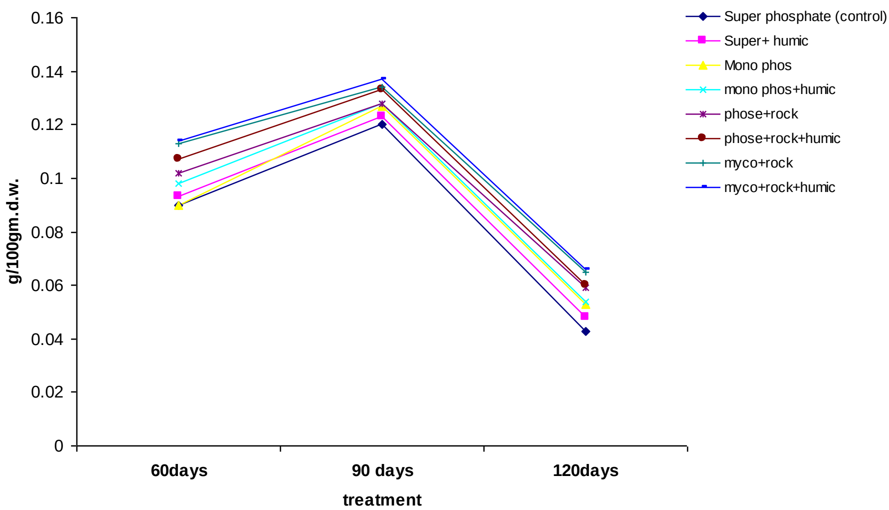

Fig.(19): Total soluble organic (p) in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

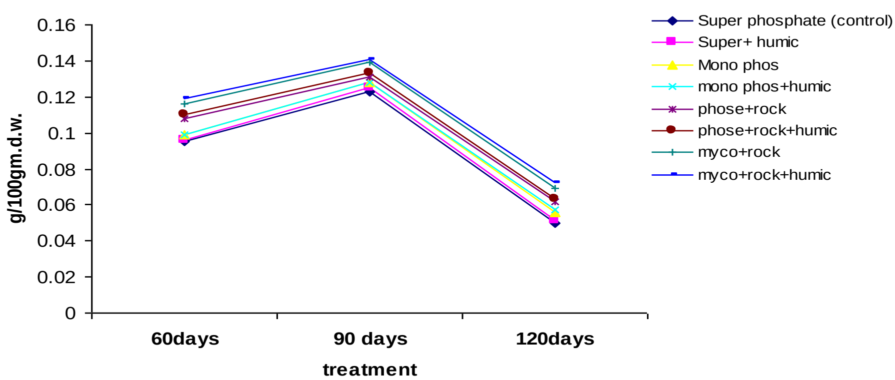

Fig.(20): Total soluble organic (p) in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

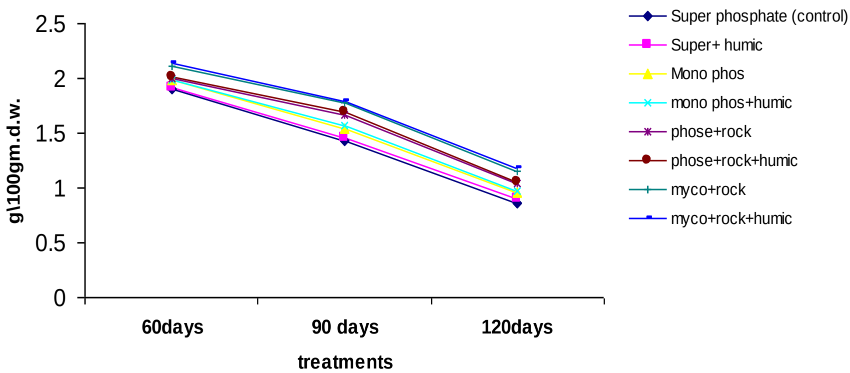

Fig.(21): Total nitrogen in shoot plant 60,90 and 120 days after sowing without iron 1st season.

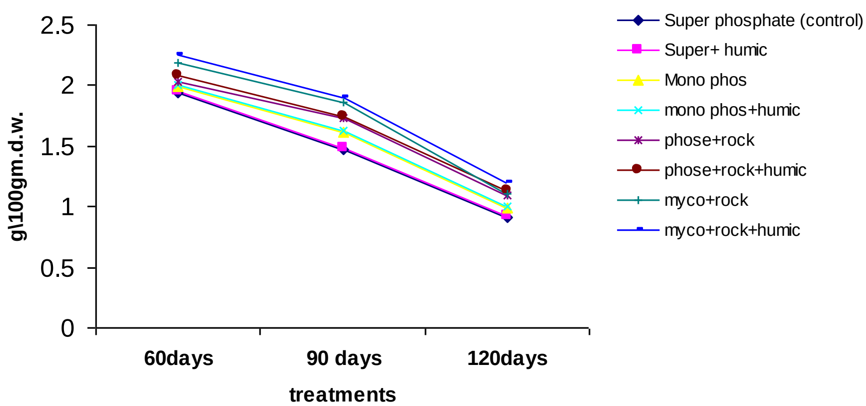

Fig.(22): Total nitrogen in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

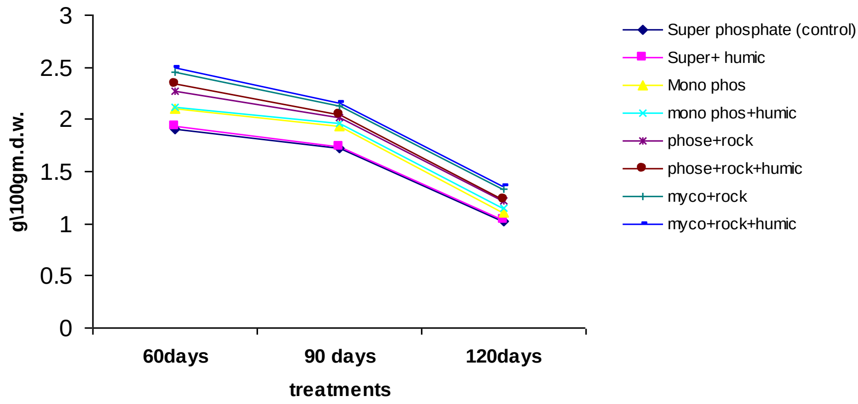

Fig.(23): Total nitrogen in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

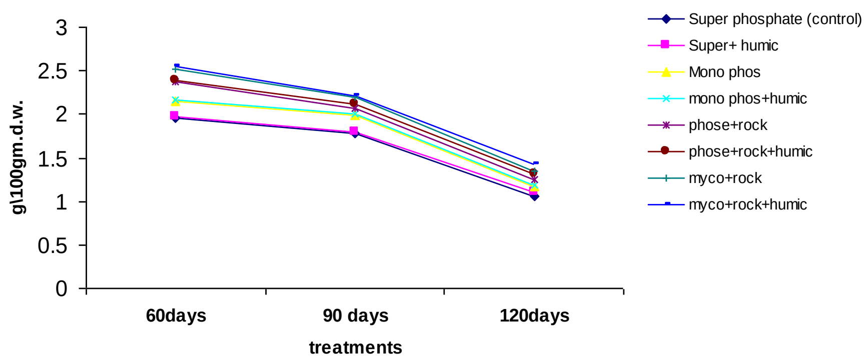

Fig.(24): Total nitrogen in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

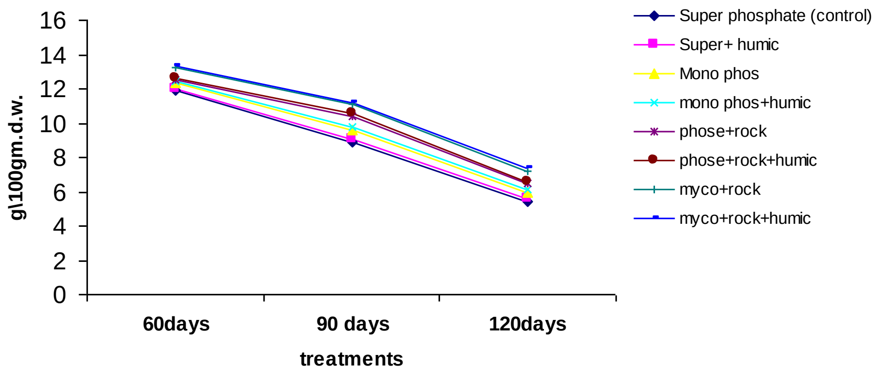

Fig.(25): Crude protine in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

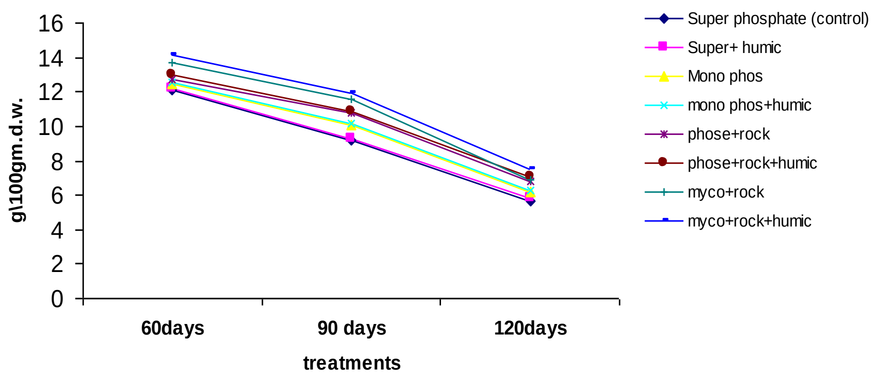

Fig.(26): Crude protine in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

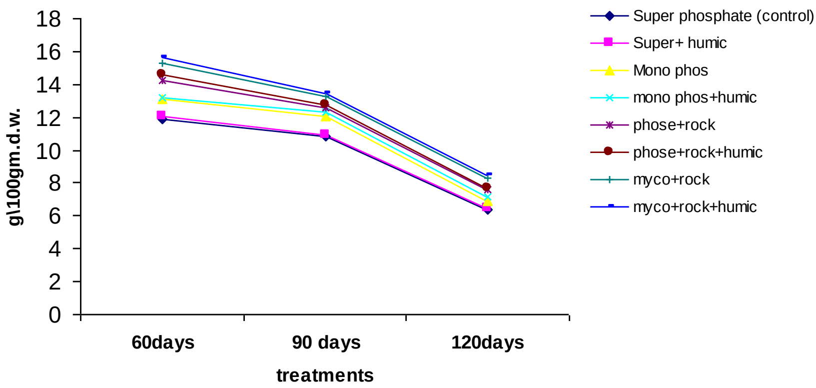

Fig.(27): Crude protine in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

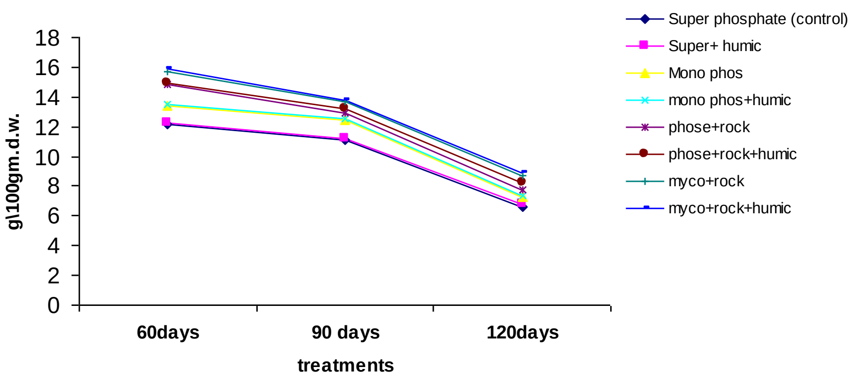

Fig.(28): Crude protine in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

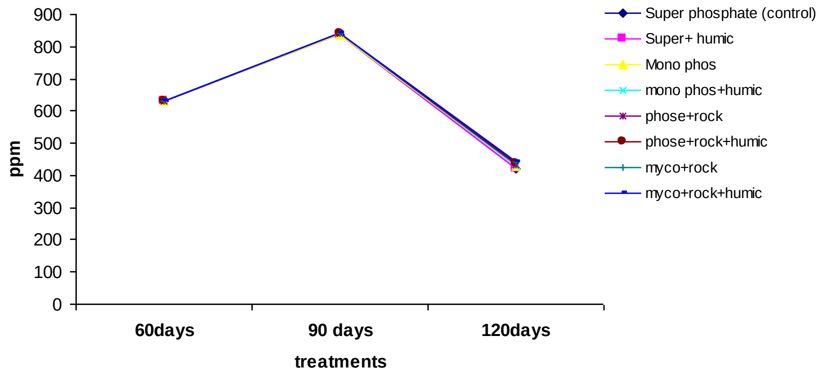

Fig.(29): Pottasium content in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

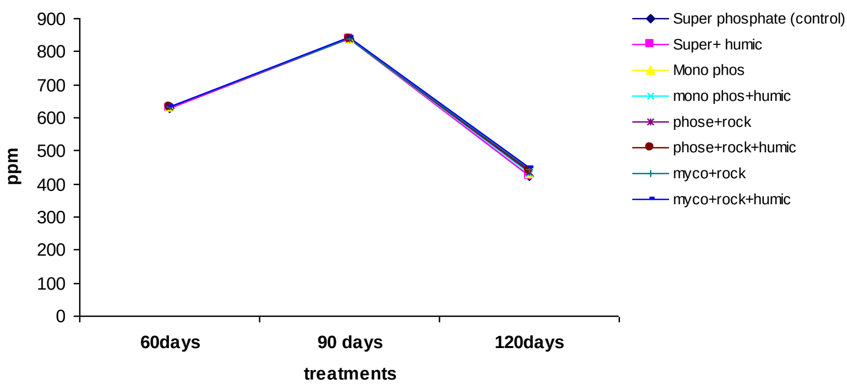

Fig.(30):Pottasium content in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

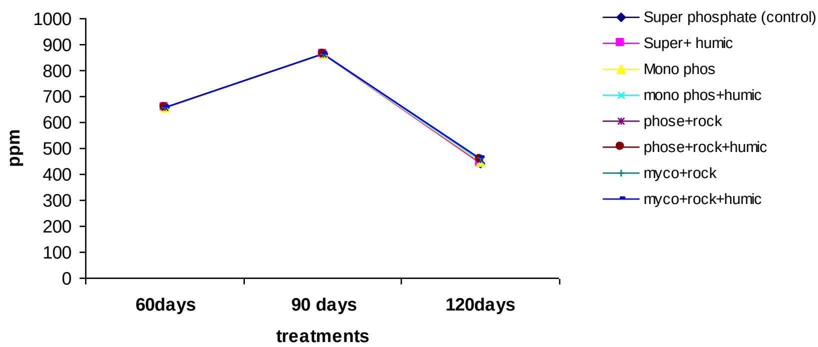

Fig.(31): Pottaasium content in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

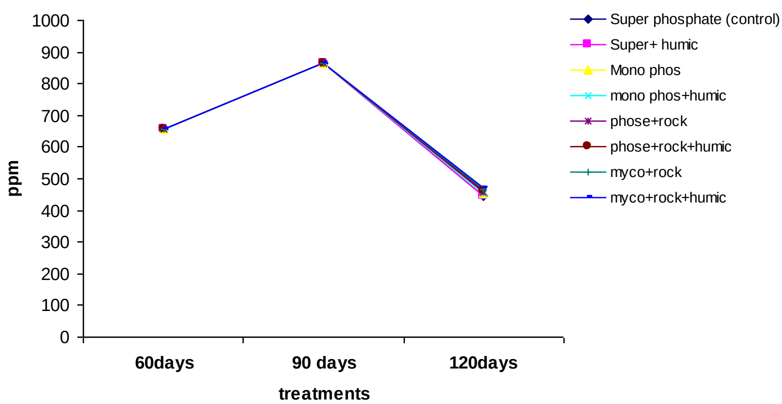

Fig.(32): Pottasium content in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

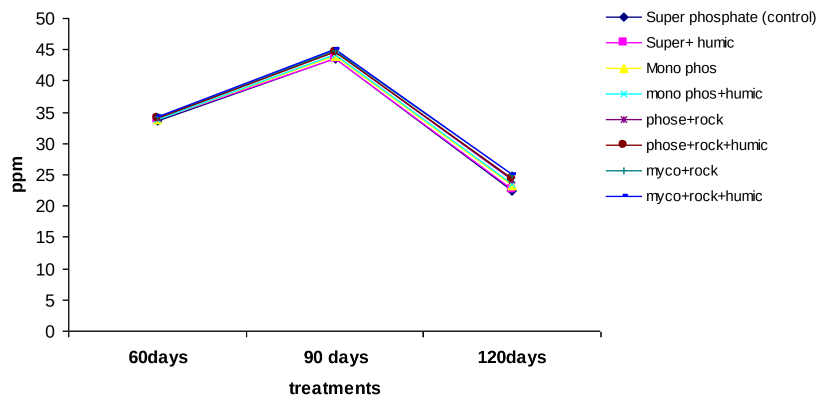

Fig.(33): Mangensium content in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

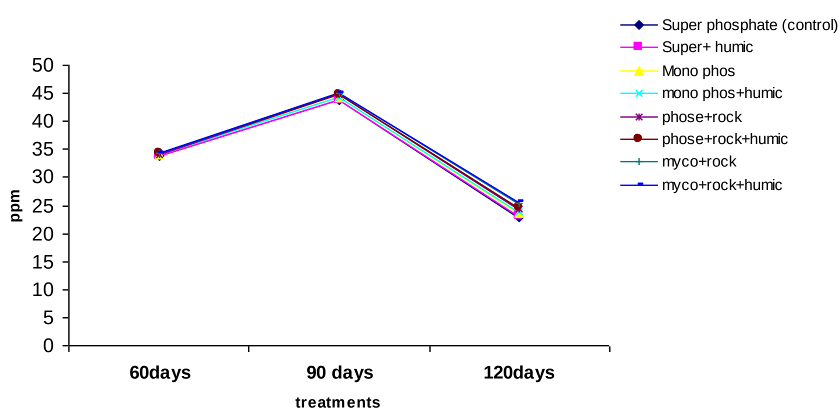

Fig.(34): Mangnesium content in shoot plant 60,90and 120 days after sowing with magnetic iron 1st season.

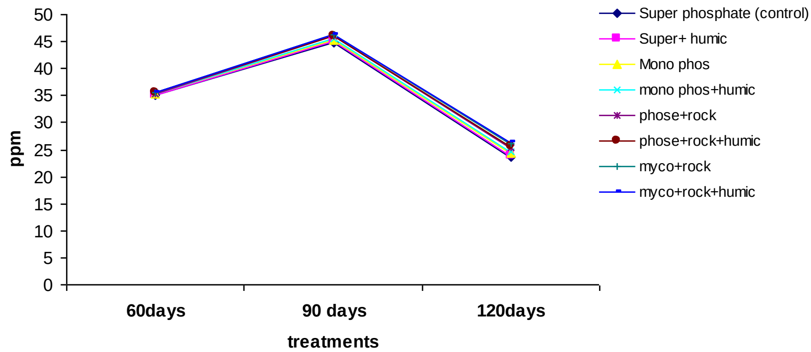

Fig.(35): Mangnesium content in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

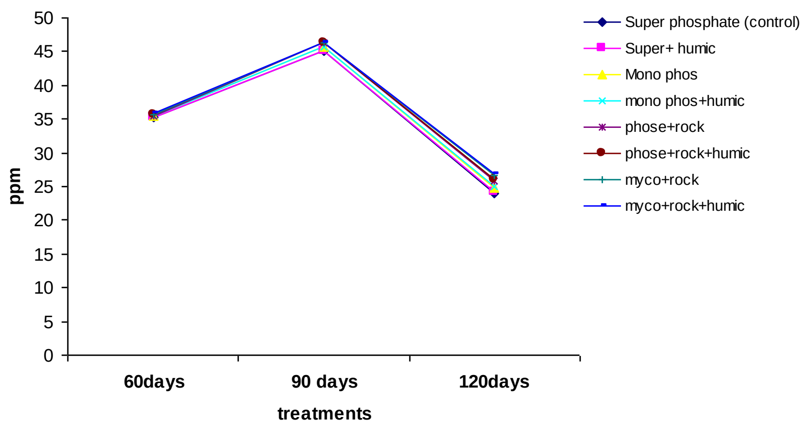

Fig.(36): Mangnesium content in whole plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

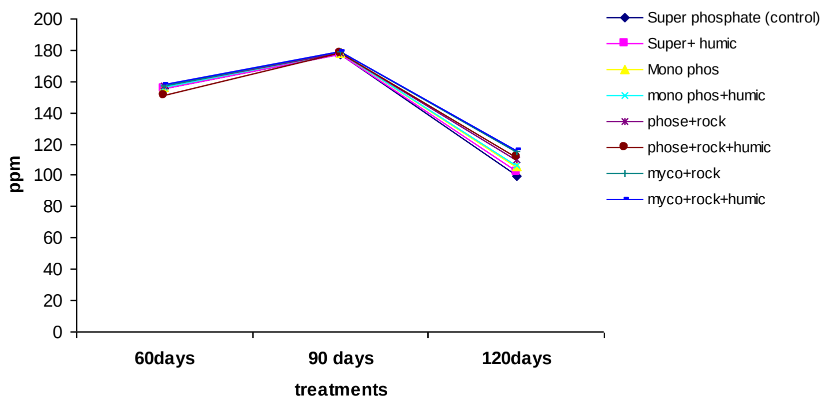

Fig.(37): Calcium content in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

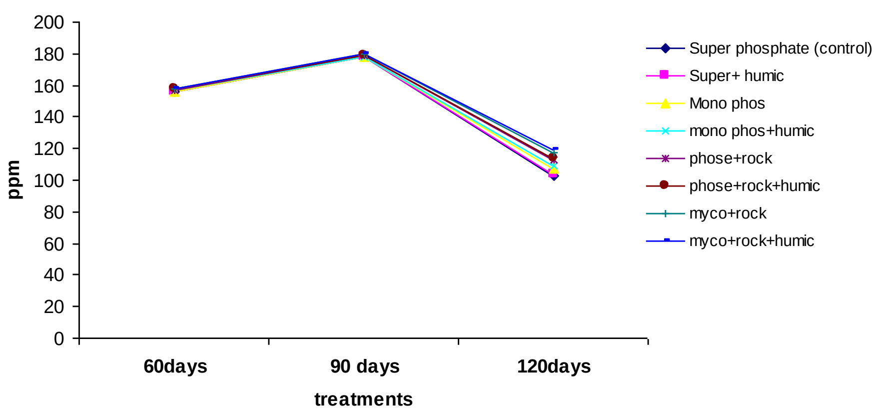

Fig.(38): Calcium content in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

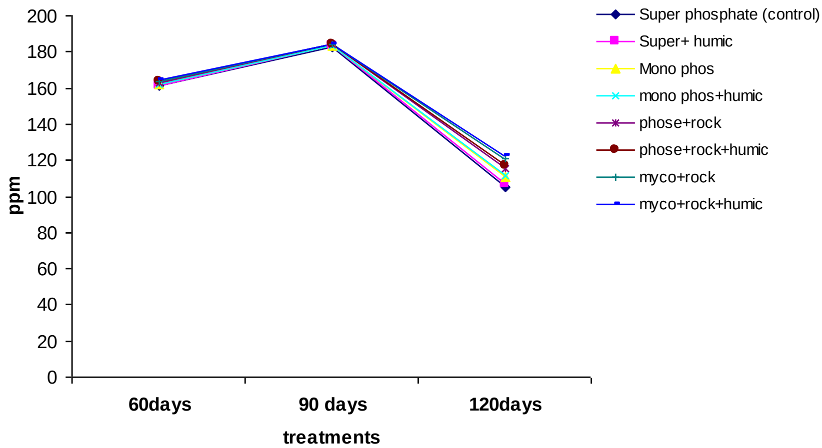

Fig.(39): Calcium content in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

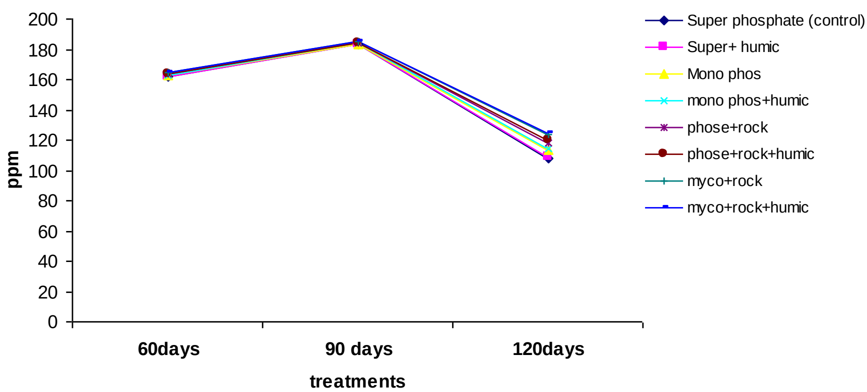

Fig.(40): Calcium content in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

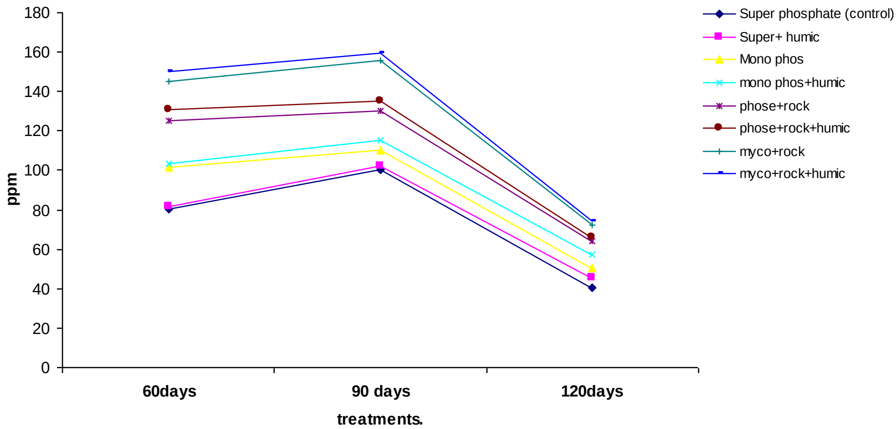

Fig.(41): Sulpher content in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

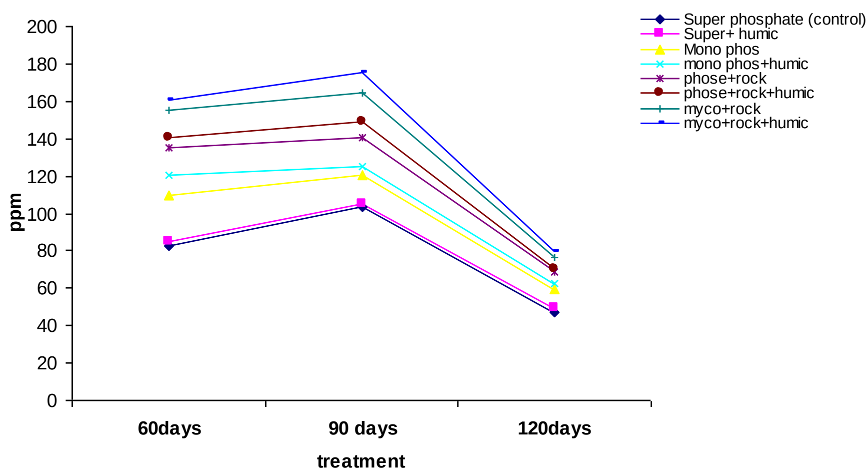

Fig.(42): Sulpher content in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

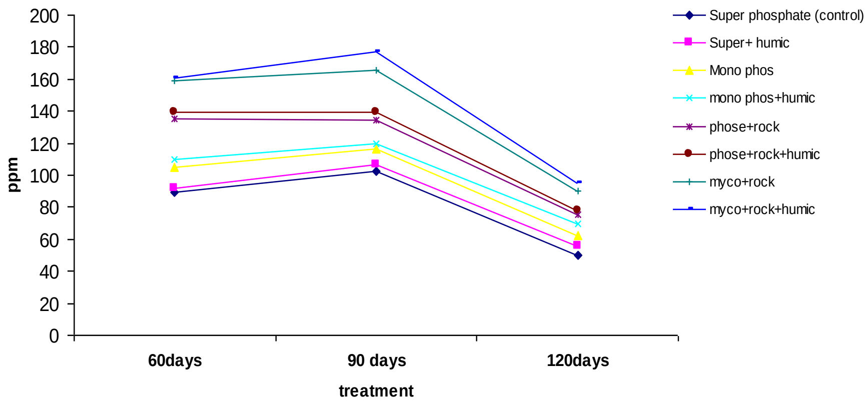

Fig.(43): Sulpher content in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

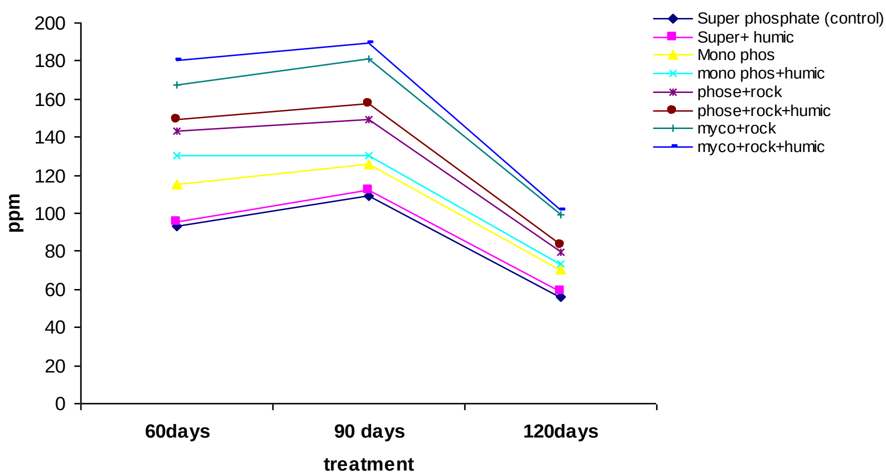

Fig.(44): Sulpher content in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

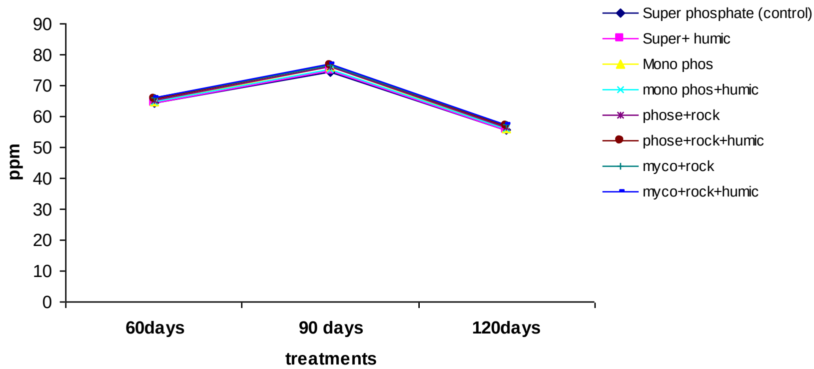

Fig.(45): Iron content in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

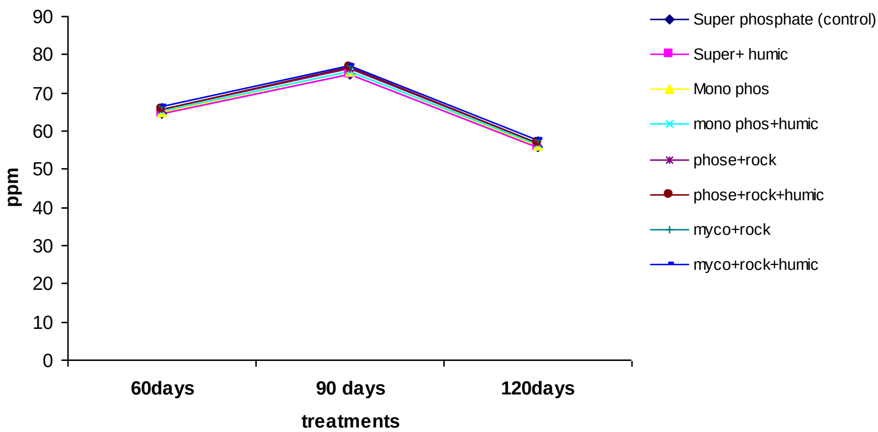

Fig.(46): Iron content in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

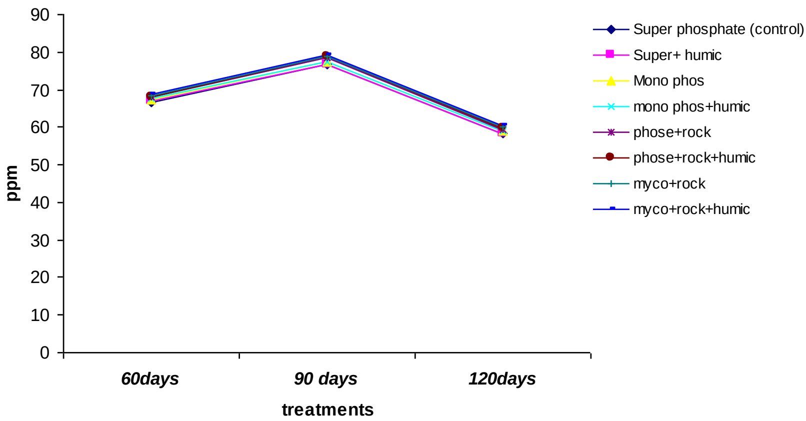

Fig.(47): Iron content in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

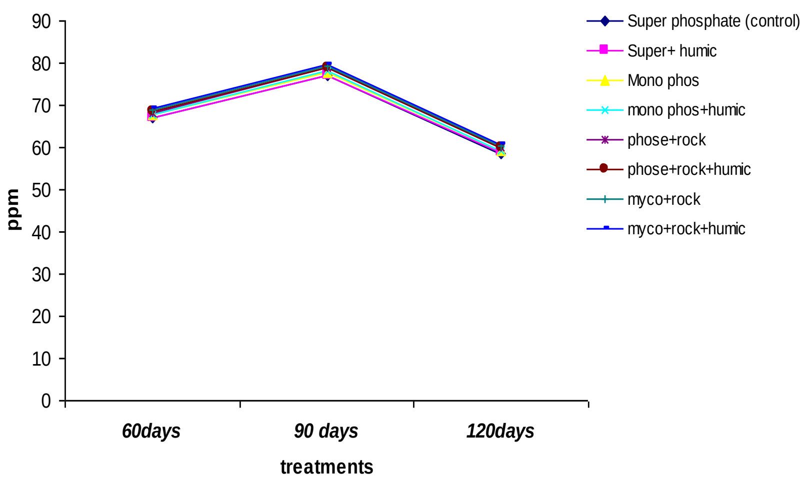

Fig.(48): Iron content in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

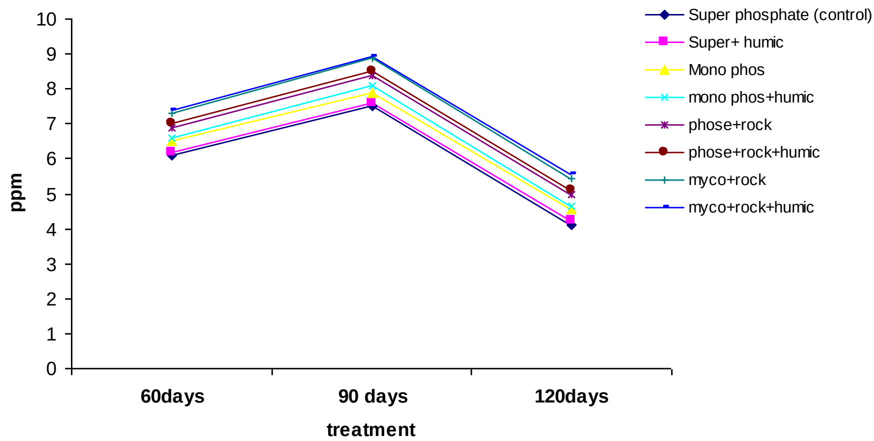

Fig.(49):Zinc content in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

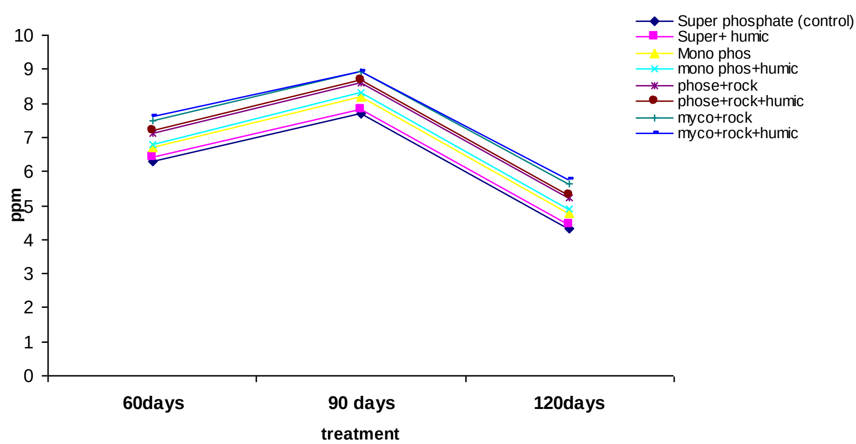

fig.(50): Zinc content in shoot plant 60,90 and 120 days after with magnetic iron 1st season.

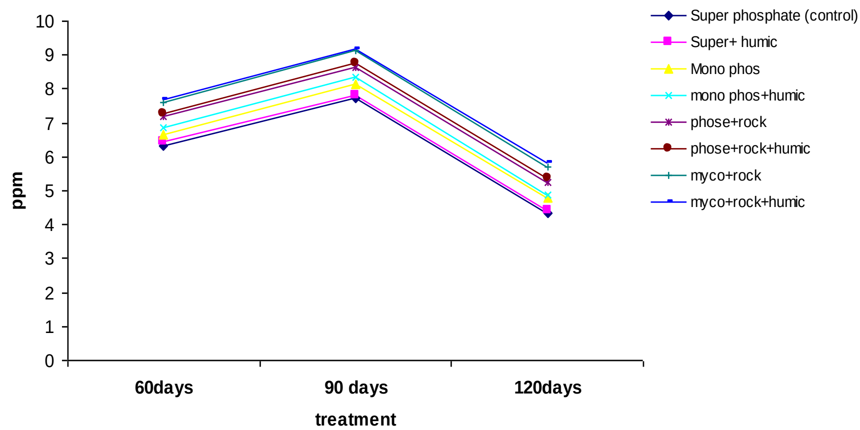

Fig.(51): Zinc content in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

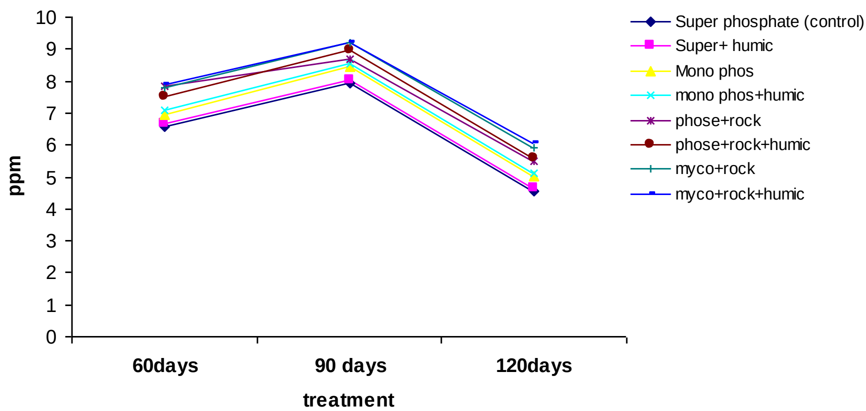

Fig.(52): Zinc content in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

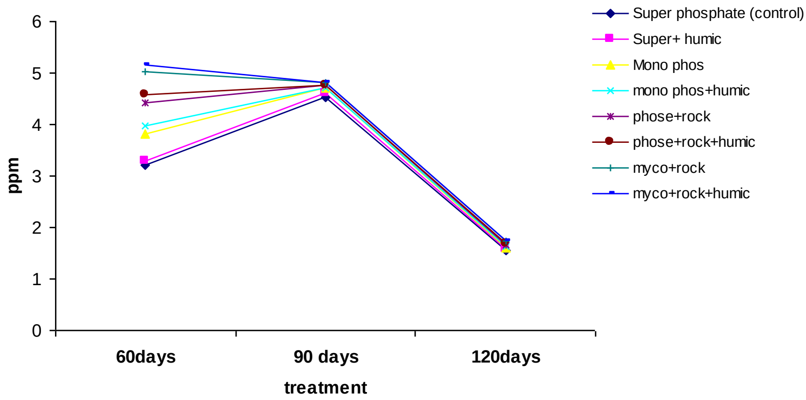

Fig.(53): Manganise content in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

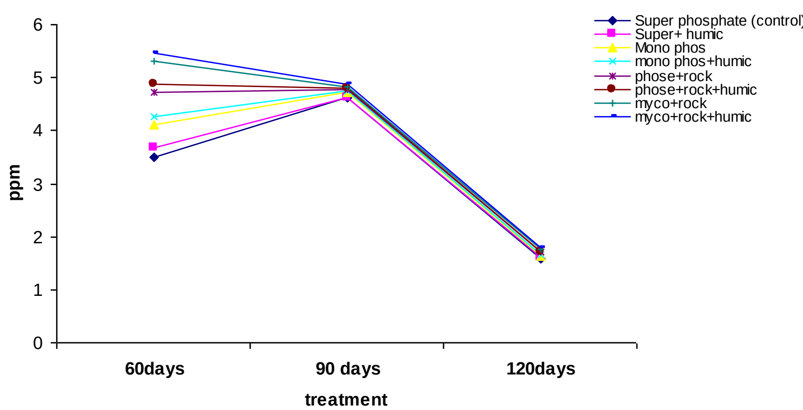

Fig.(54): Manganise content in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

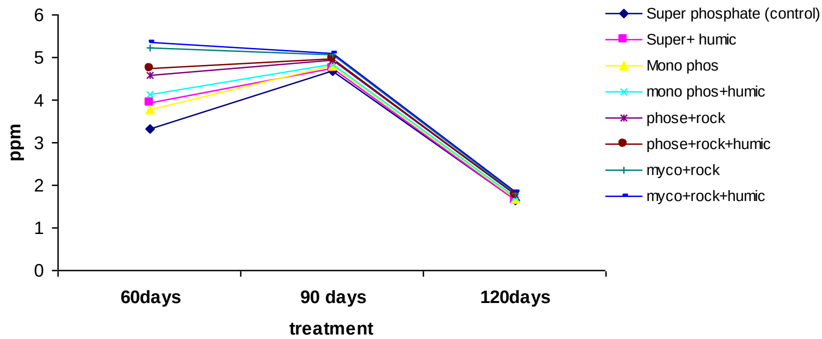

Fig.(55): Manganise content in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

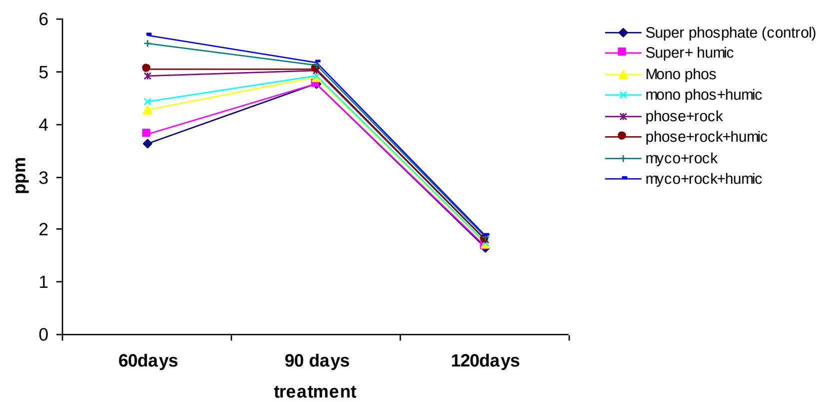

Fig.(56): Manganise content in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

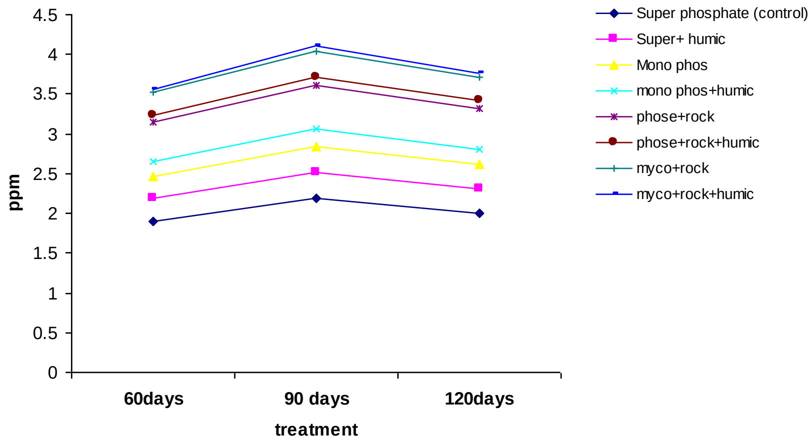

Fig.(61): Boron content in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

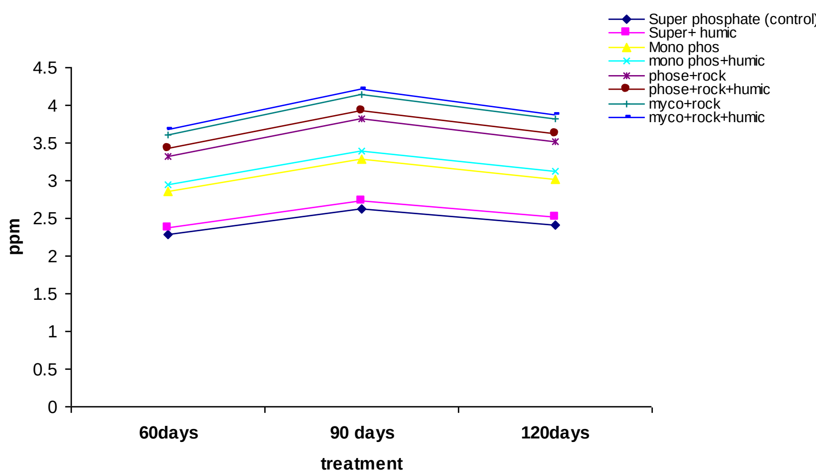

Fig.(62): Boron content in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

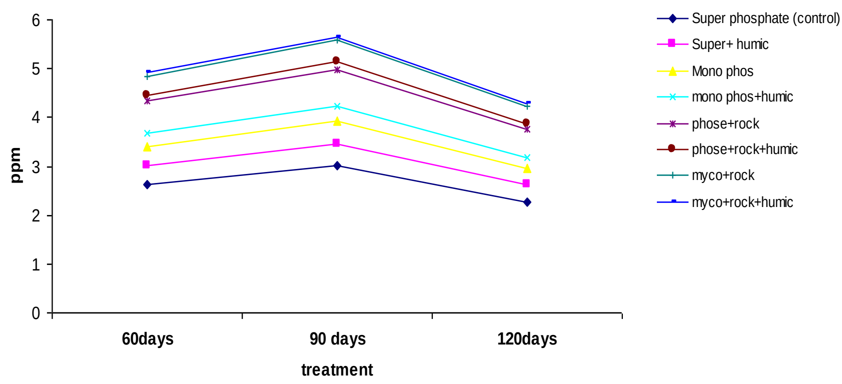

Fig.(63): Boron content in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

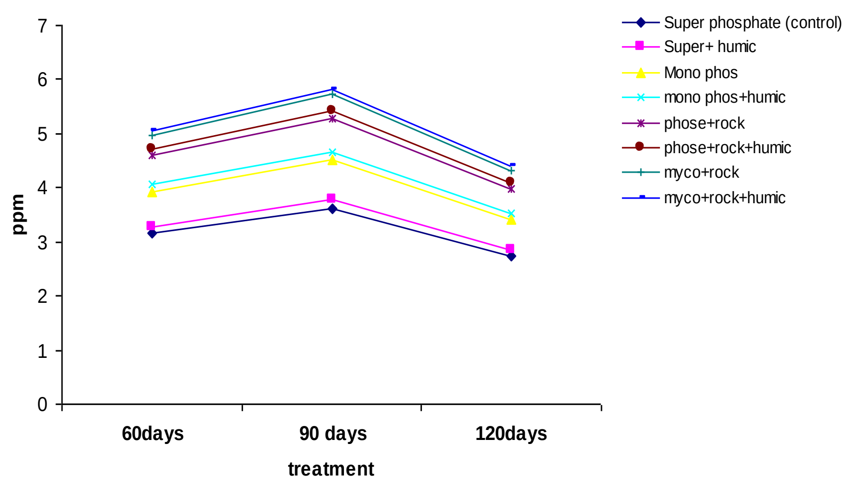

Fig.(64): Boron content in shoot plant 60,90 and 120 days after sowing with magentic iron 2nd season.

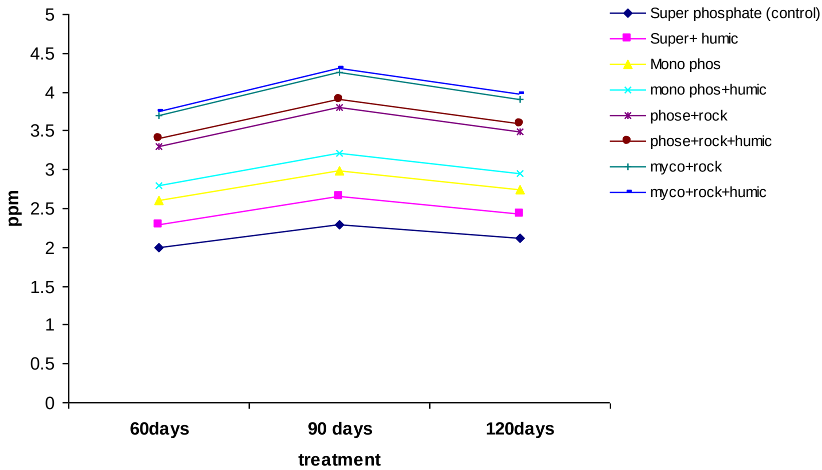

Fig.(57): Copper content in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

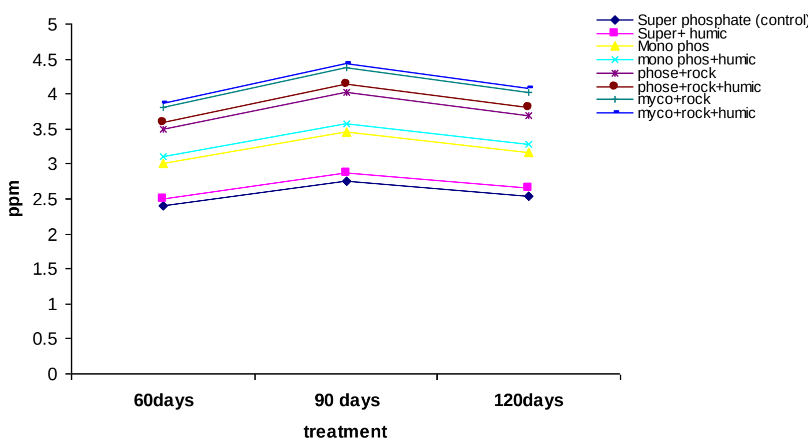

Fig.(58): copper content in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

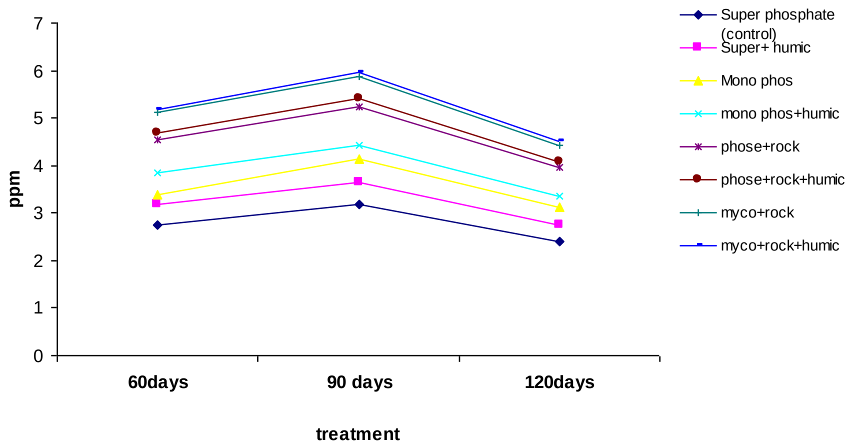

Fig.(59): Copper content in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

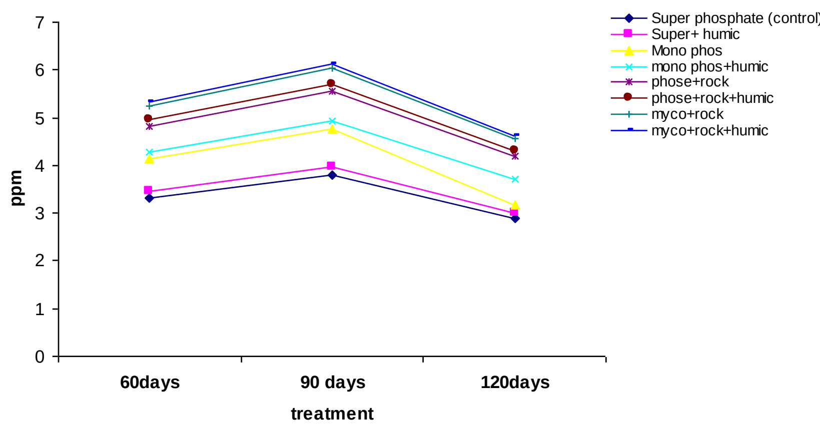

Fig.(60): Copper content in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

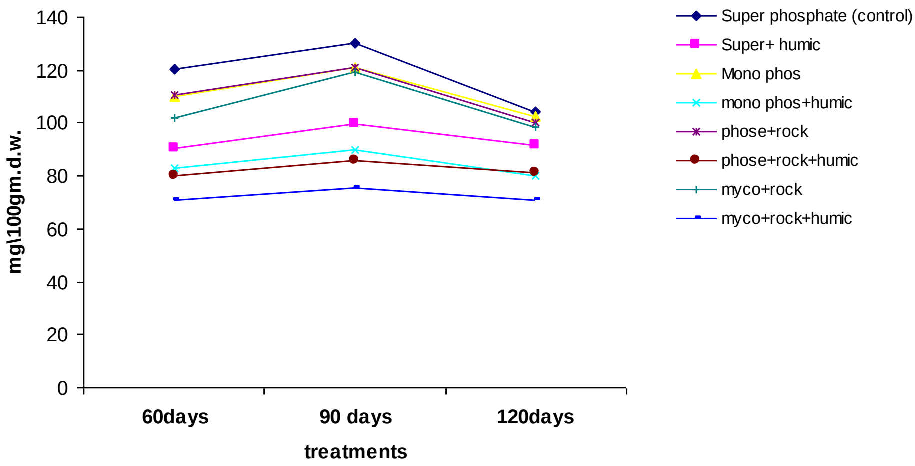

Fig.(65):Sodium content in shoot plant 60,90 and 120 days after sowing without magnetic iron 1st season.

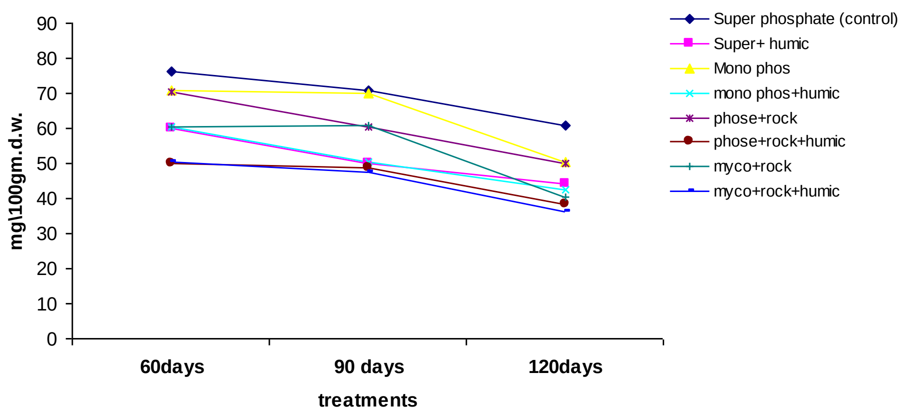

Fig.(66): Sodium content in shoot plant 60,90 and 120 days after sowing with magnetic iron 1st season.

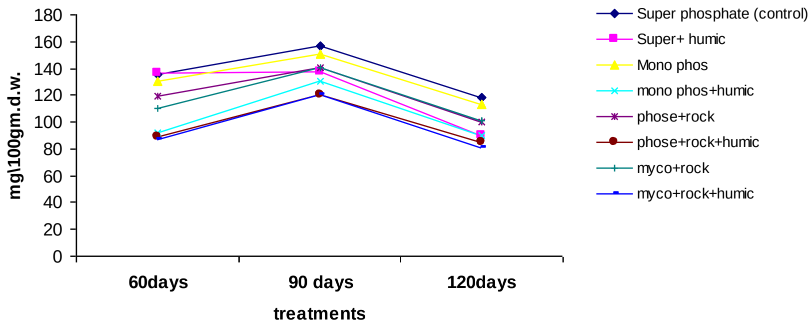

Fig.(67): Sodium content in shoot plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

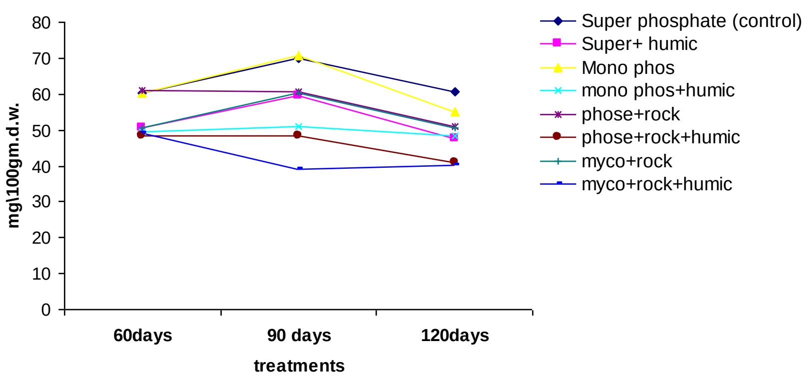

Fig.(68): Sodium content in shoot plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

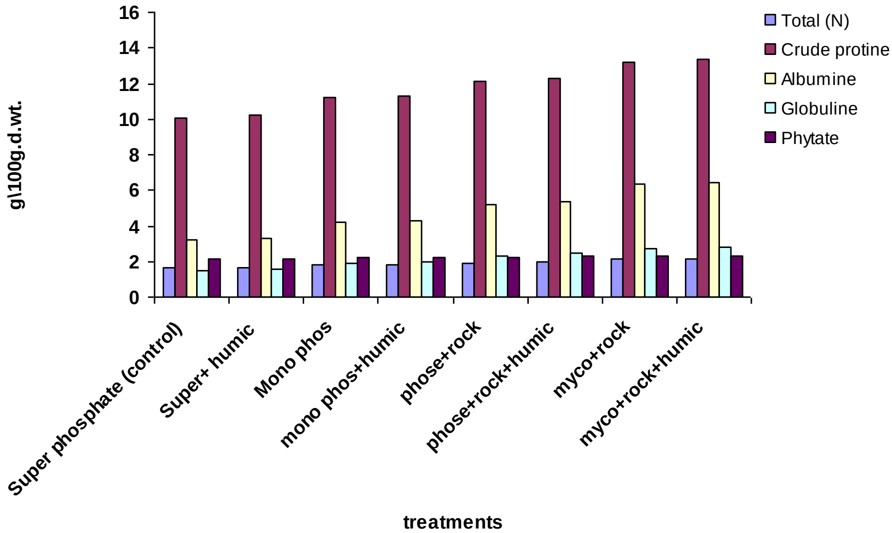

Fig.(69):Total (N),crude protine,albumine,globuline and phytat content in grains of sorghum plant without magnetic iron 1st season.

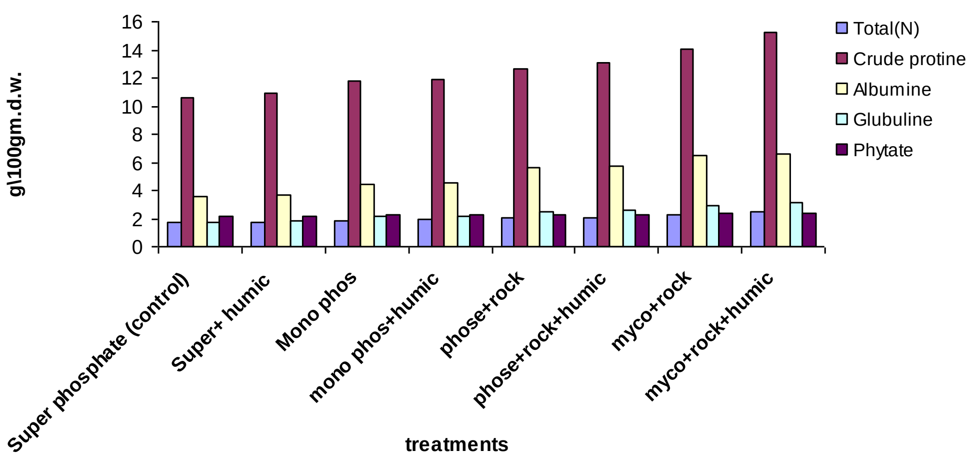

Fig.(70):Total(N),crude protine,albumine,glubuline and phytate content in grains of sorghum plant with magnetic iron 1st season.

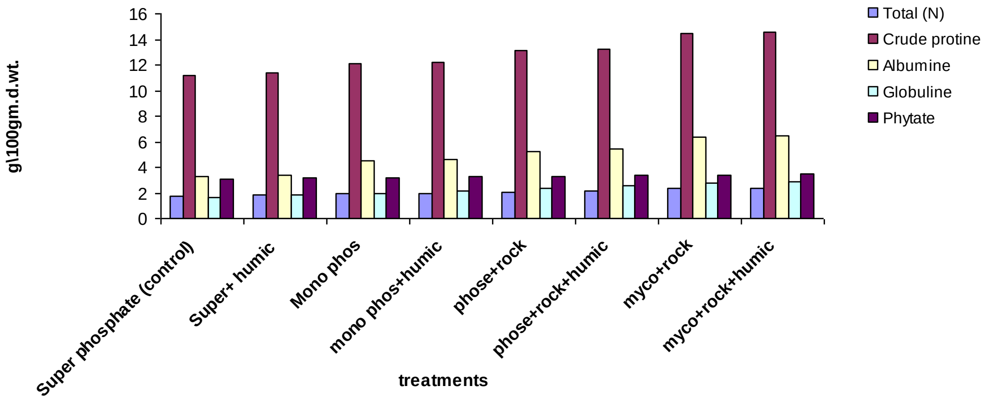

Fig.(71):Total(N),crude protine,albumine,glubuline and phytate content in grains of sorghum plant without magnetic iron 2nd season.

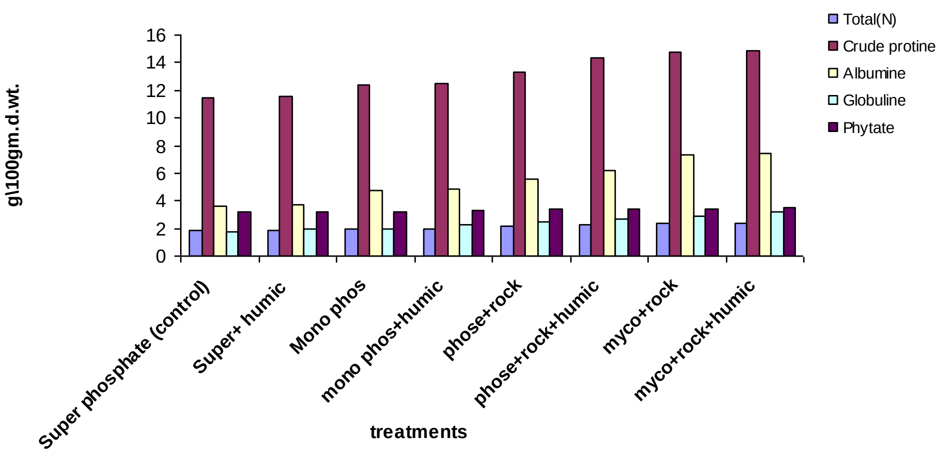

Fig.(72):Total(N),crude protine,albumine,glubuline and phytate content in grains of sorghum plant with magnetic iron 2nd season.

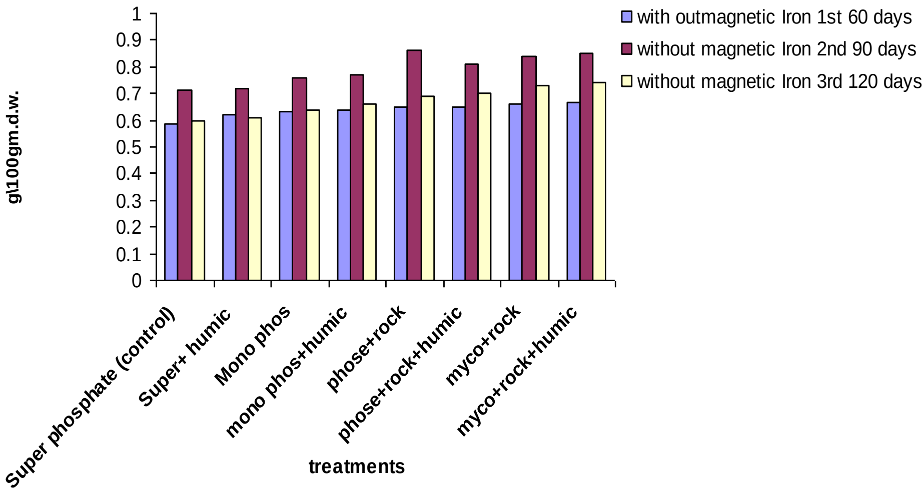

Fig.(73): Total phosphorus in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season.

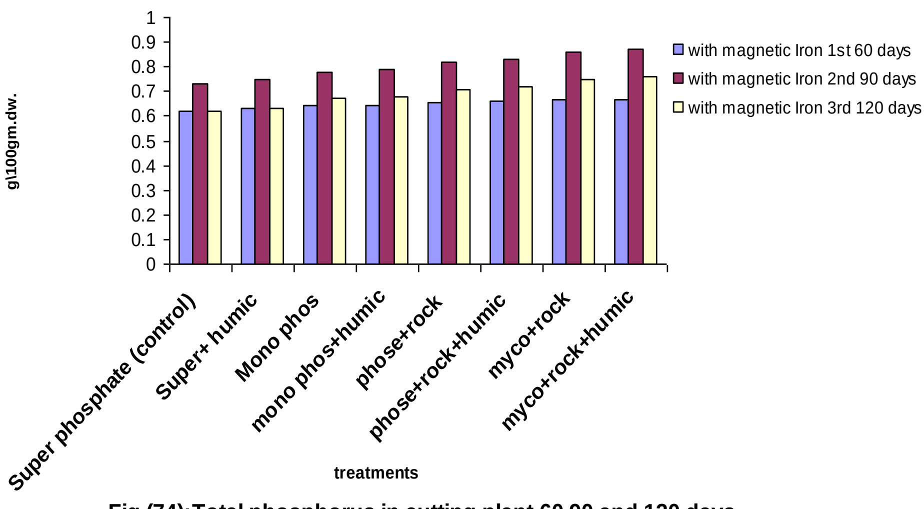

Fig.(74):Total phosphorus in cutting plant 60,90 and 120 days after sowing with magnetic iron 1st season.

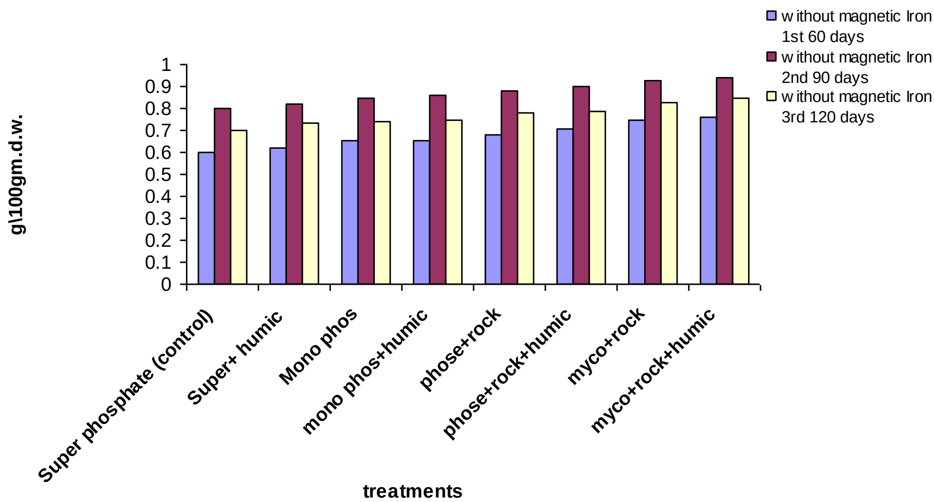

Fig.(75): Total phosphorus in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

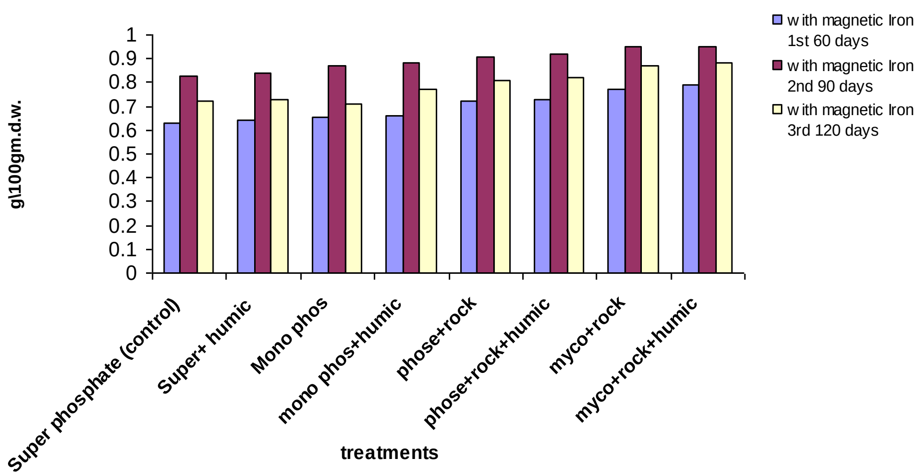

Fig.(76): Total phosphorus in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

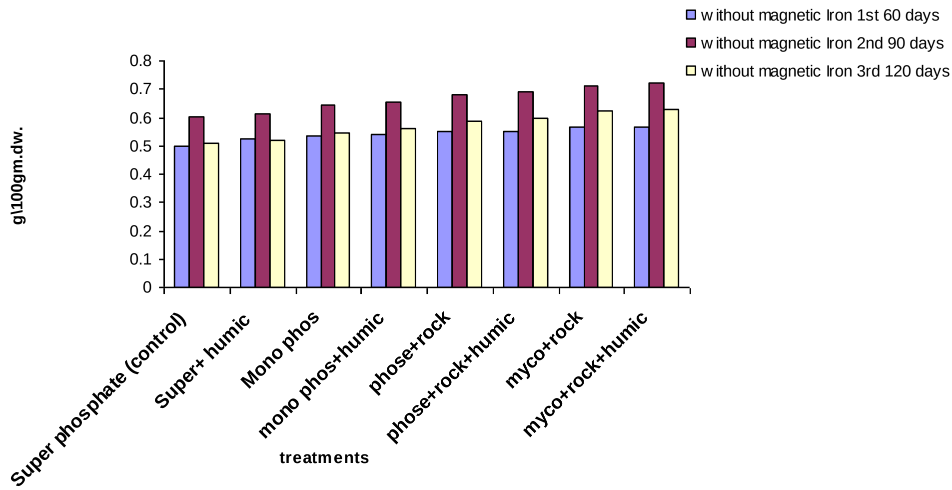

Fig.(77):Total soluble (p) in cutting plant 60,90 and120 days aftre sowing without magnetic iron 1st season.

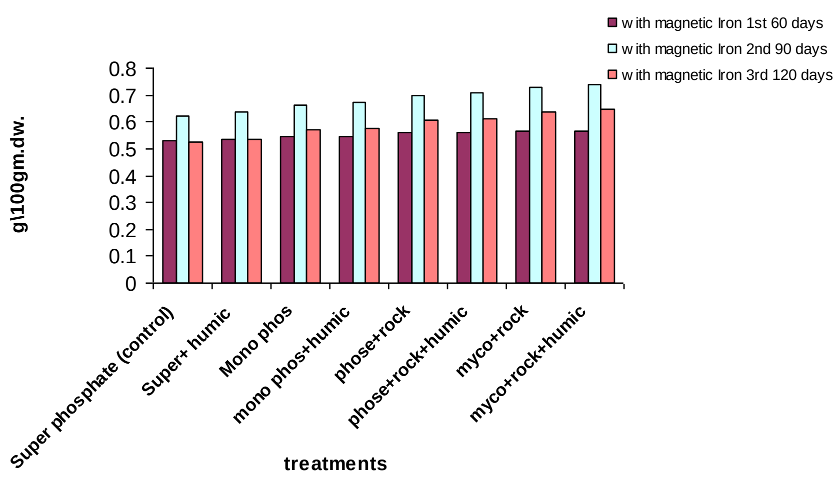

Fig.(78):Total soluble (p) in cutting plant 60,90 and 120 days after sowing with magnetic iron1st season.

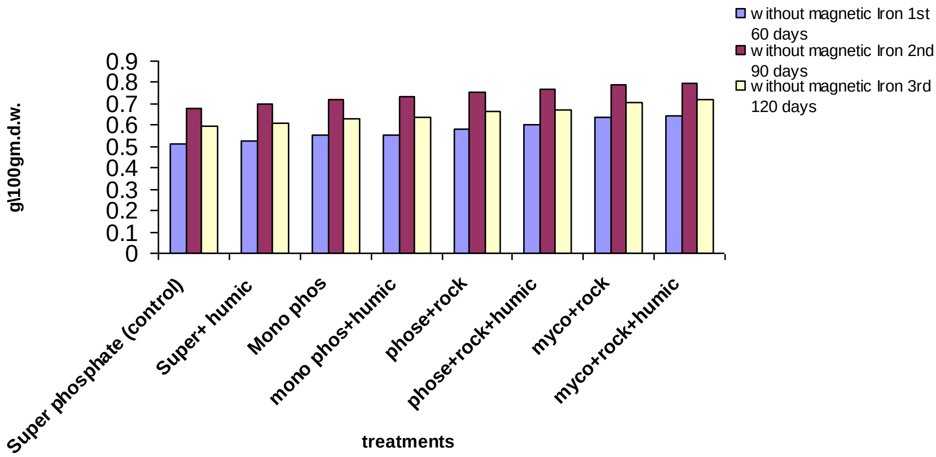

Fig.(79): Total soluble (p) in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

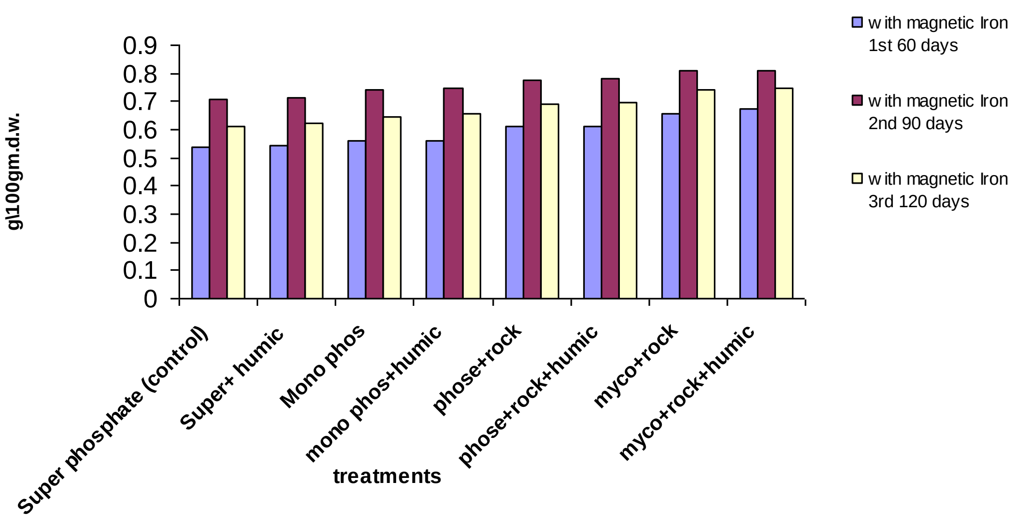

Fig.(80): total soluble (p) in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

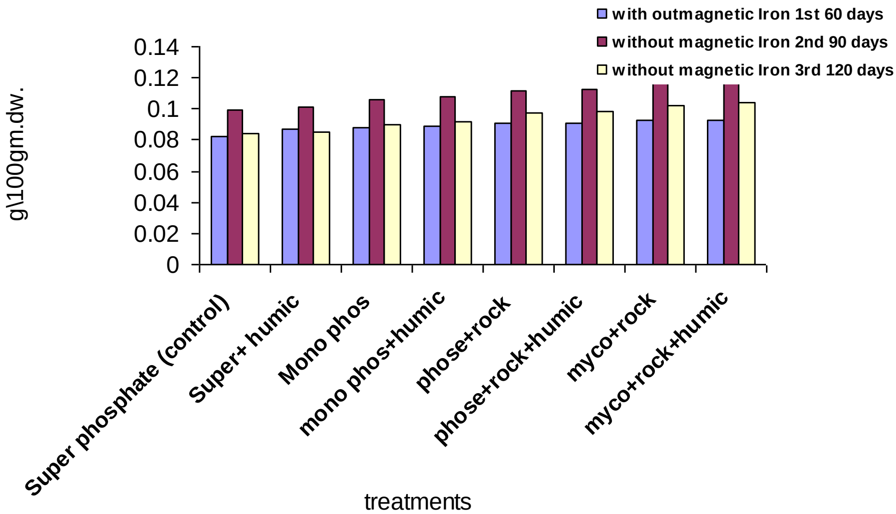

Fig.(81):Total insoluble (p) in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season.

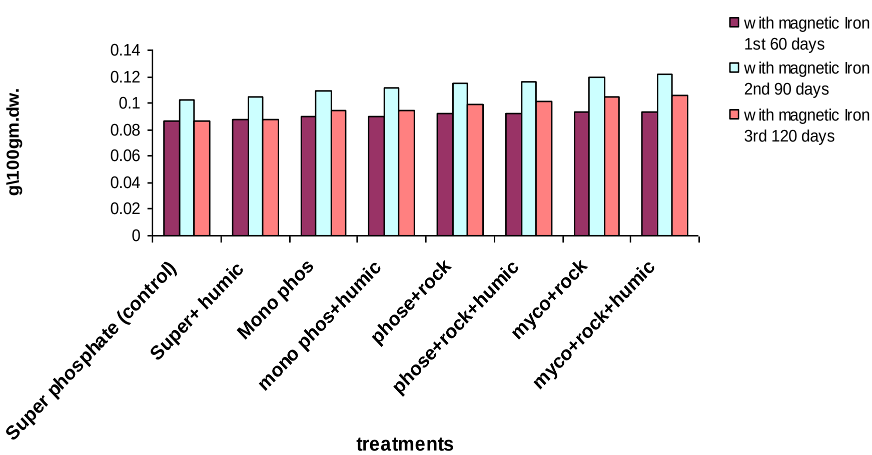

Fig.(82):Total insoluble (p) in cutting plant 60,90 and 120 days sowing with magnetic iron 1st season.

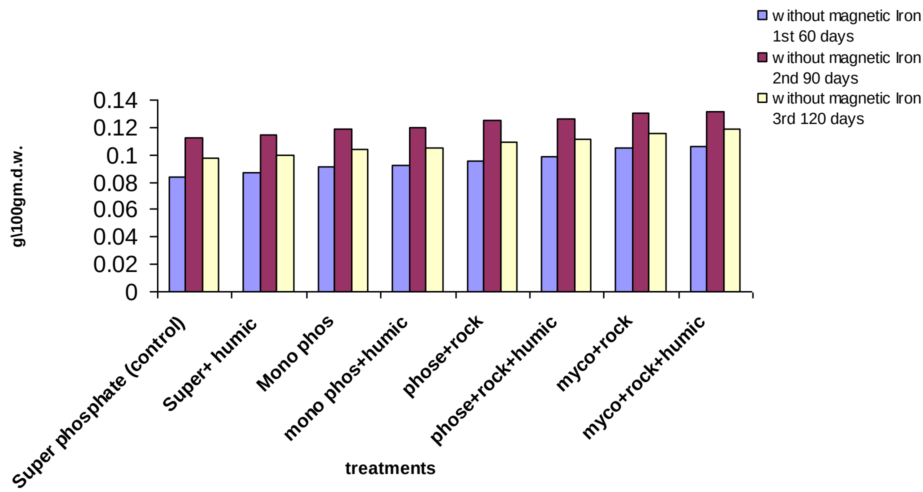

Fig.(83): Total insoluble (p) in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

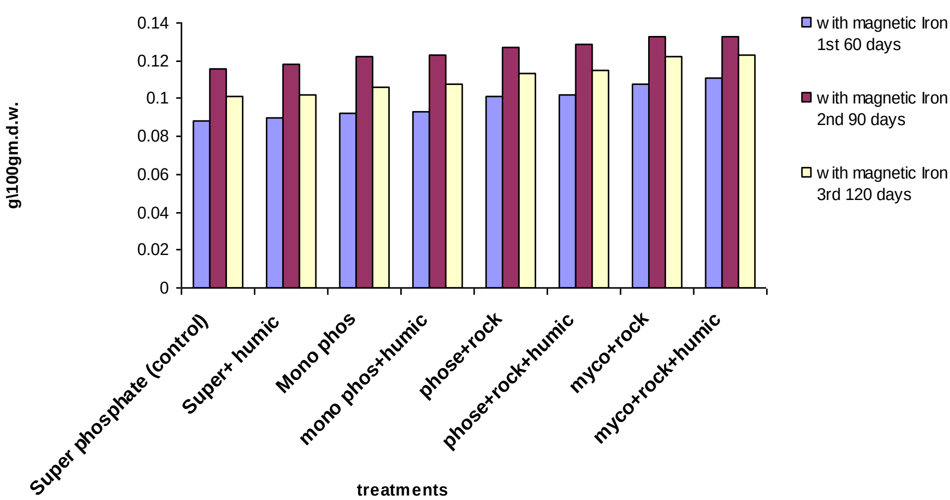

Fig.(84): Total insoluble (p) in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

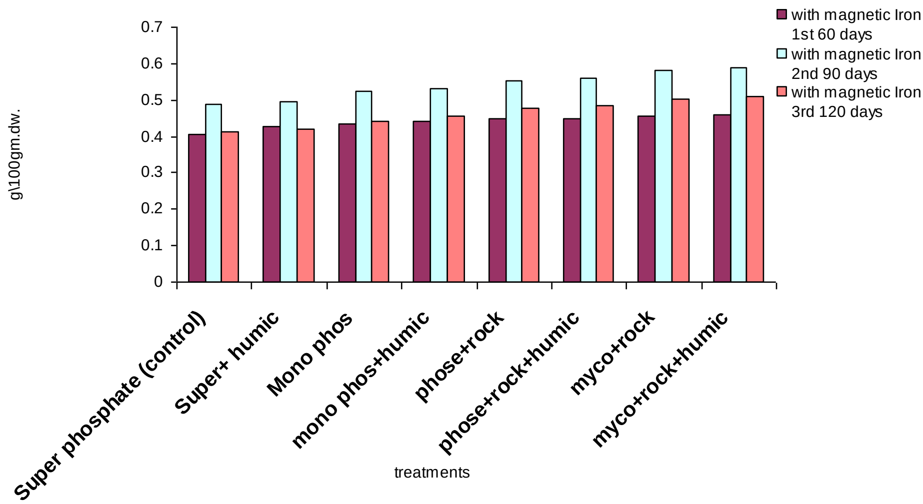

Fig.(85):Inorganic phosphorus in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season.

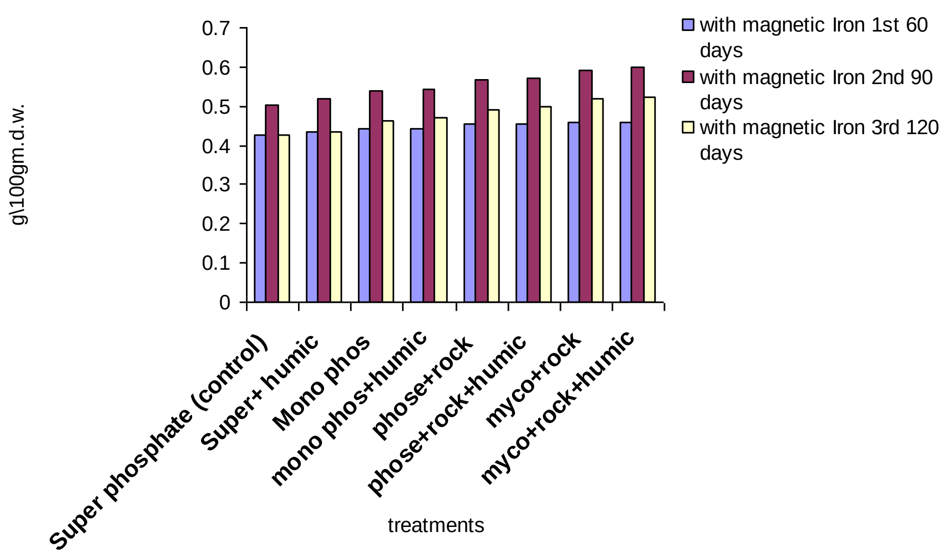

Fig.(86):Inorganic phosphorus in cutting plant 60,90 and 120 days after sowing with magnetic iron 1st season.

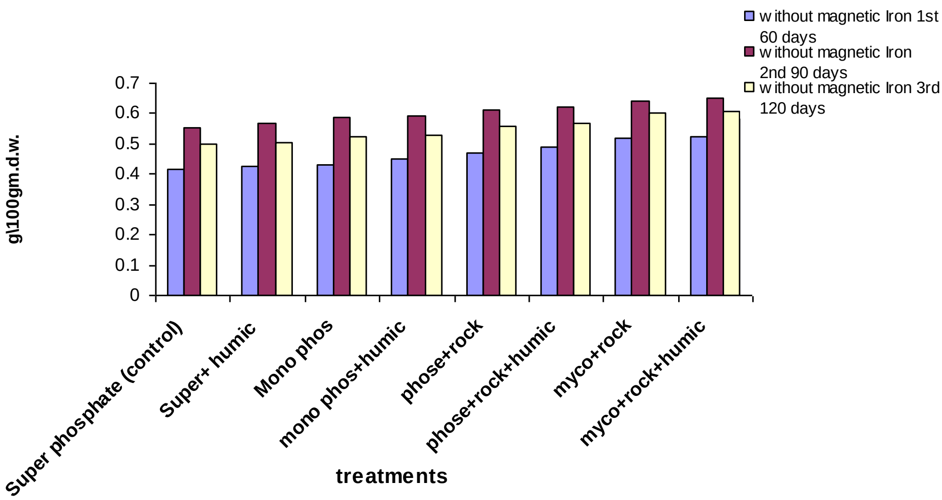

Fig.(87): Inorganic phosphorus in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

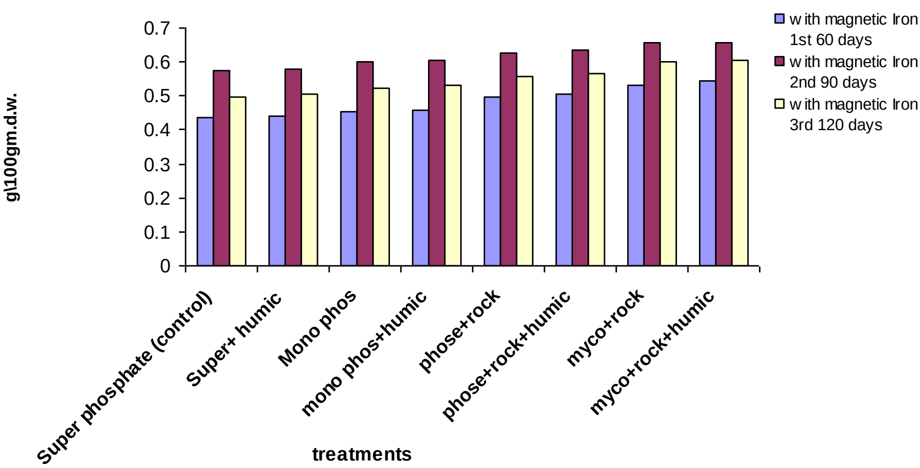

Fig.(88): Inorganic phosphorus in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

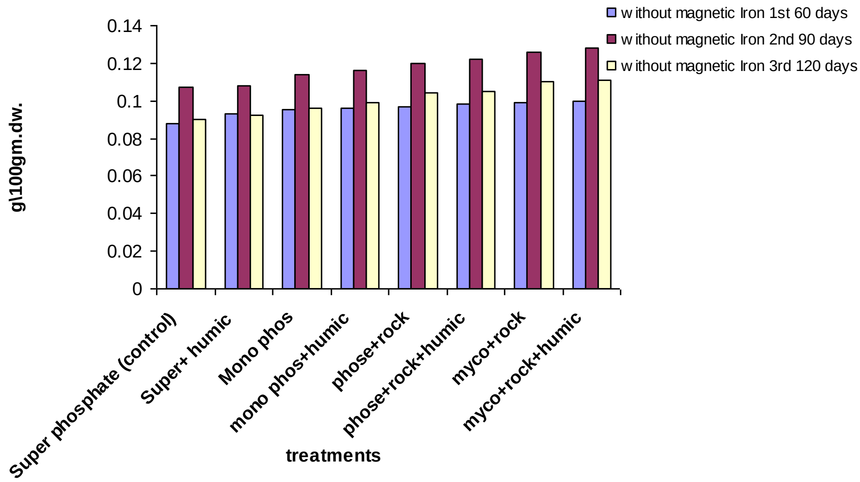

Fig.(89):Total soluble organic (p) in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season.

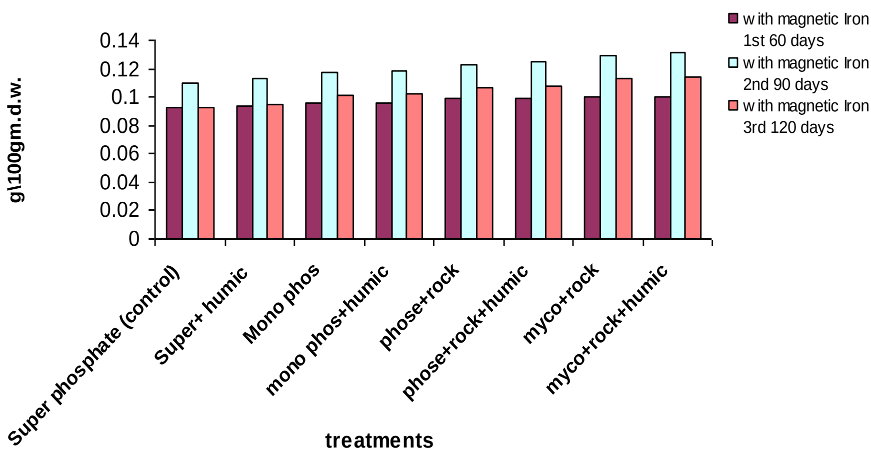

Fig.(90):Total soluble organic (p) in cutting plant 60,90 and 120 days after sowing with magnetic iron 1st season.

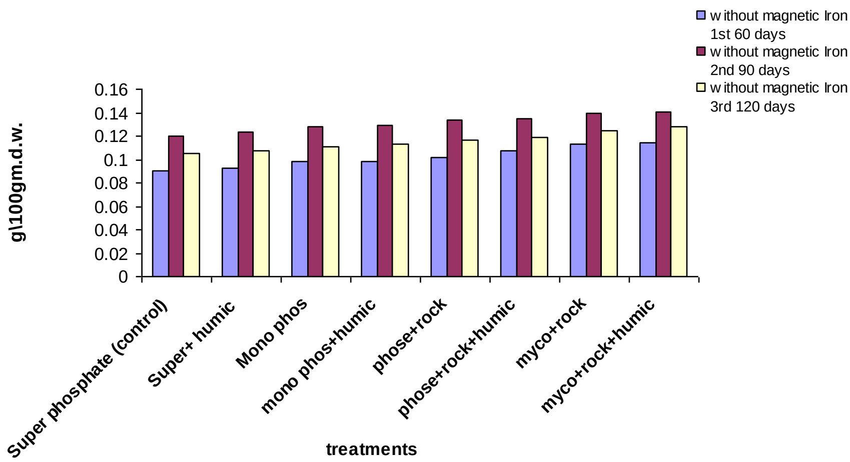

Fig.(91): Total soluble organic (p) in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

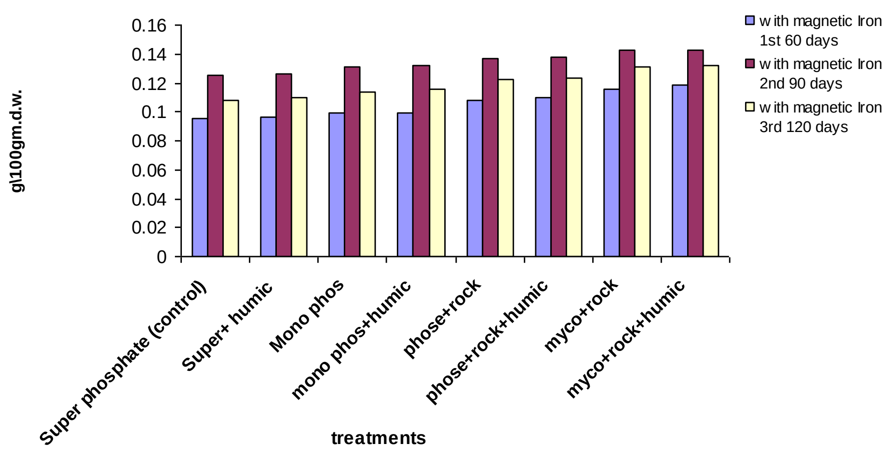

Fig.(92): Total soluble organic (p) in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

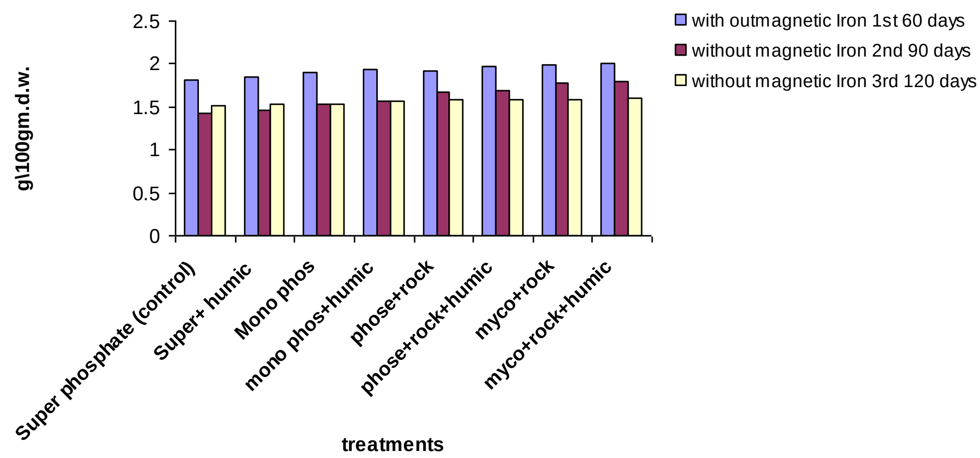

Fig.(93): Total nitrogen in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season.

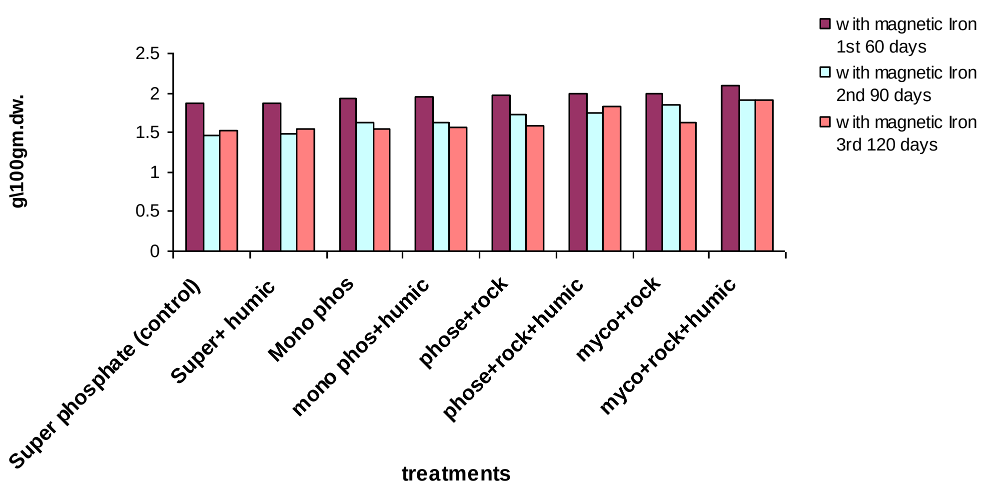

Fig.(94):Total nitrogen in cutting plant 60,90 and 120 days after sowing with magnetic iron 1st season.

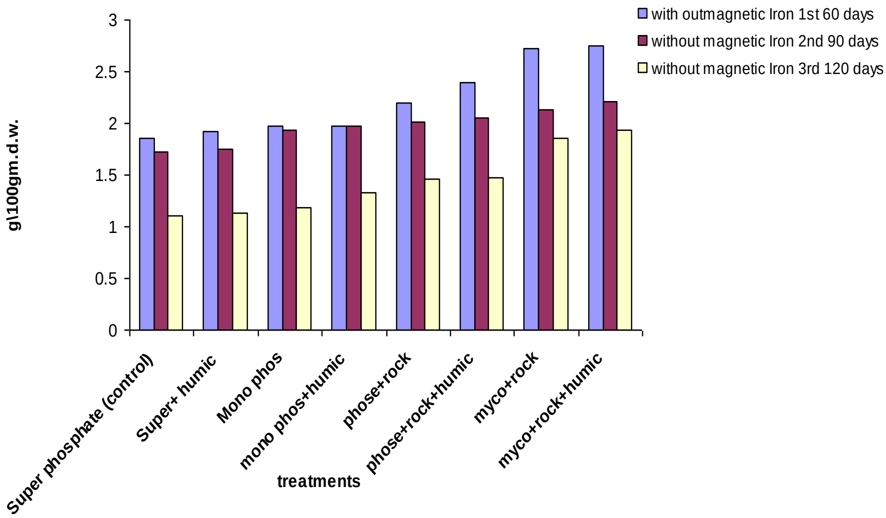

Fig.(95): Total nitrogen in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

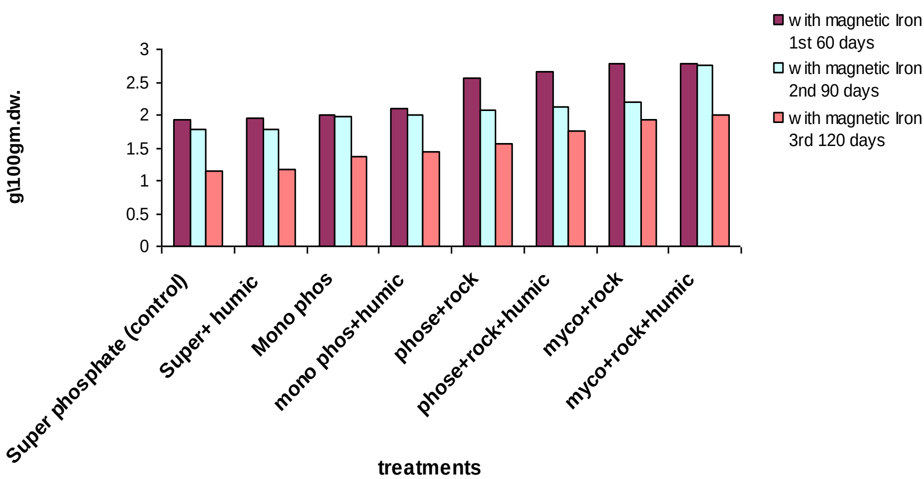

Fig.(96):Total nitrogen in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

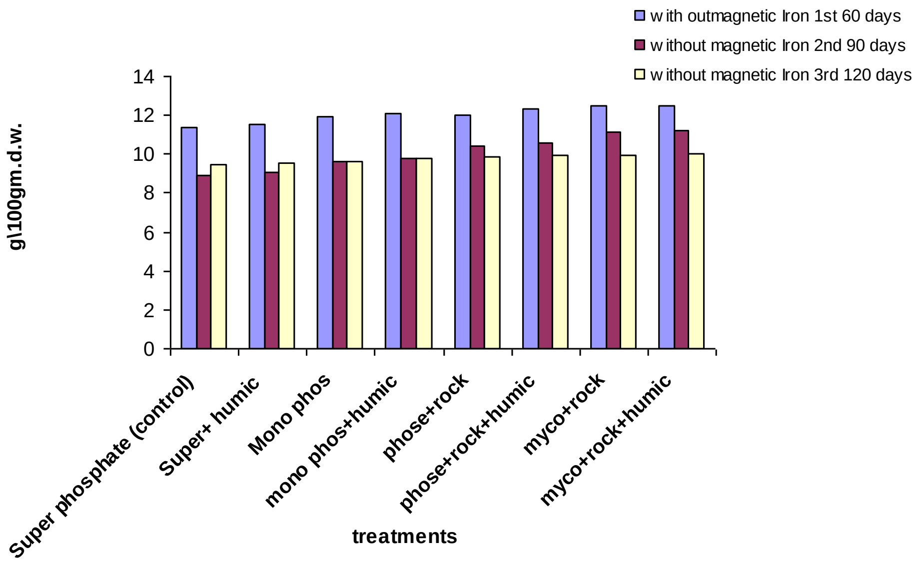

Fig.(97): Crude protien in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season.

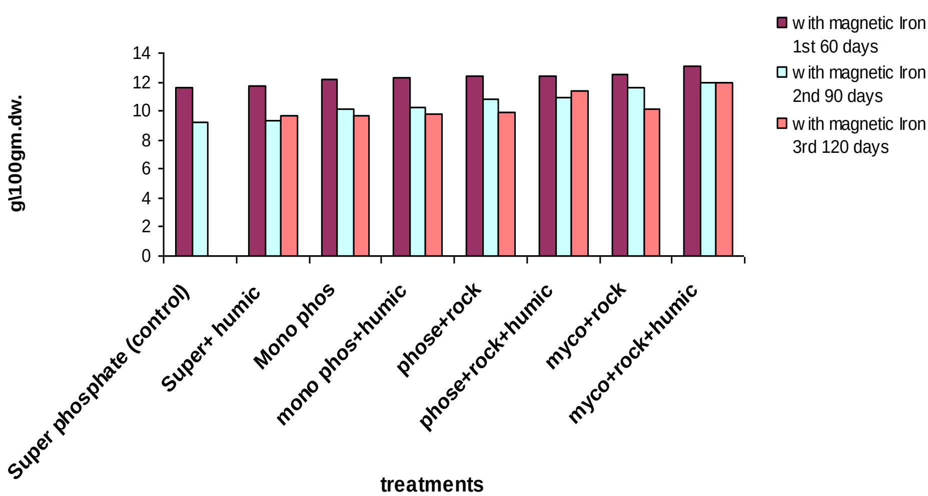

Fig.(98):Crude protine in cutting plant 60,90 and 120 days after sowing with magnetic iron 1st season.

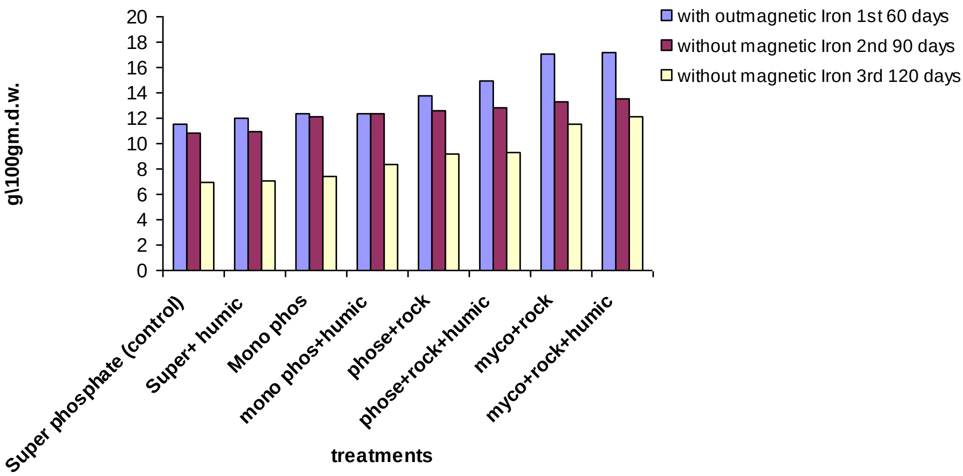

Fig.(99): Crude protien in cutting plant 60,90 and 120 days after sowing without iron 2nd season.

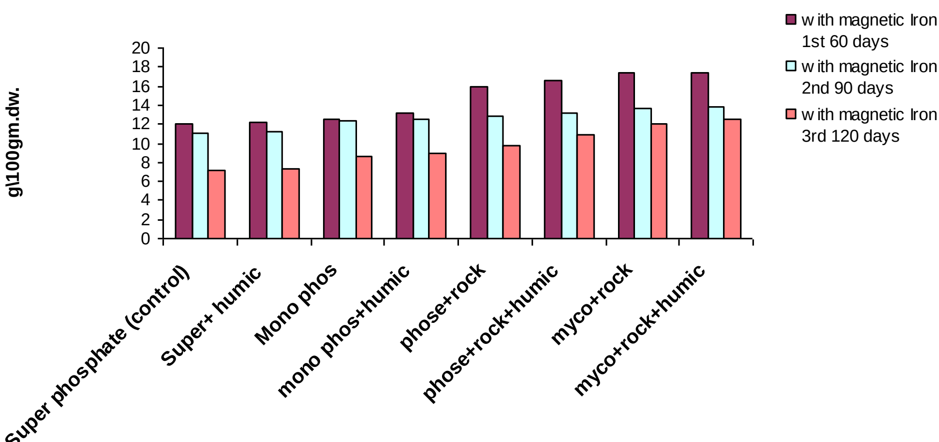

Fig.(100):Crude protine in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

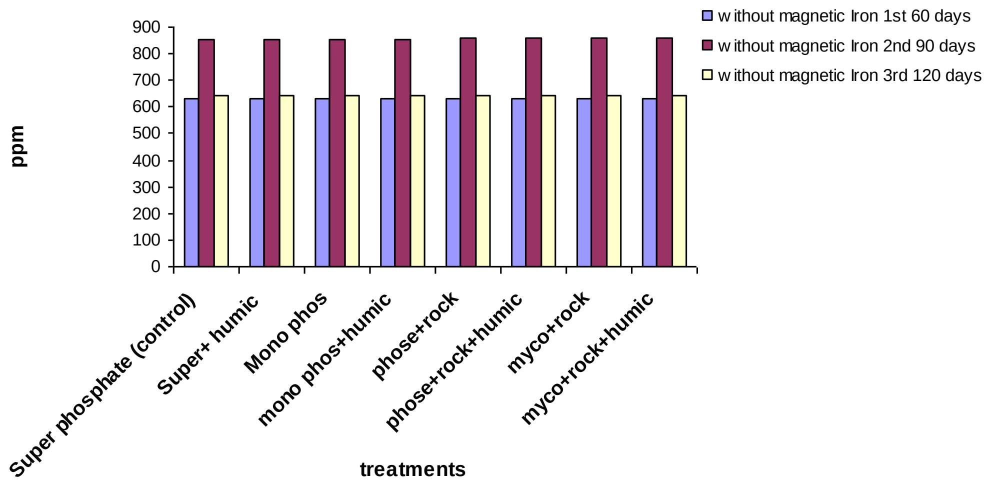

Fig.(101):Pottasium content in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season.

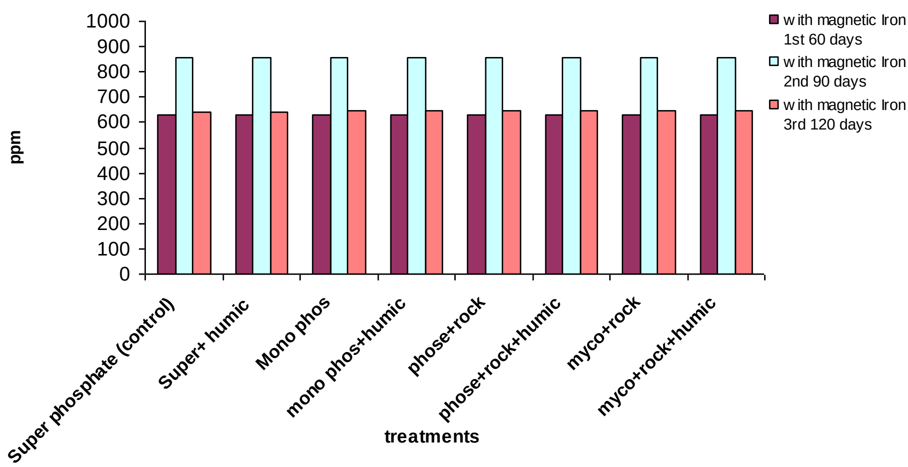

Fig.(102):Pottasium content in cutting plant 60,90 and 120 days after sowing with magnetic iron 1st season.

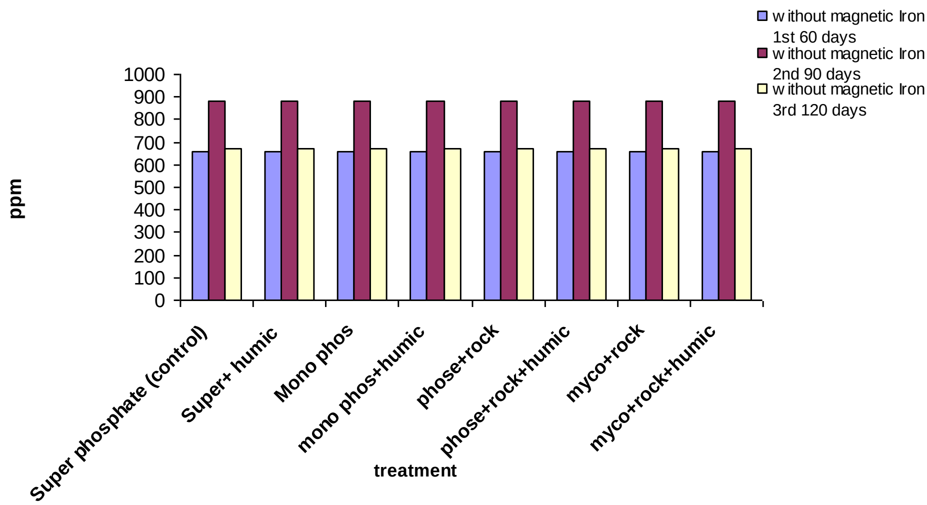

Fig.(103): Pottasium content in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

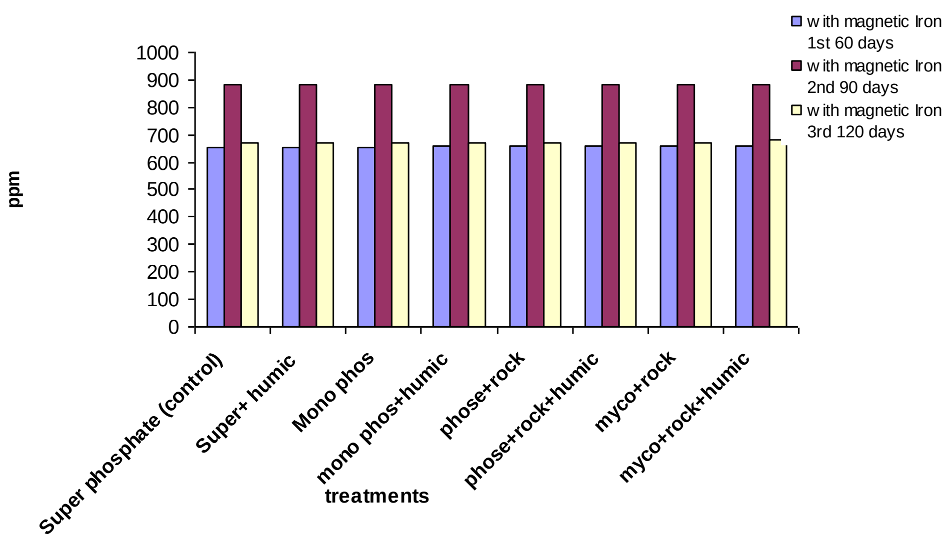

Fig.(104): Pottasium content in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

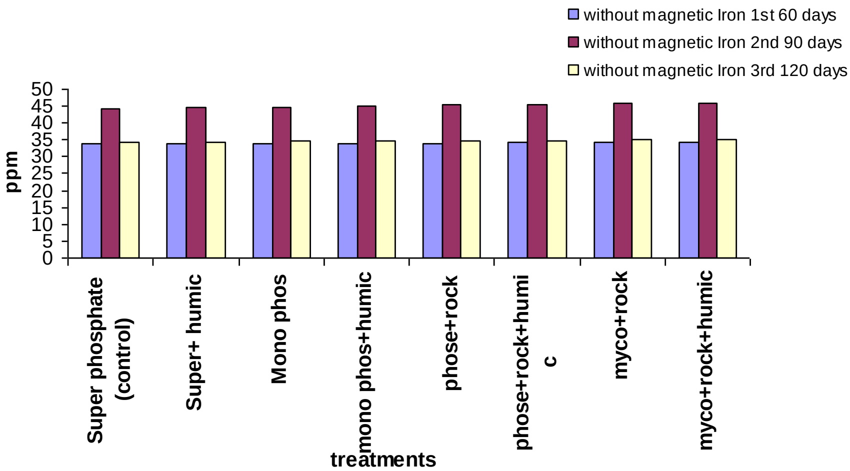

Fig.(105): Magnesium content in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season.

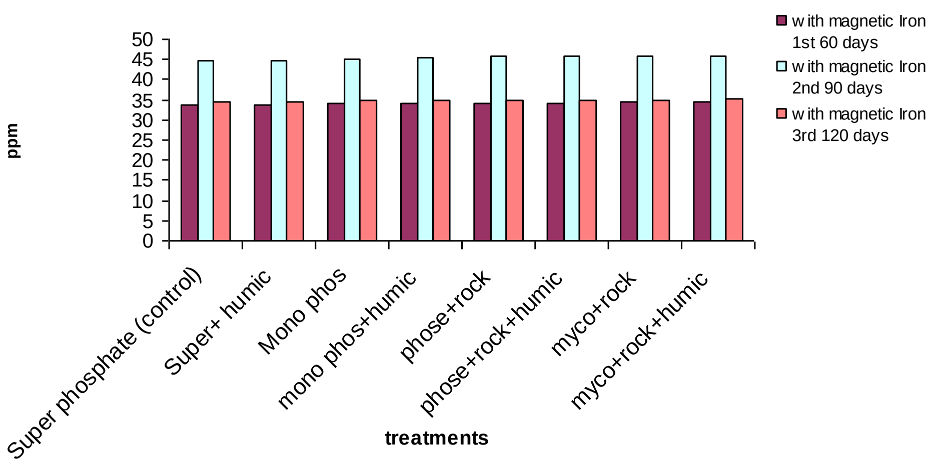

Fig.(106):Magnesium content in cutting plant 60,90 and 120 days after sowing with magnetic iron 1st season.

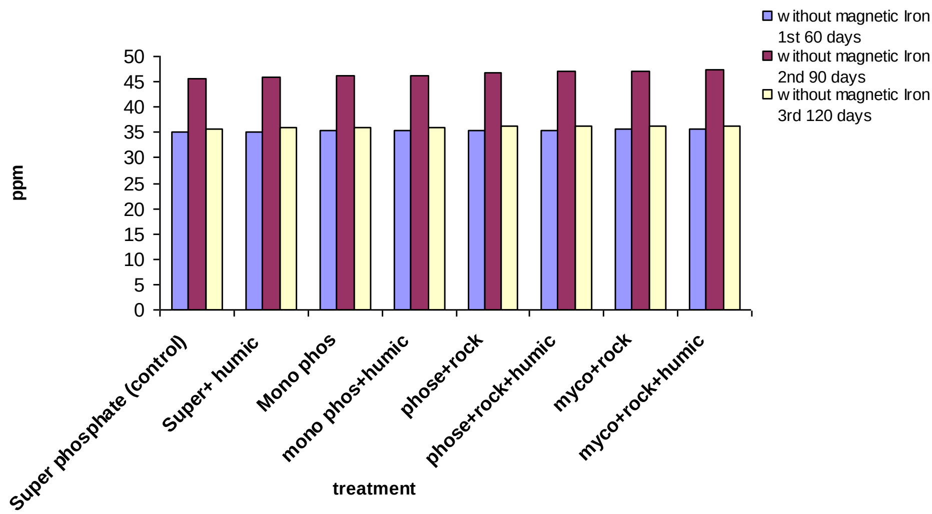

Fig.(107):Magnesium content in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

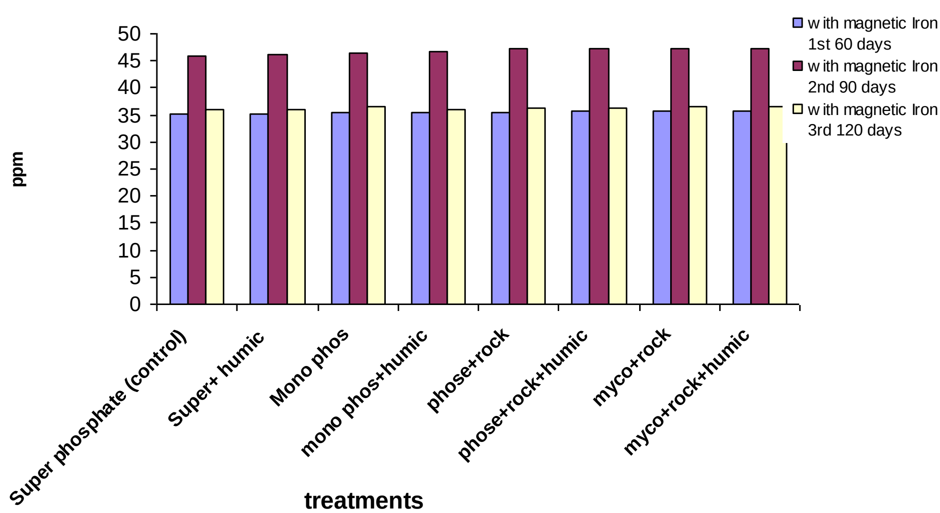

Fig.(108): Magnesium content in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

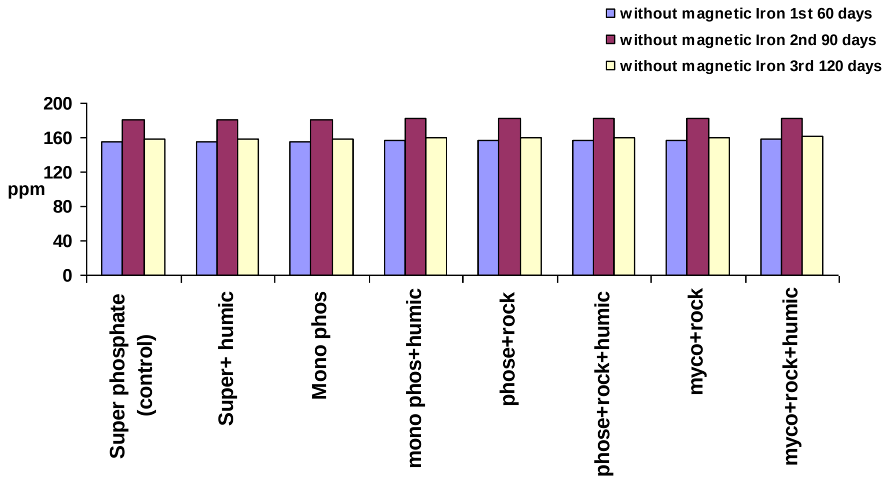

Fig.(109):Calcium content in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season .

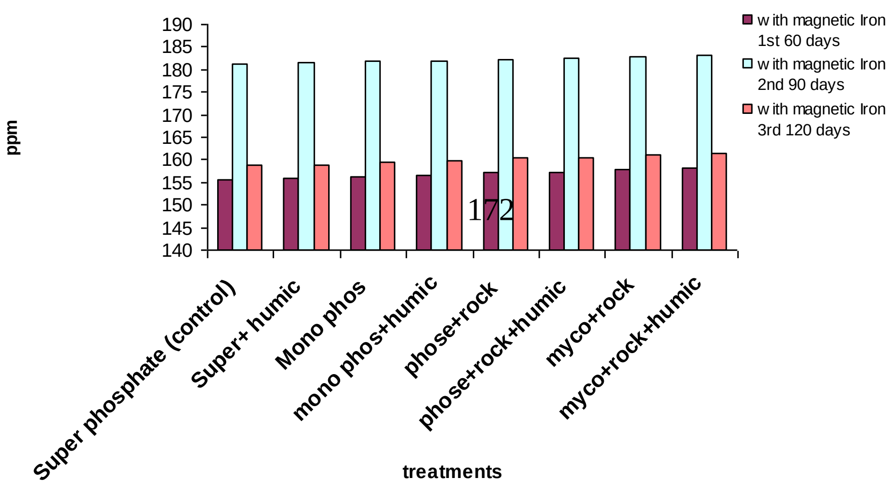

Fig.(110):Calcium content in cutting plant 60,90 and 120 days after sowing with magnetic iron 1st season.

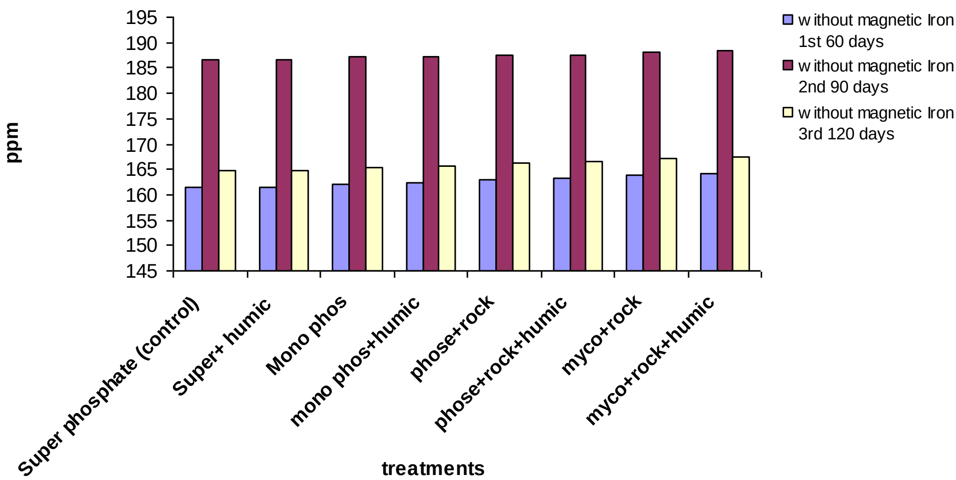

Fig.(111): Calcium content in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

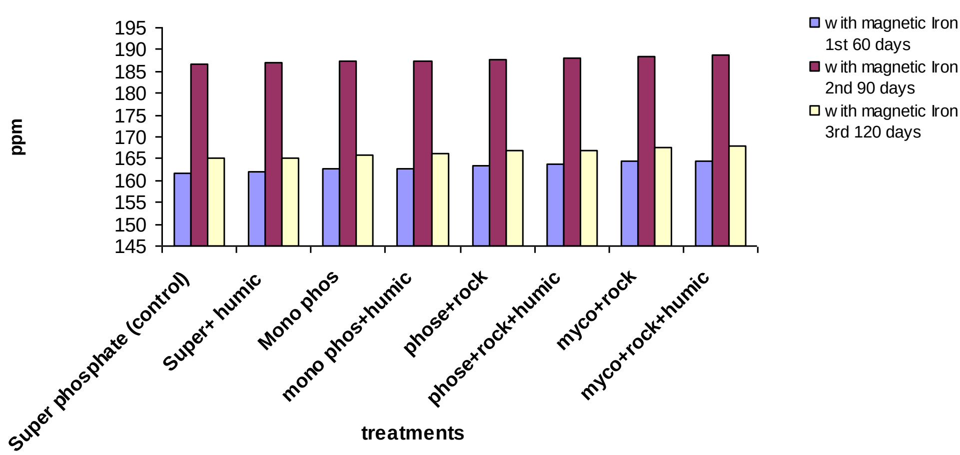

Fig.(112): Calcium content in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

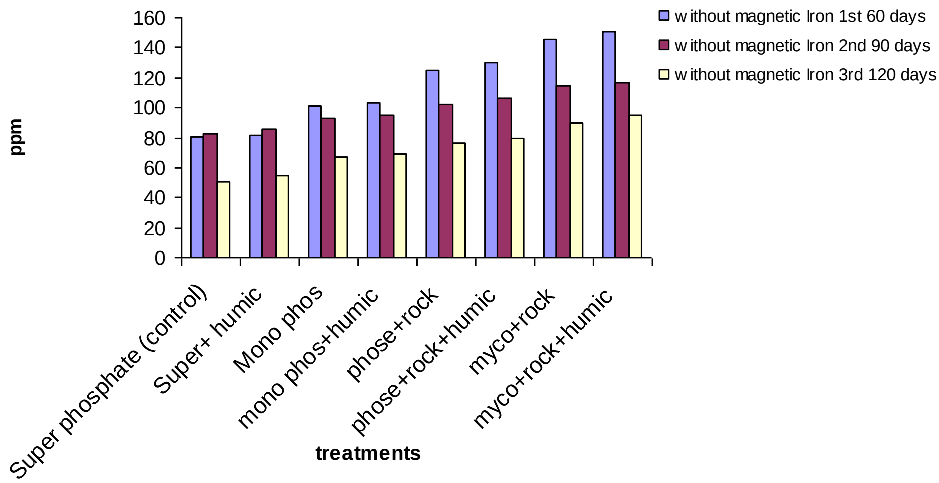

Fig.(113):Sulpher content in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season.

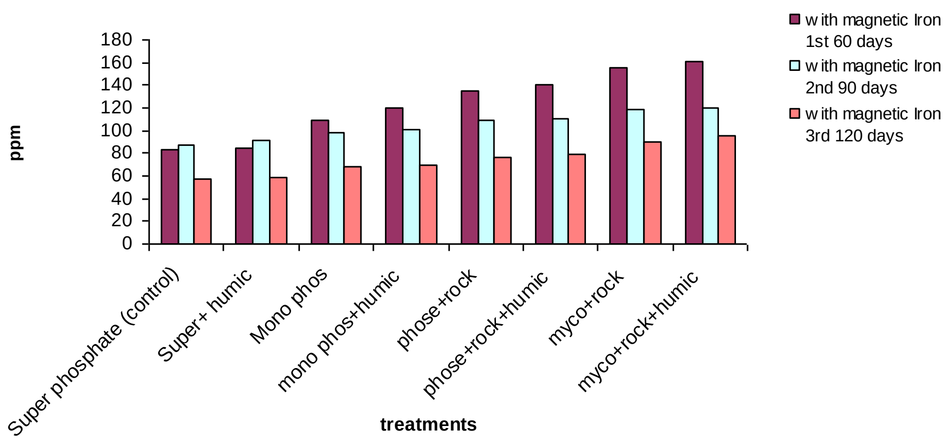

Fig.(114):Sulpher content in cutting plant 60,90 and days after sowing with magnetic iron 1st season.

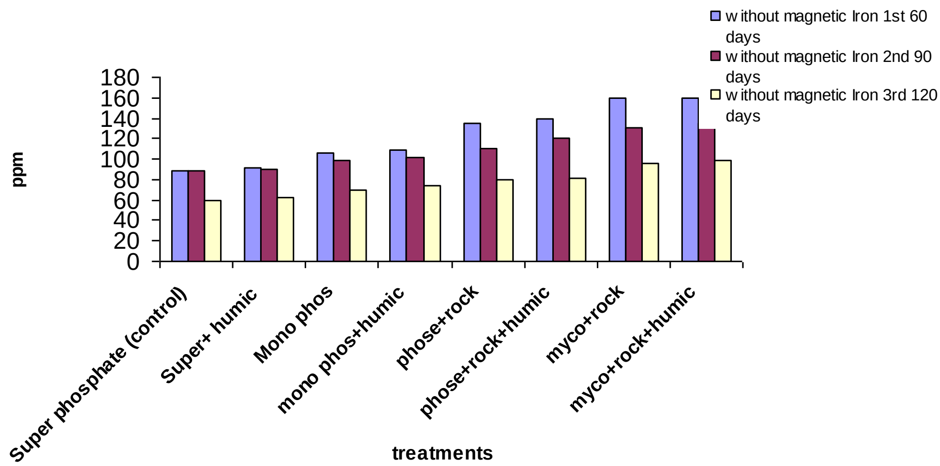

Fig.(115): Sulpher content in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

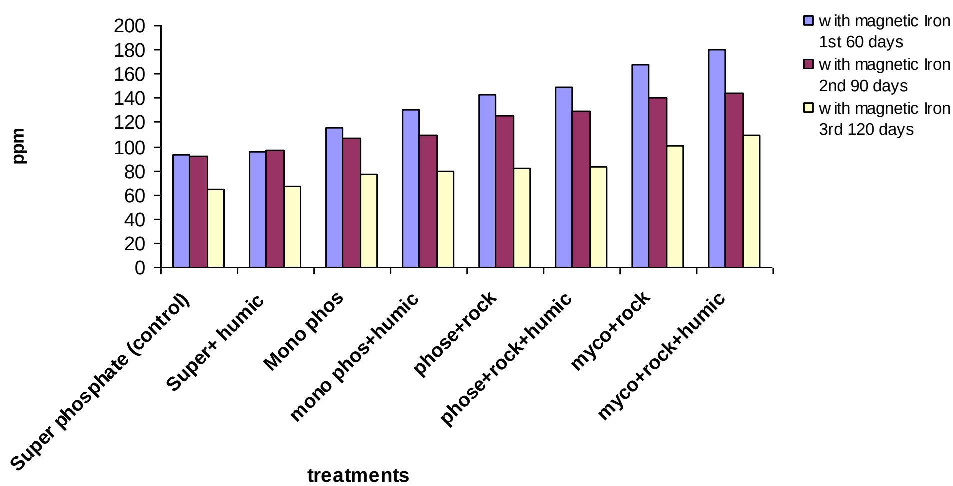

Fig.(116): Sulpher content in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

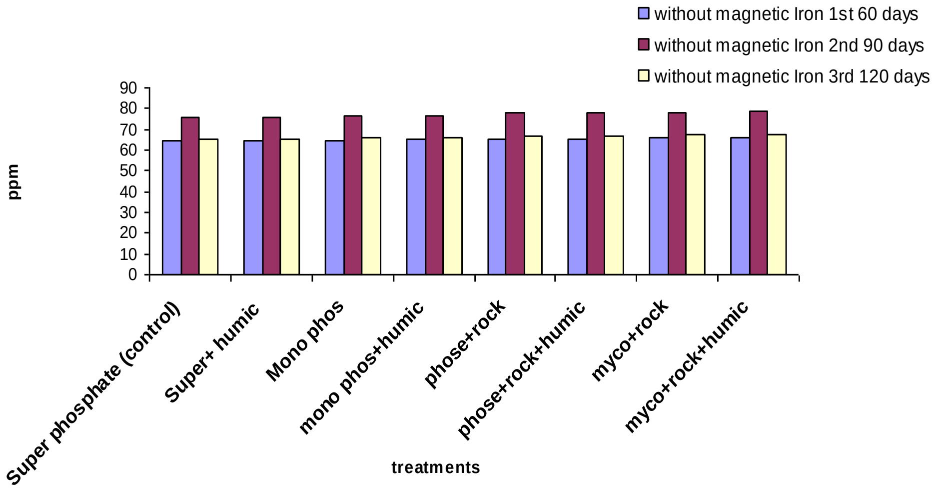

Fig.(117):Iron content in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season.

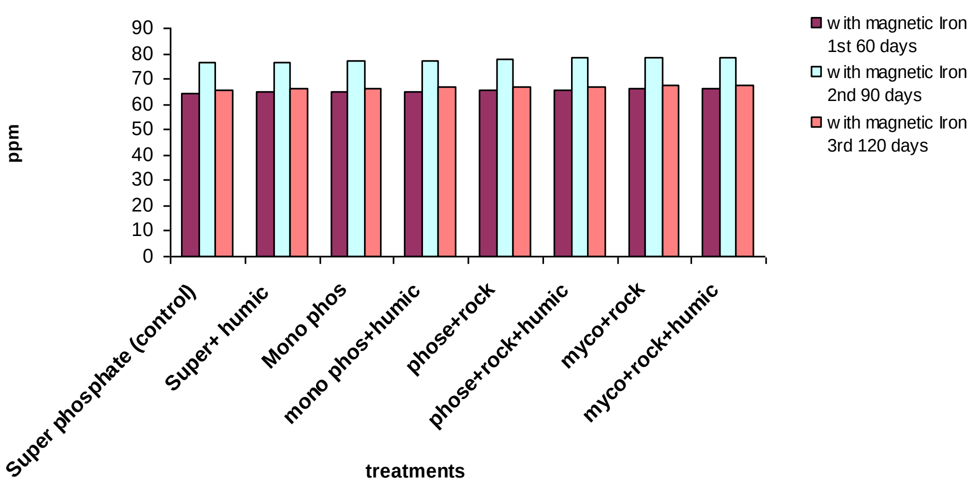

Fig.(118):Iron content in cutting plant 60,90 and 120 days after sowing with magnetic iron 1st season.

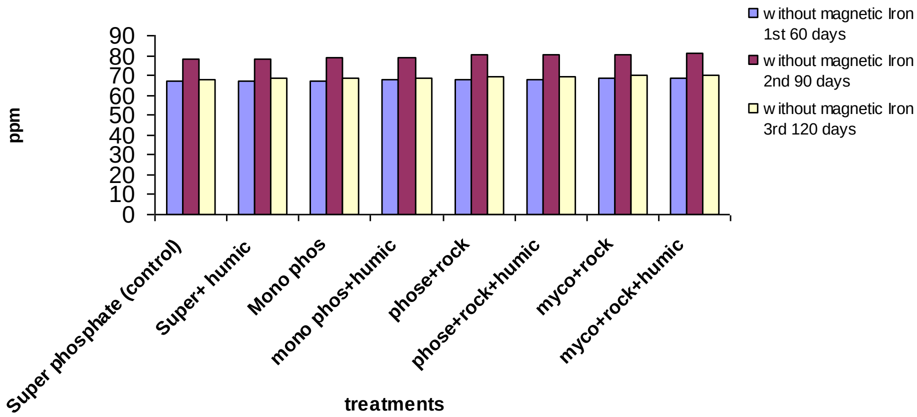

Fig.(119): Iron content in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

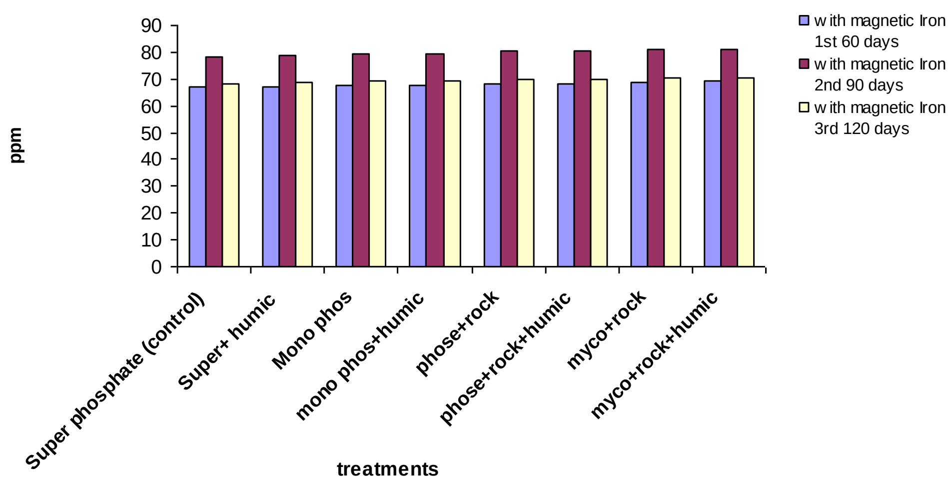

Fig.(120): Iron content in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

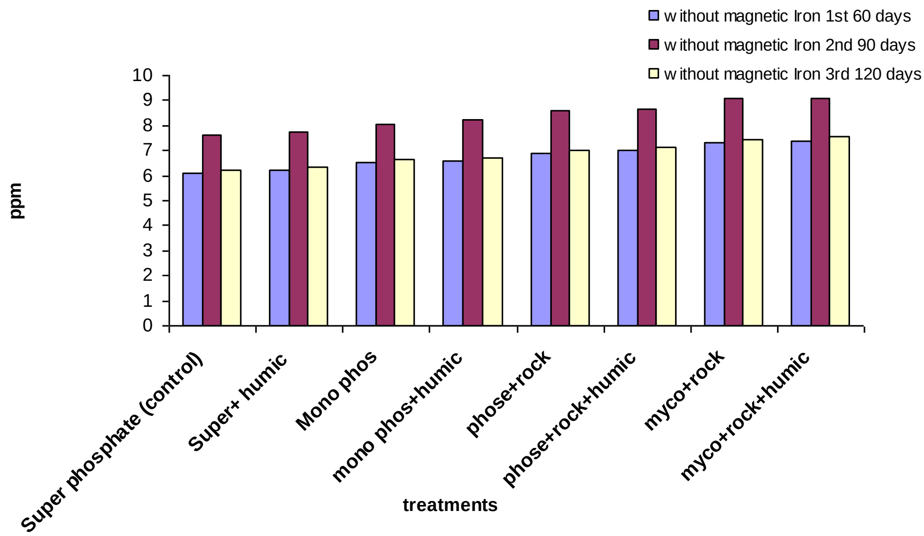

Fig.(121):Zinc content in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season.

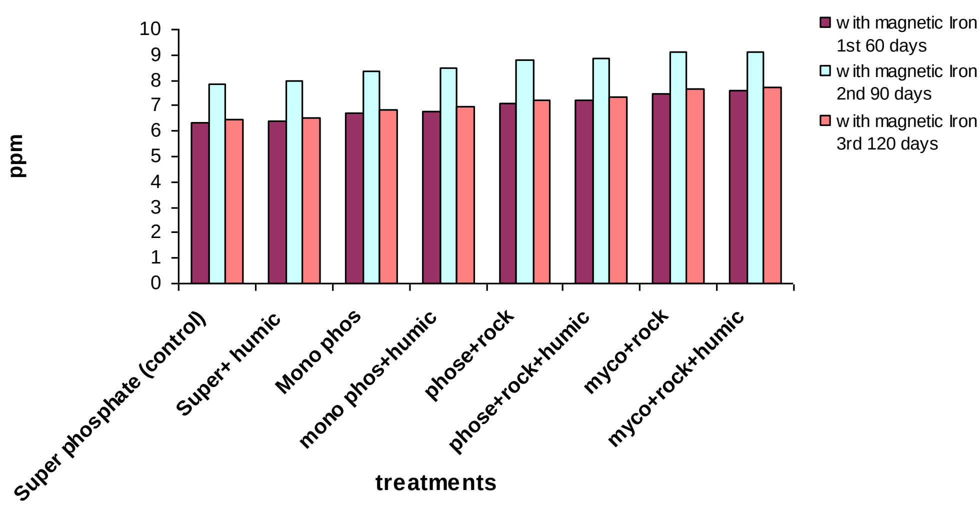

Fig.(122):Zinc content in cutting plant 60,90 and 120 days after sowing with magnetic iron 1st season.

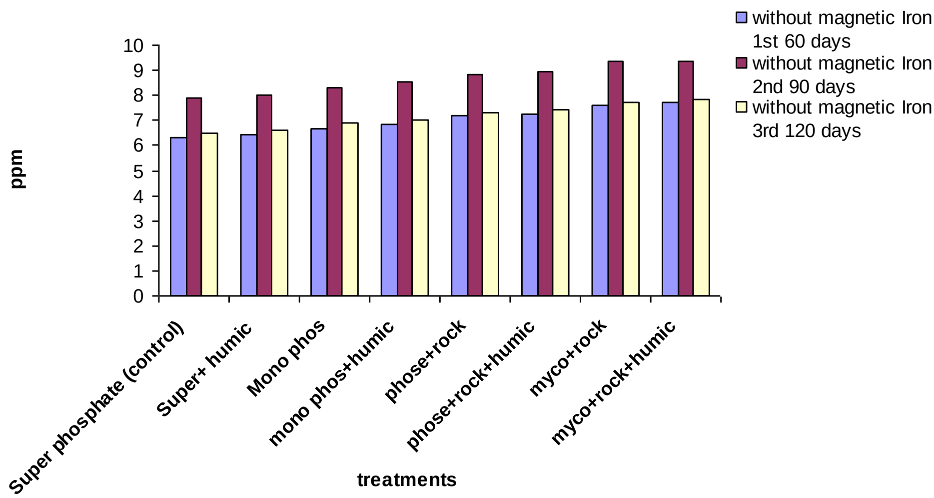

Fig.(123): Zinc content in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

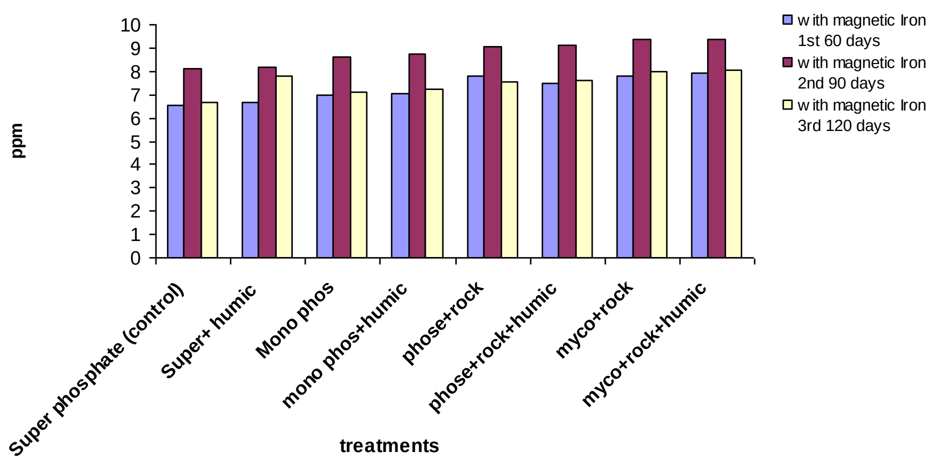

Fig.(124): Zinc content in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

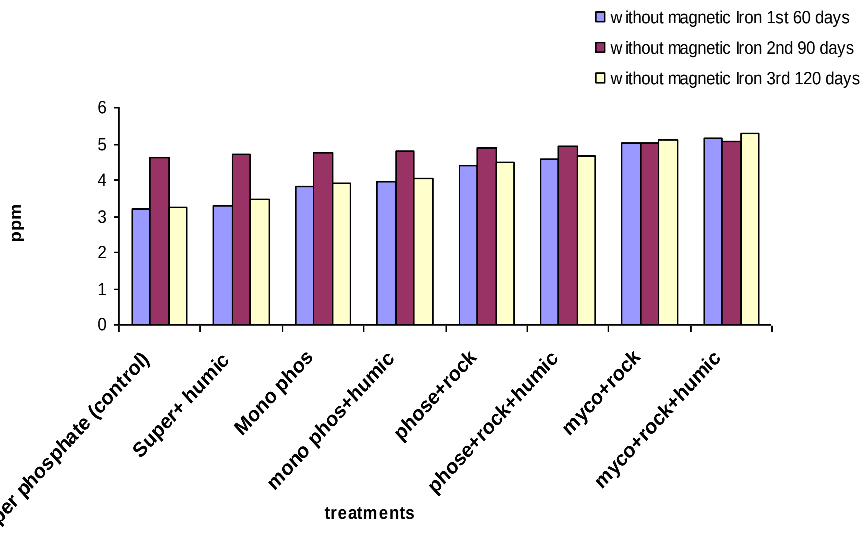

Fig.(125):Manganise content in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season.

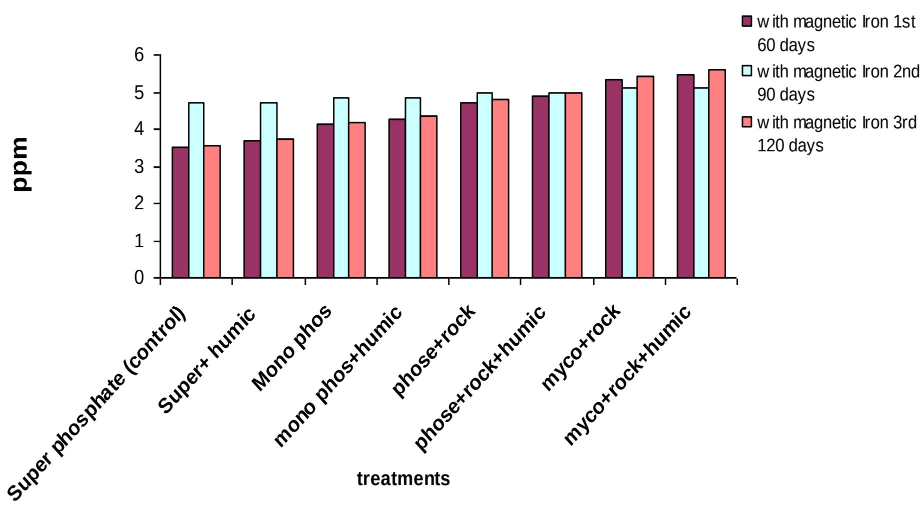

Fig.(126): Manganise content in cutting plant 60,90 and 120 days after sowing with magnetic iron 1st season.

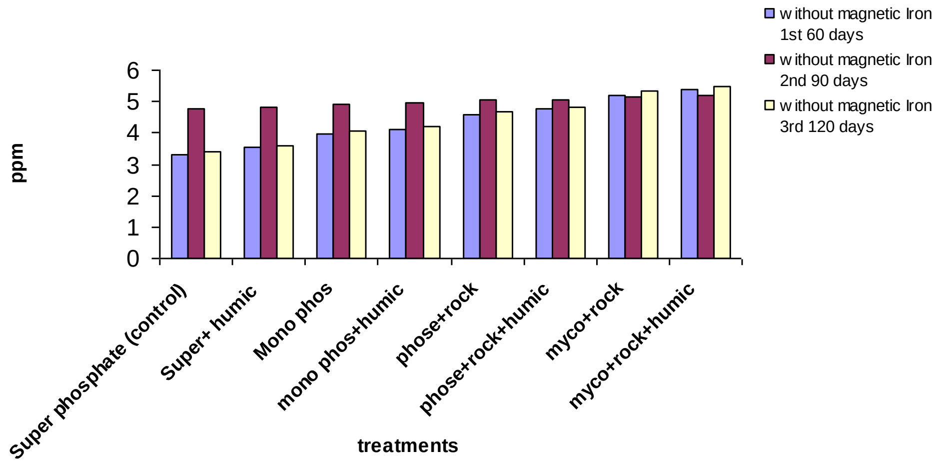

Fig.(127): Manganise content in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

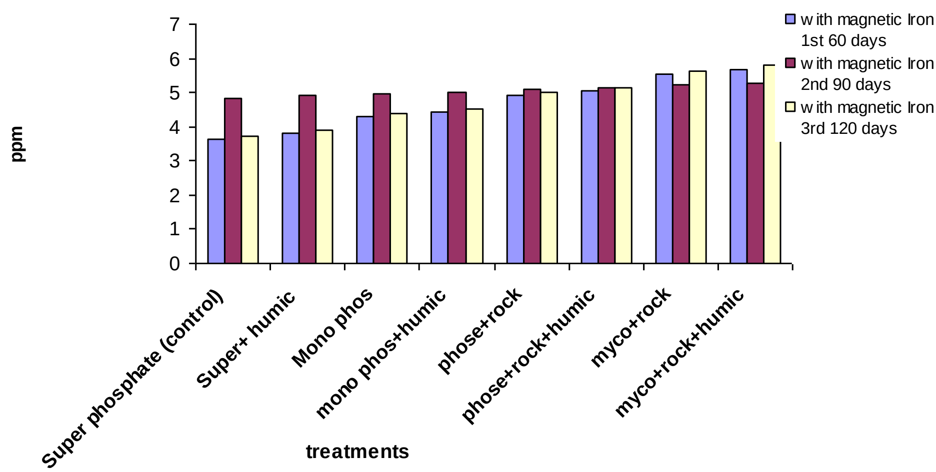

Fig.(128): Manganise content in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

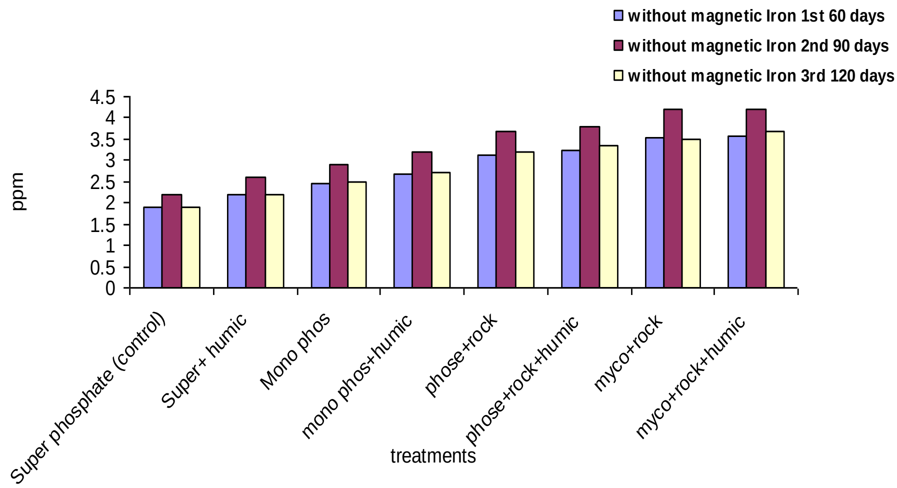

Fig. (129): Boron content in cutting plant 60, 90 and 120 days after sowing without magnetic iron 1st season

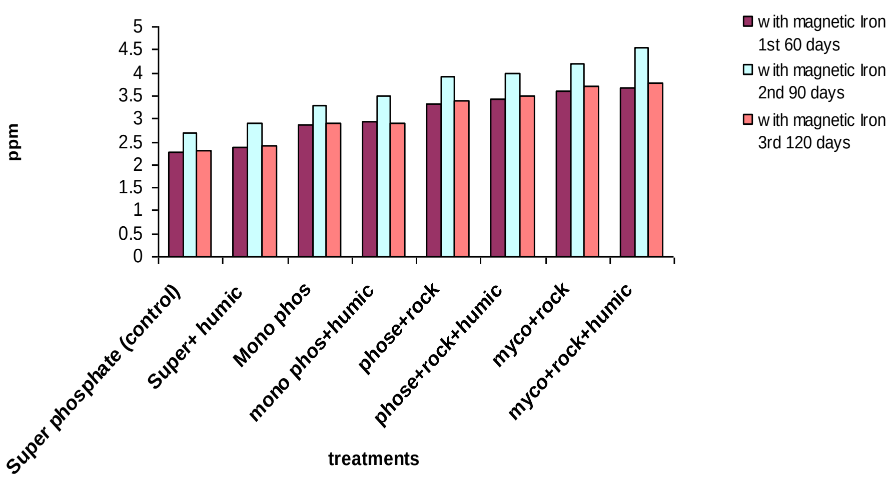

Fig. (130): Boron content in cutting plant 60, 90 and 120 days after sowing with magnetic iron 1st season

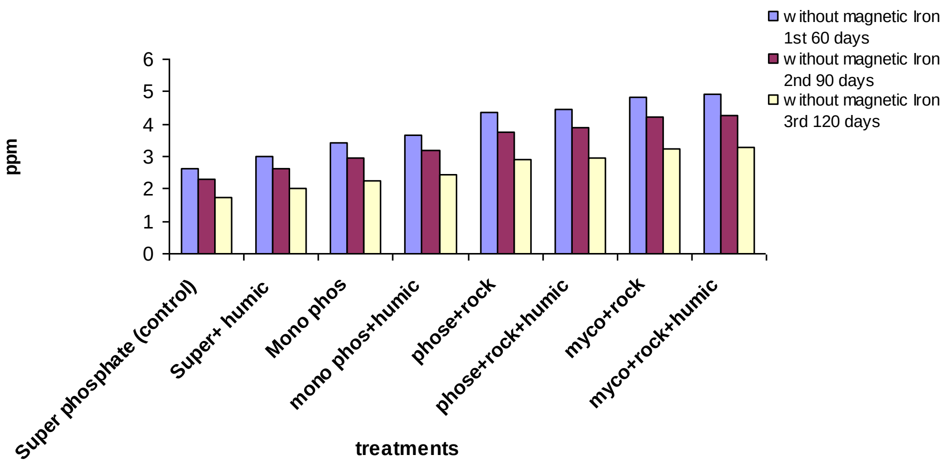

Fig. (131): Boron content in cutting plant 60, 90 and 120 days after sowing without magnetic iron 2nd season

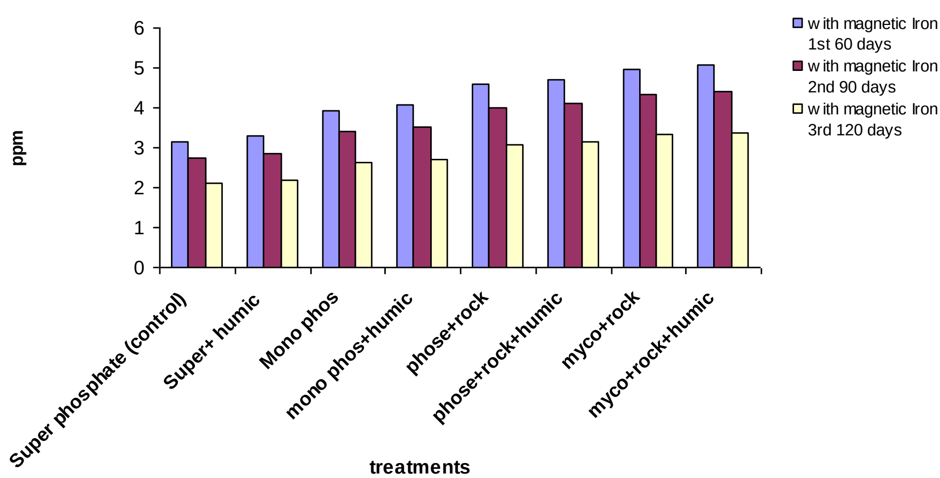

Fig. (132): Boron content in cutting plant 60, 90 and 120 days after sowing with magnetic iron 2nd season

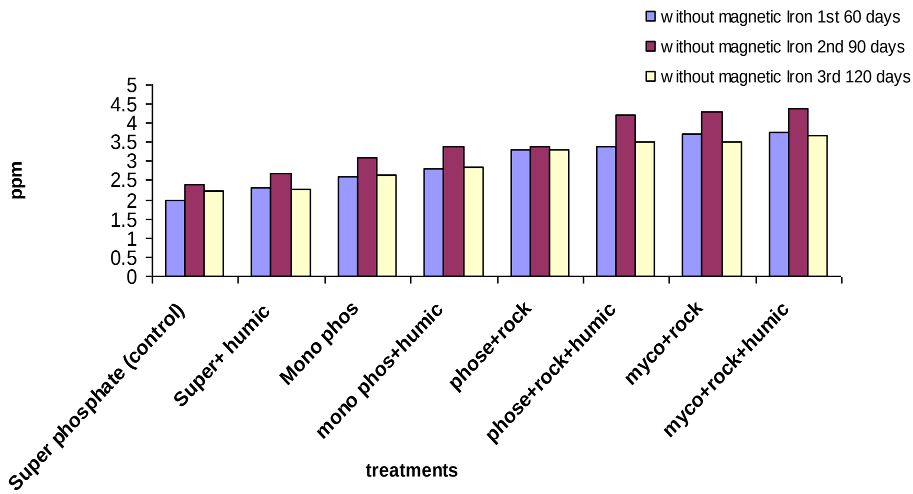

Fig. (133): Copper content in cutting plant 60, 90 and 120 days after sowing without magnetic iron 1st season

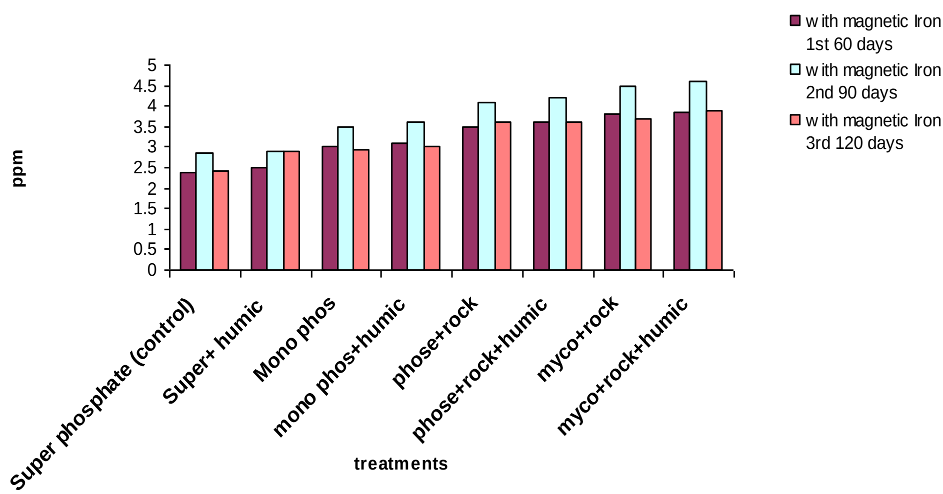

Fig. (134): Copper content in cutting plant 60, 90 and 120 days after sowing with magnetic iron 1st season

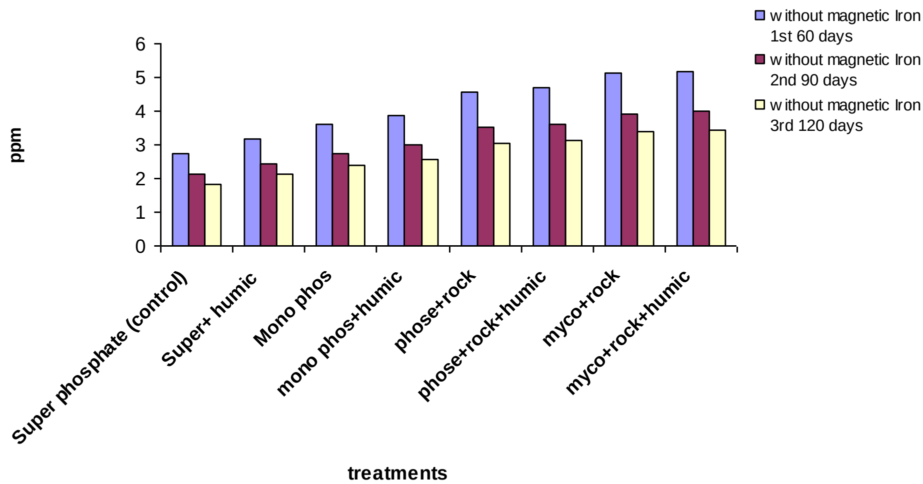

Fig. (135): Copper content in cutting plant 60, 90 and 120 days after sowing without magnetic iron 2nd season

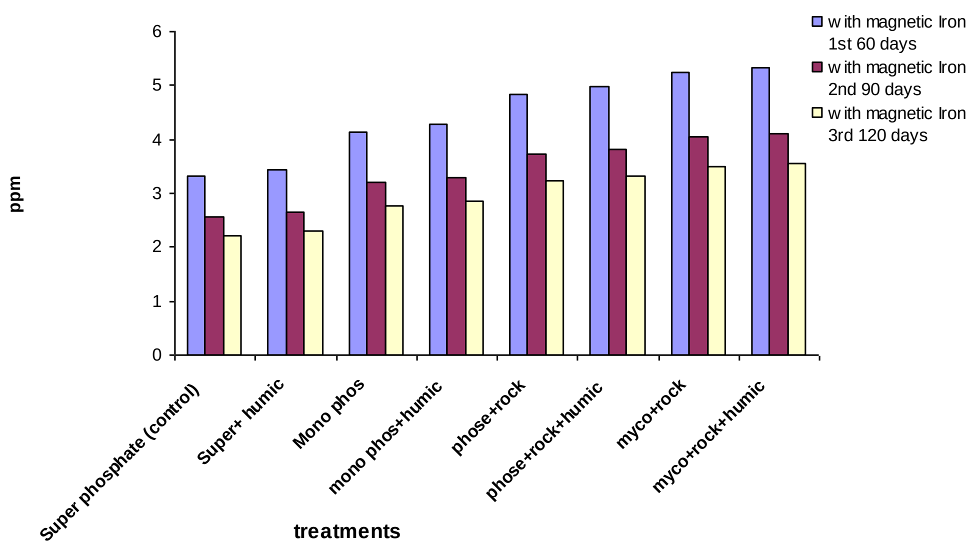

Fig. (136): Copper content in cutting plant 60, 90 and 120 days after sowing with magnetic iron 2nd season

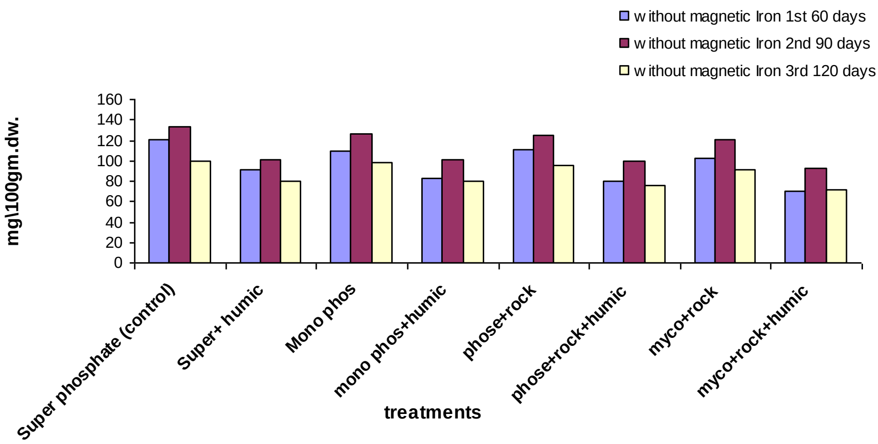

Fig.(137):Sodium content in cutting plant 60,90 and 120 days after sowing without magnetic iron 1st season.

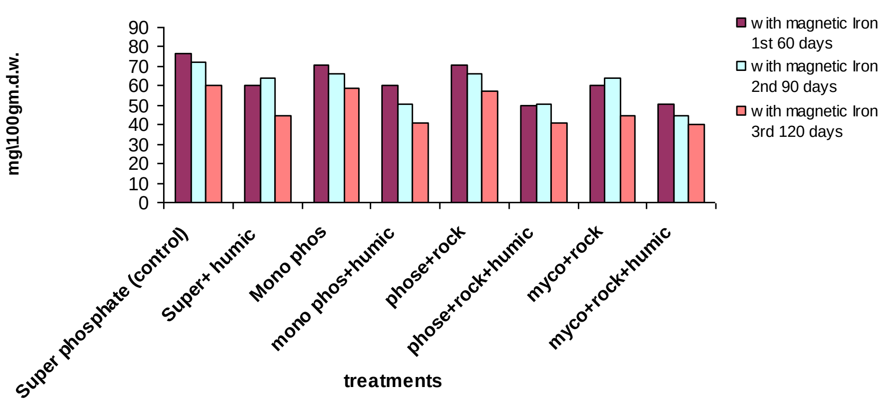

Fig.(138): Sodium content in cutting plant 60,90 and 120 days after sowing with magnetic iron 1st season.

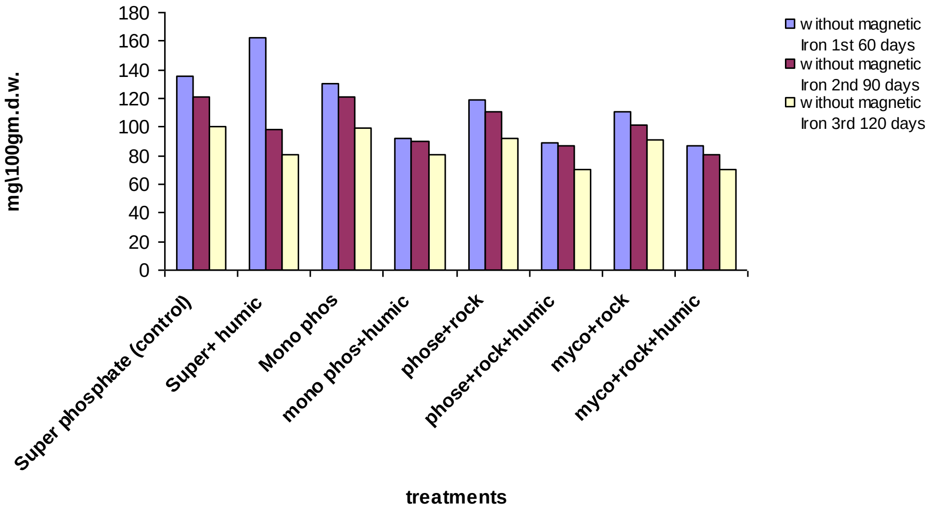

Fig.(139): Sodium content in cutting plant 60,90 and 120 days after sowing without magnetic iron 2nd season.

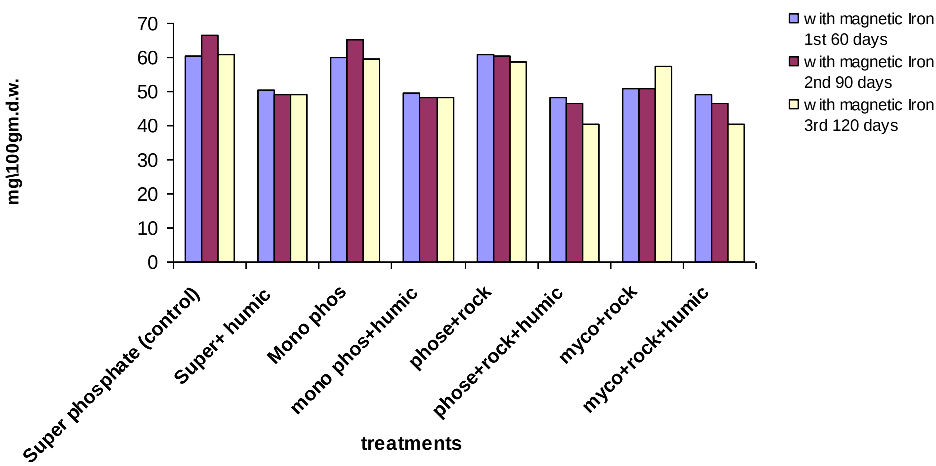

Fig.(140): Sodium content in cutting plant 60,90 and 120 days after sowing with magnetic iron 2nd season.

V. DISCUSSION

A. Intact plant:

The results obtained from the experiment dealing with intact plant (shoot), illusrated that rock posphate plus mycorrhiza was more efficient than other P treatments (R+P, MP and SP). These treatments came in descending order. However, such increase reached the significant level for different growth characters studied such as leaf area, fresh and dry weights per plant against the rest of P treatments. Humic acid and magnetic iron applications also stimulated the previous growth characters, since the interaction of rock phosphate + mycorrhiza with humic acid and magnetic iron achieved significantly the highest response for growth characters studied which reflected itself on grain yield production. Hence it was the resultant of the weight of 100 grains. Rock phosphate + phosphorine combined with humic acid and magnetic iron also stimulated grain yield production of both seasons as well the weight of 100 grains. Meanwhile, super phosphate singly recorded the least grain yield production. In this respect **Salih *et al*. (1989)** demonstrated that the responses of plant dry matter and P uptake to inoculation with fungi were better in calcareous soil treated with rock phosphate than that treated with triple super phosphate. Also, **El-Demerdash *et al*. (1992)** showed that the calcareous soil inoculated with mycorrhiza and treated with rock phosphate gave higher plant dry matter than the soil inoculated with mycorrhiza and treated with super phosphate. Recently biofertilizer has been identified as an alternative to chemical fertilizer not only to increase soil fertility and crop production but also to reduce fertilizer cost. In this respect **Wu *et al*. (2005)** reported that the application of biofertilizer containing mycorrhizal-fungi and three species of bacteria significantly increased the growth of maize plants. They added that addition half of the amount of biofertilizer application had similar effects when compared with organic fertilizer or chemical fertilizer treatments.

However, as for stimulation of growth characters and grain yield by spraying humic acid, **Sharif *et al*. (2002)** reported that the spraying of humic acid by the rate of 50 or 100 mg caused significant increase in shoot dry matter of maize plants compared to control. Also, **Sharif *et al*. (2003)** added that, the residual effects of humic acid caused significant increase in grains, total dry matter and stalk yields of maize. The possitive effect of humic acid application on plant may occur either due to direct enhancement of plant growth by slight increase of organic matter and decreasing soil pH values consequently improved soil P concentration **(Sarir *et al*., 2004)**, or indirectly, by stimulating hyphal growth and mycorrhiza formation **Grynder *et al*. (2005)**.

The results also indicated that the different applications had no effect on the regulation of grain protein fractions. The albumin always constitute double content against globuline, under different applications. In this regard, **Marschnar (1995)** reported that the regulation of the synthesis of individual proteins (albumine, prolamine, etc.) is correlated to the genetic code. Therefore the proportion of lysine in the various protein fractions is not altered by nitrogen supply. Concerning the phytate content in the grains, the result indicated an obviously increase in shoot Zn content under mycorrhizal rock phosphate treatment and that may be reflected on grain phytate. In this regard **Marschnar (1995); Hacisalihoglu and Kochian, 2003** found that Zn lays catalytic, co-catalytic or structural roles in many plant enzymes, all of which could be involved in fractionation. Much of the Zn in a plant is stored as Zn-protein-phytat complexes, which can be remobilized later during plant development and potentially play an important role in determining plant Zn-assimilation efficiency.

The treatment (rock phosphate + mycorrhiza + humic acid) in presence or absence of magnetic iron reduced pH value of the soil from 7.9 to 6.9 which reflected itself on the availability of soil nutrients. Since, this treatment stimulated N and P uptake as well, Mn, Zn, B & Cu. Moreover, the rock phosphate used in this experiment contained (4%)

sulfur which altered both soil and plant sulfer content. Results revealed that mycorrhiza application with rock phosphate stimulated P uptake to reach 12.5% in the first seaon and extended to reach 25% in the second one above those obtained from super phosphate (control), also phosphorin with rock phosphate stimulated P uptake to record 10.3% & 13.5% in both seasons respectively. Other P fractions of different treatments ran almost parallel to that obtained with total P. It could be concluded that, the rock phosphate + mycorrhiza treatment played the most important role in improving total P and its fractions in plant shoot. Also the soil analysis clearly show that, the lowest pH value was detected under rock phosphat + mycorrhiza treatment concomitant with sharp increase of $PO^{=}_4$ availability. These results are in agreement with previous work of **Casanova (2003)** he found that application of partially acidulated rock phosphate yielded excellent results in comparison with traditional fertilizers. This increase in yield reached 29% over the national average yields of sorghum. **Xiong *et al*. (1994)** suggested that application of partially acidulated rock phosphate to calcareous soils is only of short tern benefit. In the long run this fertilizer is not a desirable source of P in calcareous soils since the unacidulated part in the fertilizer was not solubilized in the alkaline conditions. Also **Jena *et al*. (2004)** reported that rock phosphate combined with monoammonium phosphate + sulfur produced higher grain and stover yield of maize crop than untreated rock phsphate. On the other hand **Agea *et al*. (1988)** showed that inorganic P by microorganism in solution culture was related to their ability to reduce pH. Other workes sugested that the phosphate solubilizing property of soil fungi is related to their acid and neutral phosphatase production **(Tarafdar 1984). Salih *et al*. (1989)** suggested that the solubilization of phosphorus by soil fungi was not related to the changes in soil pH but with the nature of organic acid produced by fungi which is more important in releasing P from insoluble phosphate more than total acidity. **Leyval and Berthelin (1991)** reported that the mycorrhiza fungi have a considerable capacity for production and excreating organic acids.

However, in calcareous soils the higher rates of respiration (CO_2 production) of mycorrhiza compared to non mycorrhizal roots increase the solubility of calcium phosphate and might thereby also increase the effectivity in phosphorus acquistion **(Knight *et al*. 1989).** Moreover the presence of acid phosphatase as ectoenzyme of mycorrhiza is well established, its activity being high all along the external mycelium **(Dinkelakr and Marschner, 1992)** and the surface of the sheathed roots **(Group and Pargney, 1991).** However, **Dalpe & Monreal (2004)** reported that the increasing in the capacity of plant roots for water and nutrients uptake from the soil when colonized by mycorrhiza was proposed as the main mechanism to explain the effect of mycorrhiza in plant performance. They added that, this behaviour is particularly evident with soil nutrients that are more immobile such as phosphorus (P), Zinc (Zn) and copper (Cu). However, K, Mg & Cu contents of sorghum plant negligibly affected by dfifferent P treatments applied in support with these findings. Quantitative data on the delivery of mineral nutrients such as K, Mg or micronutrient via the external mycelium to the host plant are scarce, except for Zn. **(Marschner 1995).** That the colonization of roots by AMP can result in improved plant. Zn nutrition is well established **(Gao *et al*., 2007; Kothari *et al*. 1991; Marschner and Dell 1994; Ortas *et al*., 2002; Smith and Read 1997.** Direct evidence for uptake of Zn by mycorrhiza has come from studies employing ^{65}Zn as a tracer **(Cooper and Tinker 1978; Bürkert and Robson 1994; Jansa *et al*., 2003; Mehravaran *et al*., 2000 and Cavanaro, 2008).**

Also, the results obtained of this experiment revealed that, the same treatment (rock phosphate + mycorrhiza + humic acid + magnetic iron) diminished greatly Na uptake in comparison to the other interactions particularly in the presence of humic acid and magnetic iron. Magnetic iron was much effective in minimizing Na content of the shoot of sorghum plant inparticular with super phosphate application which effected also by sampling date. Such reduction reached 75, 86 and 58% with 2^{nd} season in the three sampling dates respectively. Meanwhile, the reduction obtained with R + M in presence of magnetic iron recorded 38, 82 and 40% for 2nd season during the three samplig dates. However, the reduction of sodium content was much pronounced with super phosphate application as well plant age in case of intact plant.

B. Cutting plant :

With respect to the second experiment dealing with sorghum as fodder plant, cutting of plants monthly commencing 60 days after sowing revealed that the second cut gained high growth in terms of plant height, No. of leaves, leaf area, fresh and dry weights. P treatments differed greatly since, rock phosphate + mycorrhiza achieved the significant increase in these characters as well as No. of tillers commencing from the second cut. On the contrary SP reduced greatly No. of leaves and leaf area. In agreemet with these result **Rabindra *et al*. (1986)** as an alternative source of P calcareous soil, gave better resudual response than single super phosphate. Moreover **Salih *et al.* (1989)** and **El-Demerdash *et al*. (1992)** reported that the positive effect of rock phosphate in calcareous soil was better when inoculated with dissolving P microorganisms than that treated with super phosphate. **Neweigy *et al*. (1997)** found that the treatment with mycorrhizal inoculation gave higher values of plant height, leaf area per plant, fresh and dry weights of root and shoot sorghum plant than treatments which included phosphate solubilizing bacteria. Also, **Patrdar and Mali (1997)** indicated that the inoculation of *Azospirillum alpne* in combination with phosphate solubilizing bacteria (*Bacillus megaterium*) significantly increased fodder yields of sorghum and also the straw yield of wheat increased owing to the residual effect. However, **Khalied *et al.* (2003)** reported that the phosphorus fertilizer (single super phosphate) stimulated fodder yield of two sorghum cultivars as the result in increasing of plant height, stem diameter, number of leaves per plant and leaf area, in this regard, **Sharif *et al*. (2003)** reported that the residual effect of humic acid caused significant increase of total dry matter and stalk yield of maize.

Irrespective wih P Fertilizers the addition of humic acid or magnetic iron stimulated plant growth agaisnt untreated plants. Furthermore rock phosphate combined with humic acid or magnetic iron gained maximum cutting yields for the three cutting dates. Moreover, magnetic iron with R+M induced taller plants with increasing number of tillers which stimulated cutting yield production as well plant dry weight. Magnetic iron when combined with R+M and humic acid significantly stimulated plant height, No. of leaves, leaf area and No. of tillers to surpass other interactions which was reflected clearly on yield cutting at the three different dates and plant dry weight. Also, the cutting plants under different treatments almost behaved as that previously obsrved for the intact plant for P, N, S nutrients as well Zn, Mn, B & Cu which responded positively with R+M + humic acid and magnetic iron. On the other hand K, Ca & Mg as well as Fe did not clearly differ with different interactions.

In this regard, **Hashem (1999)** found that calcareous soil treated with phosphate dissolving bacteria led to significant increase in dry matter and the wheat plant uptake of N, P and K. **Subbiah and Thenmozhi (2001)** added that mycorrhizal fungi as soil application and phoshobacterin as seed behind plant treatment in calcareous soil had beneficial effect not only on enhancing fruit yield and P use efficiency but also on improving the quality besides saving the cost. However, **Neweigy *et al*. (1997)** reported that the sorghum plants treated with mycorrorhiza gave higher values of growth characters than those inoculated with phosphate solubilizing bacteria.

The role of beneficial mycorrhizal effects on its host plants has been discussed by **Marschner (1995)** who reported that, the most distinct growth enhancement effect by mycorrhiza occurs by improved supply of minerl nutrients of low mobility in the soil solution, predominantly phosphorus. Whereas, external hyphae can absorb and translocate phosphorus to the host from soil outside the root depletion zone of mycorrhizal roots. He added that such enhancing effect of mycorrhizal plants uptake of phosphorus per unit root length is 2-3 times higher than in nonmycorrhizal plants.

More positive aspects of mycorrhiza on host plant has been discussed by **O'Keefe and Sylvia (1993)** observed that external hyphae adhere to soil particles, which would improve contact with the soil solution. Furthermore, they demonstrated that hyphae access smaller pore spaces than plant roots and root hairs. As soil water content decreases, the relative importance of these factors would increase. Enhanced plant growth and yield following mycorrhiza fungal inoculation was related to improve uptake of P and Cu especially under water stress condition **Sylvia *et al*. (1993) and Al-Karaki (1998)**

As for the beneficial effect of humic acid on nutrient uptake, **Sharif *et al*. (2002)** reported that the soil P concentration significantly improved by the addition of humic acid, but P accomulation of maize plant was not significantly affected. Micronutrients (Zn, Fe, Mn and Cu) concentrations of soil and plant increased insignificantly over untreated control. Also **Sherif *et al*. (2003)** reported that humic acid nonsignificantly increased N accumulation in plant over control. In the contrary **Chen *et al*. (2007)** indicated that humic acid can obviously promote the absorption of N, P and K by maize plants.

Boron content differed in the two seasons, since the second cutting recorded the highest B content of the first season whereas it started early in second one since it began from the first cutting date. This owe much to the repetition of the treatments in the same plot area. Also, the results indicated that the application of either phosphorine or mycorrhiza stimulated B content above other phosphorus sources. Since the application of phorphorine + rock phosphate achieved around 65% above the super phosphate treatment (control) which reached 85% with mycorrhizal rock phosphate. This might be clearly reflect the beneficial role of mycorrhiza on Boron transport into plant. In this regard **Allen *et al*. (1980, 1982)** noticed that the mycorrhiza might enhance growth of mycorrhizal/ plants through enhance nutrients uptake and synthesis of plant growth promoting hormones, in particular auxins, cytokinins and gibberellins and/or increased number of vascular bundles. **(Daft and Okusanya 1973) i**mproved nutrient uptake due to the increased of absorptive surface of the root system by external mycorrhiza mycelia. As external mycelia ramificate through the soil beyond the nutrient depletion zone they absorb and translocate mineral elements mainly phosphorus, zinc, copper and boron to the root system **(Linderman 1994).** In addition the fungi might have improved water uptake from the growth medium **(Hardie, 1985).** Concerning the beneficial effect of magnetic iron on growth critira and some nutrients uptake **Abd El-Al (2003)** showed that addition of iron for eggplant at the time of transplanting resulted in the higher values of N, P, K and Fe and increased plant height, leaf number, fresh and dry weight compared with the no iron addition.

With the respect to the sodium content in cutting plants here again the effect of magetic iron was pronounced clearly for super phosphate applicatio sice the reduction recorded 75, 54 and 40% in the 2nd season during the three cutting dates respectively while the reduction for R + M treatment ranged between 38, 34 and 30% respectively, in the same season than the untreated (without magnetic).

Two field experiments were carried out at King Maryot, North Western coastal region of Egypt during 2004 and 2005 seasons. This study was conducted to evaluate the effect of phosphorus fertilizers [Super phosphate, Mono ammonium phosphate and rock phosphate either combined with mycorrhiza or phosphorine] in the presence or absence of humic acid and magnetic iron on sorghum plants grown under calcareous soil.

The results obtained clearly showed that the mycorrhizal rook phosphate combined with humic acid and magnetic iron achieved significantly the highest P, N, S, Mn, Zn & B contents in shoot which reflected positively on improving the growth characters, grain yield (quantitive and quality) and cutting yield above all other P sources.

VI. SUMMARY

The objective of this work was to evaluate the effect of some P-sources in present or absence of phosphorine and mycorrhiza, humic acid and magnetic iron on growth of intact and cutting sorghum plant, grain and forage yield and macro and micronutrient content of plants grown in calcareous soil at North Western coast.

For this goal Two field experiments were conducted at the experimental farm of Desert Research Center (DRC) King Maryot, North Western Coastal Region of Egypt during summer seasons of 2004 and 2005 respectively.

Phosphorus treatments were as follows:

Super-phosphate was added at the rate at 200 kg/fed (During soil preparation). Mono ammonium phosphate was sprayed at the rate 2000 ppm. Rock phosphate was added at the rate 150 kg/fed. (During soil preparation) accompanied either with the phosphorine to the grains just before sowing or with mycorrhiza added to the soil just before sowing at the rate of 1 g/hill (containing 10^8).

The previous phosphor as treatments were applied singly or combined with humic and / or magnetic iron.

Magnetic iron treatment was applied broadcating at the rate 100 kg/fed. To the treated plots during soil preparation, while the control plots were left without any addition.

Humic acid was sprayed at the concentration 2000 ppm.

The response of intact and cutting sorghum plants to these treatments were tested in terms of grwoth features grain yield, and its content macro and micronutrients content of shoot at 60, 90 & 120 days after sowing either for whole plants or cutting plants.

A. Intact plant :

I. Growth and yield :

1. Seasonal changes of plant height, leaves number, ;eaf area, shoot fresh and dry weights of the sorghum plant during the three successive

sampling dates 60, 90 and 120 days generally tended to increase wih advancement of the age in both seasons.

2. (R+M) + humic when combined with magnetic application significantly recorded the highest plants against the dfferent treatments in both seasons as well as RM treatment with magnetic iron without humic application of the second and third samples in the second season.
3. (R+M) + humic treatment particularly with magnetic iron achieved significant increase of the leave numbers during the three sampling dates in both seasons. Such behaviour was detected with the same treatment in the 1st season at the early and late sampling dates (60 & 120). (R+P) + humic tended to reach the same level of significance when combined with magnetic iron application in 1st and 3rd samples of the 1st season as well 1st and 2nd of the 2nd one when compared the other treatments.
4. (R+M) + humic treatment particularly with magnetic iron achieved significants increase of the leaf area at most sampling dates compared the other treatments.
5. (R+M) + humic acid and magnetic significantly recorded the highest fresh and dry weights during the three sampling dates of both seasons compared the other treatments.
6. (R+M) + humic when combined with magnetic iron significantly achieved Maximum grain yield production in both seasons above the other interactions, RP + humic acid with magnetic iron followed that obtained with RM + humic when combined with magnetic iron in both seasns. Super phosphate SP singly or with humic recorded least grain yield production particularly with magnetic iron application.
7. The previous response of grain yield was the same result of that recorded with the weight of 100 grains with almost the same level of significance.

Chemical content:

1. Total nitrogen content, crude protein as well albumin and globuline behavied almost similalry to grain yield production. Mychorrhiza + Rock phosphate, phosphorin + Rock phosphate, mono ammonium phosphate and super phosphate treatments, came in dessending manner when combined with humic or magnetic iron. The albumin constitute (double content) against globulin.
2. The percentage of total P and it's fractions were tended to increase by age to reach their maximum at the second date then sharply declined at third date. Such increase reached 30% until 90 days whereas, the reduction recorded 61% in last age of the first season. However, similar trend was observed in the second season undersuper phosphate (SP) and monoamonium phosphate (MP) treatments. Meanwhile, the rock phosphate applications either with humic acid or magnetic iron achieved less reduction ~50% (0.48 g/100 g) in last age against 61% in the first season.
3. Mg, K, Ca, S, Fe, Zn and Cu content in shoot gained the maximum values at the second sample date then declined at the next sample date (120 days after sowing).
4. Mn uptake for different treatments applied tended to increase tell 90 days after sowing except for M.R with or without humic acid as well PR with humic acid in presence with magnetic iron on the other hand the first, two treatments (MR with or without humic acid and without magnetic iron) also slightly increased in this date (90 days after sowing).
5. Concerning the effect of different manurial treatment on the total P and its fractions at all sampling dates during two seasons, Mycorrhiza application with rock phosphate stimulated P uptake to reach ~12% in the first season and extended to reach ~25% in the second one above those treated with super phosphate (control). Whereas, phosphorin application also with rock phosphate stimulated P uptake to record 10.3% & 13.5% in both seasons respectively.

6. (R+M) + humic acid when combined with magnetic iron initiated an increase of about 6% of K and 11% of Mg contents in plant shoot above superphosphate application (control with magnetic iron) at last sampling date in both seasons.
7. (R + M) + humic acid promoted greatly sulfur content of sorghum plant to reach ~94% with magnetic iron at the first sampling date in both seasons against control for each date, and nearly about 72% in other two samples of both seasons. Other treatments (R+M), (R+P) + humic acid, (R+P), MP + humic acid, MP came descendingly below (R+M) + humic acid either with or without magnetic iron during the three dampling dates of both seasons.
8. (R+M) application combined with humic acid and magnetic iron increased Fe content in plant shoot at the three successive sampling dates to reach ~3.4%, 3.6% and 4.0% above those obtained under control treatments in both seasons.
9. Rock phosphate application either with mycorrhiza or Phosphorin with or without humic acid or magnetic iron surpus zinc content in shoot plant than that recorded under SP or MP applications during the three sampling dates, of both seasons to be much superior with rock phosphate + mycorrhiza to reach about 20% in both first two samples and 35% in the last one, in both seasons.
10. The application of Mycorrhiza either with or without humic acid and magetic iron recorded maximum Cu content above the other applications. These increase was 87.8% at all sampling dates in both seasons.
11. Rock phosphate application either with phosphorin or mycorrhiza stimulated boron content above the other P sources. Since, the application R+P without humic acid achieved ~65% above the SP treatment in the first sample, which reached 85% with micorrhiza + rock phosphate without humic acid and magnetic iron. This was almost true during the next two sampling dates.

12. Opsite to that recorded with macro and micro nutrient content of sorghum plant treated with P applications, humic and magnetic iron, sodium content of whole plant recorded reversable response with P applicaton, since mycorrhiza +rock phosphate + humic acid absorbrbe. The least sodium content below the other P applications to be the lesser with magnetic iron at the three sanpling dates in both seasons on the contrary, super phosphate achieved much sodium content above rest of P applications magnetic iron application tended to reduce sodium ptake below those untreated (without magnetic iron) in the different sampling dates in both seasons.

B. cutting plants:

Growth and yield:

1. Plant gained its maximum height, under different treatments, at the first cut, then it decreased desendingly at the next two dates. Meanwhile, number of leaves and leaf area tended to increase by advancing the cutting age to reach their maximum at second cut then decreased at last one.
2. (R+M) + humic when combined with magnetic iron significantly stimulated plant height and leave area of sorghum plant above the other combination during the three cutting dates.
3. (R+P) or (R+M) treatment when combined with humic as well magnetic iron recorded significant increase in leaf number at the three cutting dates above the other interactions.
4. (R+M) or (R+P) when combined with humic and magnetic iron applications accumulated dry matter production during the three cutting dates to record significantly an increase above the other interactions.
5. (R+M) treatment singly or with humic when each combined with or without magnetic iron significantly promoted number of branches above the rest of interactions particularly in the second season. Since (R+M) + humic + magnetic or without magnetic achieved significant

number of branch as well RM without humic when combined with magnetic iron application.

6. (R+M) + humic and magnetic iron significantly increased cutting yield at the different dates as well RM with magnetic at the first cutting date of both seasons above the rest of the interactions.

Chemical content :

1. The total P content as well its fractions were greater at the second cutting date than those found at the first or third cutting dates. In contrary to that obtained in intact plant which gained less content at the last sampling date (120 days after sowing). Here the cutting gained almost the same content at those of the first cut or slightly increased at the last cut.
2. The highest values N or crude protein was detected at the first cutting date then decreased in the two successive cutting dates to reach the lowest content at the third cutting date.
3. Potassium, Magnesium, Calcium, Zinc and Cupper contents in shoot recorded the maximum accumulation at the second cutting date then decreased at the last one.
4. A part from the sulfur increase recorded with SP singly or when combined either with humic acid or magnetic iron in the second cutting date of the first season, generally the other treatments of both seasons tended to decrease S content with advancement of cutting date.
5. Manganese uptake of sorghum plant within different cutting date illustrated the second cutting date gained much Mn above the other two cutting dates except for MR either with humic acid or magnetic iron. Since the cutting dates negligibly affected Mn content to be almost the same or with slightly less magnitude in the second cutting date.
6. Maximum Boron content was detected at the second cutting date of the first season, whereas, the repetition of the treatments in the same

plots alternated such behavior in the second season to reach its maximum content early at the first cutting date.

7. Mycorrhiza rock phosphate application combined with humic acid and magnetic iron achieved the highest P contents in shoot above all other applications. This was true at the three cutting dates in both seasons. However, in case of cutting plants, the beneficial effect of (R+M) was increased by advancing the cutting dates against super phosphate treatment.
8. Different P applications either with humic acid or magnetic iron negligibly affected K, Mg, Ca and Fe.
9. R+M with humic acid and magnetic iron recorded the highest Zn, Mn, B and Cu contents in plant shoot above the rest of treatments.
10. Rock phosphate application with humic acid reduced sodium content at different cutting dates of both seasons, whereas super phoshate applicaton singley accumulated much sodium above the rest of P applications. Also magnetic iron and humic acid treatments reduced sodium content for each P treatments. Moreover, the effect of magnetic iron was most effective in the second season, since the treatments were repeated in the same areas.

VII. REFERENCES

Abd El-Al, F.S. (2003). Different nitrogen sources and magnetic iron addition as affected the productivity of eggplant (*Solanum melogena* L.) plant. J. Agric. Sci. Mansoura Univ. 28 (4): 2903-2916.

Abd El-Ghany, B.F. (1999). New bio-organic approach and their correlation with maize production in new cultivated calcareous soil. Desert Institute Bulletin, Egypt. Publ. (1999); 47 (2): 363-378.

Abdel-Latif, I.A. and K.S. Abdel-Fattah (1983). The influence of different organic residues and inorganic phosphatic fertilizers on growth and nutrients of barley (*Hordeum vulgare*). Egyptian Journal of Soil Science; 23 (2): 171-179.

Ahmed, F. and Kh. Tan (1991). Availability of fixed phosphate to corn (*Zea mays*) seedlings as affected by humic acids. Indonesian Journal of Tropical Agriculture; 2 (2): 66-72.

Albornoz, A.; N.Christensen; W. Lindemann and R. Gil (1993). Evaluation de fertilizantes liquidos de base acid en unsistema de produccion de sorgo bajo labranza minima. Agronomia Tropical, 43 (1-2): 5-25.

Al-Karaki, G.N.; A.Al-Raddad and R.B. Clark (1998). Water stress and mycorrhizal isolate effects on growth and nutrient acquisition of wheat. J. Plant. Nutr. 21: 891-902.

Allen, M.F.; T.S. Moore and M. Christensen (1980). Phytohormone changes in *Bouteloua gracilis* infected by vesicular-arbuscular mycorrhizae. 1. Cytokinin increases in the host plant. Canadian Journal of Botany, 58: 371-374.

Allen, M.F.; T.S. Morre and M. Christensen (1982). Phytohormone changes in *Bouteloua gracilis* infected by vesicular-arbuscular mycorrhizae. II. Altered levels of gibberelline-like substances and abscissic acid in the host plant. Canadian Journal of Botany, 60: 468-471.

AOAC (1995). Method of analysis. Association of Official Agriculture Chemists. 16^{th} Ed., Washington, D.C.USA.

Avnimelech, Y. and J. Hagin (1985). On the use of phosphorus solubility parameters for the evaluation of phosphate plant availability. Communications in Soil Science and Plant Analysis; 16 (11): 1211-1218.

Aydn, A.; M. Turan and Y. Sezen (1999). Effect of fulvic + humic acid application on yield and nutrient uptake in sunflower (*Helianthus annuus*) and corn (*Zea mays*). Improved crop quality by nutrient management. Kluwer Academic Publishers, Dordrecht, Netherlands, 249-252.

Barak, P.; B.O. Jobe; A. Krueger; L.A. Peterson and D.A. Laird (1997). Effect of long-term soil acidification due to agricultural inputs in Wisconsin. Plant and Soil, 197: 61-69.

Barthakur, H.P. (1978). Solubilization of relatively in soluble phosphate by some fungi isolated from rhizosphere or rice. Ind. J. Agric. Sci. 48, 762-766.

Bradford, M.M. (1976). A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein Dye Binding. Analy. Biochem. 72; 248-254.

BSTID-NRC (Board on Science and Technology For International Development-National Research Council) (1996). Lost crops of Agrica. Academic Press, Washington. DC, pp. 127-213.

Burkert, B. and A. Robson (1994). ^{65}Z uptake in subterranean clover (*Trifolium subterraneum*) by (3) vesicular arbuscular mycorrhizal fungi in a root-free sandy soil. Soil Biol. Biochem., 26: 1117-1124.

Camira, A.L. and F.M. Clydesdale (1982). Analysis of phytic acid in foods by HPLC. Journal of Food Science, 47, 575-578.

Casanova, O.E. (2003). Evaluating the effectiveness of phosphate fertilizers: phosphate rock use and related technology in Venezuela. Direct application of phosphate rock and related appropriate technology-latest development and practical experinces.

Proceedings of an international meeting, Kuala Lumpur, Malaysia, 16-20 July. IFDC An international centre for soil fertility and agricultural development, Muscle Shoals, USA; 306-321.

Cavagnaro, T.R. (2008). Isotopic fractionation of zinc in field grown tomato. Can. J. Bot. 85: 230-235.

Chapman, D.D. and P.E. Pratt (1961). Methods of analysis for soil, plant and waters “Univ. of California, U.S.A.”.

Chen, Z. De; H.E. Jinming; L.I. Xiangyun and J. Chen (2007). Studies on increasing N utilizing effiiency in maize by applying humic acid. Chinese Journal of Eco-agriculture. Science Press, Beijing, China; 15 (1): 52-54.

Cooper, K.M. and P.B. Tinker (1978). Translocation and transfer of nutrients in vesicular-arbuscular mycorrhizas. II. Uptake and translocation phosphorus, zinc and sulphur. New-Phytal, 81: 43-52.

Cooper, R. (1959). Bacterial fertilizers in the Soviet Union. Soils Fert. 22, 327-333.

Daft, M.J. and B.O. Okusanya (1973). Effect of endogone mycorrhiza on plant growth. VI. Influence of infection on the anatomy and reproductive development of four hosts. New Phytologist 72: 1333-1339.

Dash, R.N.; S.K. Mohanty and S.A. Patnaik (1990). Transformation and availability of P in soils from acidulated phosphate rocks under simulated wheat rice wheat moisture conditions. Journal f the Indian Society of Soil Science; 38 (4): 613-620.

Davies, F.T.; J.R. Potter and R.G. Linderman (1992). Mycorrhiza and repeated drought exposure affect drought resistance and repeated drought exposure affect drought resistance and extraradical hyphae development on pepper plants idependent of plant size and nutrient content. J. Plant Physical 139: 289-294.

Dearing, J.A.; K.L. Hay; S.M. Balsan; A.S. Huddleston; E.H. Wellington and P.J. Loveland (1995). Magnetic susceptibility of soil: An evalution of contributing theories using a national data set. Geohys. J. Inttern.; 127, 728-734.

Dewis, J. and F. Freitas (1970). Physical and chemical methods of soil and water analysis. Soil Bulletin, No. 10: 233-238. Food and Agric., organization of United Nation.

Dinkelaker, B. and H. Marschner (1992). *In vivo* demonstration of acid phoshatase activity in the rhizosphere of soil grown plants, Plant Soil 144, 199-205.

Dlpe, Y. and M. Monreal (2004). Arbuscular mycorrhiza inoculum to support sustainable cropping systems. Plant Management Network. On line. Crop Management di: 10. 10941 CM-2004-0301-09-RV.

Duangpatra, P.; P. Prabuddham and C. Suwannarat (1993). Agronomic effectiveness of calcined phosphate (phospal-34) on maize (*Zea mays*). Kasetsart Journal, Natural Sciences; 27 (4): 480-483.

Duncan, D.B. (1955). Multiple range test and multiple F test. Biometrics. 11L 1-42.

El-Demerdash, M.E.; Y.Z. Ishac; M.A. El-Borollosy and N.F. Clair (1992). Performance of Rhizobium lentil symbiosis as influenced by host genotype, soil type and phosphate amendment. Annals of Agricultural Science, Cairo, 37 (2): 359-369.

El-Dewiny, C.Y.; H.A. El-Aila and S.A. Mohamed (2005). Evaluation of sorghum response to different sources and rates of phosphorus fertilizers. Egyptian Journal of Soil Science. National information and documentation centre (NIDOC), Cairo, Egypt, 45 (1): 31-40.

El-Ghany, B.F.; M.O. Salem and M.A. El-Sibaie (19979). Effect of bacterial inoculation, P and organic fertilization on microbiological properties, growth and production of fenugreek plant under saline calcareous soil conditions. Desert-Intitute-Bulletin, Egypt. Publ. (1999); 47 (1): 1-13.

El-Sersawy, M.M.; B.F. El-Ghany; K.W. Khalil and S.Y. Awadalla (1997). Interaction between organic manure mixture, applied N-level and biofertilization on calcareous soil properties and wheat production in wadi-Sudr, South Sinai. Egyptian Journal of Soil Science; 37 (3): 367-397.

Espen, L.; M. Dell'orto; P. Denisi and G. Zocchi (2000). Metabolic responses in cucumber (*Cucumis sativus* L.) roots under Fe-deficiency. A ^{31}P-nuclear magnetic resonance *in vitro* study. Planta: 210, 985-992.

Fiske, C.H. and Y. Subbarrow (1925). The colorimetric determination of phosphorus. J. Biol. Chem. 66, 375.

Gao, X.; T.W. Kuyper; C. Zou F. Zhang and E. Hoffland (2007). Mycorrhizal responsiveness of aerobic rice genotpes is negatively vorrelated with their zinc uptake when non-mycorrhizal. Plant Soil 290-283-291.

Ghazi Al-Karaki; B. McMichael and Johnzak (2004). Field response of wheat to arbuscular mycorrhizal fungi and drought stress. Mycorrhiza, (14): 263-269.

Ghodpage, R.M. and S.B. Datke (2005). Efficient use of inorganic and biofertilizers on productivity, nutritive value and nutrient uptake of rainfed (*Sorghum bicolor* L. Moench) in a vertisol. Agricultural Science digest. Agricultural Research Communication Centre, Karnal, India; 25 (4): 257-259.

Godwin, I.D. and Gray, S.J. (2000). Overcoming productivity and quality constraints in sorghum : the rate for genetic engineering in transgenic cereals. In transgenic cereals; O'Brien L Henry R.J. Eds AACC St. Paul Minnesota, USA; pp. 153-177.

Gouda, M.; E.E. Kaoud; K. Malter and M.A. Khamis (1990). Effect of some soil and water management practices on groundnut in sandy soils. Egypt. J. Soil Sci., 30: 331.

Gryndler, M.; H. Hrselova; R. Sudova; H. Gryndlerova; V. Rezacova and V. Merthautova (2005). Hyphal growth and mycorrhiza formation by the arbuscular mycorrhizal fungus *Glomus clarodieum* BEG 23 is stimulated by humic substances. Mycorrhiza. Springer-Verlag Gmbh, Heidelberg, Germany: 15, 7: 483-488.

Hacisalihoglu, G. and L.C. Kochain (2003). How do some plants tolerate low levels of soil zinc mechanisms of zinc efficiency in crop plant. New Phytol. 159: 341-350.

Harley, J.L. and S.E. Smith (1983). Mycorrhizal symbiosis. Academic Press, London, 634 pp.

Hashem, F.A. (1996). Improving calcareous soil productivity under saline water irrigation using soil amendments and biofertilizer. Annals of Agricultural Science, Moshtohor; 34 (4): 1934-1955.

Hashem, F.A. (1999). The efficiency of combined applicaton of soil conditiooners and biofertilization on properties and productivity of newly reclaimed soil. Desert-Institute Bulletin, Egypt. Publ. (1999); 47 (1): 149-167.

Hbib, L.; S.H. Chien; G. Carmona and J. Henao (1999). Rape response to Syrian phosphate rock and its mixture with TP on a limed alkaline soil. Communications in Soil Science and Plant Analysis, 30: 449-456.

Holman, G.T. and G.L. Elliott (1983). Chemical analysis of Ecological Materials Lab. Proc., 32, 91.

Jackson, M.L. (1973). Soil chemical analysis. Pkenic-Hall. Inc. Englewood Cliffs, N.J.

Jakobsen, S.T. (1993). Nutritional disorders between potassium, magnesium, calcium and phosphorus in soil. Plant and Soil; 154 (1): 21-28.

Jansa, J.; A. Mazafar and E. Frossard (2003). Long-distance transport of (P) and (Zn) through the hyphae of an arbuscular mycorrhizal fungus in symbiosis with maize. Agronomie, 23: 481-488.

Jarafdar, J.C. and H. Marschner (1994). Phosphatase activity in the rhizosphere of VA-mycorrhizal wheat supplied with inorganic and organic phosphorus. Soil Biology Biochem. 26, 387-395.

Jena, D.; M.K. Jena; S.K. Pattanayak and D. Sahn (2004). Direct effect of compacted rock phosphates on maize and their reidual effect on succeeding mustarad crop in the squence. Indian Journal of Dryland Agricultural Research and Development. Central Researchm Hyderabed, India: 19, 2: 117-122.

Jong, A.J.; F.A. Hoeberichts; E.T. Yakimora; E. Maximora and E.J. Woltering (2000). Chemical induced apoptoric cell death in tomato cells: involvement of caspase-like proteases. Planta, 211: 656-662.

Kabesh, M.O.; M.S. Saber and M. Yousry (1975). Effect of phosphate dissolving bacteria and phosphatic fertilization on the P uptake by pea plants cultivated in calcareous soil. Z. Pflanzenernaehr. Bodenkd. 6, 605-611.

Kayombo, B. (2003). Effect of tillage and fertilizer on semi-arid sorghum yield. AMA, Agricultural Mechanization in Asia, Africa and Latin America, 33 (4): 12-14.

Khalid, M.; A. Ijaz and A. Mohammed (2003). Effect of nitrogen and phosphorus on the fodder yield and quality of two sorghum cultivars (*Sorghum bicolor* L.). International Journal of Agriculture and Biology; 5 (1): 63-61.

Knight, W.G.; M.F. Allen; J.J. Jurinok and L.M. Dudley (1989). Elevated carbon dioxide and solution phosphorus in soil with vesicular-arbuscular mycorrhizal western wheat grass. Soil Sci. Soc. Am. J. 53, 1075-1082.

Kothari, S.K.; H. Marschner and V. Romheld (191). Contribution of the VA mycorrhizl hyphae in acquisition of phosphorus and zinc by maize grown in a calcareous soil. Plant Soil, 131: 177-185.

Kruse, J.K.; N.E. Christian and M.H. Chaplin (2005). Remote sensing of phosphorus deficiencies in agrostis stolonifera. International-Turfgrass-Society-Research. Journal; 10: 923-928.

Leyval, C. and E.J. Joner (2001). Bioavailability of heavy metals in the mycorrhizosphere. In: Gobran, G.R. Wenzel, W.W. and Lombi, E. (eds.), Trace elements in the rhizosphere. CRC Press. Beca Raton, Florida PP: 165. s

Leyval, C. and J. Berthelin (1991). Weathering of a mixa by roots and rhizosphere microorganisms of pine. Soil Sci. Am. J. 55, 1009-1016.

Linderman, R.G. (1994). Role of vesicular arbuscular mycorrhiza fungi in biocontrol. In: Mycorrhizae and plant health. Pfleger, F.L.and Linderman, R.G. (eds), pp. 1-26. The American Phytopathological Society, St. Paul, MN.

Lindsay, W.L. and W.A. Norvell (1978). Development of DTPA soil test for Zn, Fe, Mn and Cu. Soil Sci. Soc. Am. J., 42: 421-428.

Liu, Z.Y.; W.M. Shi and X.H. Fan (1990). The rhizosphere effects of phosphorus and iron in soils, transactions 14th. International-Congress of soil science, Kyoto, Japan, August Vol. II; 147-152.

Lytton, D.L. and B.D. McCaslin (1983). Interactions of gamma irradiated sewage, nitrogen and phosphorus for sorghum on a calcareous soil. Communications in soil science and plant analysis; 14 (12): 1235-1251.

Marschner, H. (1995). Mineral nutrition of higher plants. Academic, San Diego, CA, USA.

Marschner, H. and B. Dell, (1994). Nutrient uptake in mycorrhizl symbiosis. Plant Soil 159: 89-102.

Mehravaran, H.; A. Mozafar and E. Frossard (2000). Uptake and partitioning of ^{32}P and ^{65}Zn by white clover as affected by eleven isolates of mycorrhizal fungi. J. Plant Nutr., 23: 1385-1395.

Mengel, K. and E.A. Kirkby (1987). Principles of Plant Nutrition, 4th Edition. International Potash Institute. Bern, Switzerland.

Menon, R.G.; S.H. Chien and A.E. Gadalla (1991). Comparison of olsen and Pi soil tests for evaluating phosphorus bioavailability in a calcareou soil treated with single superphosphate and partially acidulated phosphate rock. Fertilizer Research, 29 (3): 153-158.

Mills, H.A. and J.B. Jones (1996). Plant Analysis Handbook II. Micro Macro Publishing, Athens, GA.

Mohamed, A.L.; Ponnamferuma; A.J.P. Hafez and Y.S. Cereal-Chem (1986). New chromophore for phytic acid determination. J. Food Sci., 63:6: 475-578.

Morel, C. and C. Plenchette (1992). Laboratory soil test for assessing phosphorus derived from fertilizer in plant nutrition. Proceedings Second Congress of the European Society for Agronomy, Warwick University, 23-28 August, 1992; 270-271.

Nagib, M.I. (1962). A rapid colourimetic procedure for the estimation of free and conjucated sugars in plant extract. Zucker, 15: 351-353.

Nakamaru, Y.; M. Nanzyo and S.Y. Amasaki (2000). Utilization of apatite in fresh volcanic ash by pigeonpea and chickpea. Soil Sci. Plant Nutr., 46 (3): 591-600.

Neweigy, N.A.; E.A. Hanafy; R.A. Zaghloul and H.E. El-Sayeda, (1997). Response of sorghum to inoculation with azospirillum, organic and inorganic fertilization in the presence of phosphate solubilizing microorganisms. Annals of Agricultural Science, Moshtohor, Faculty of Agriculture, Zagazig Univ., Egypt; 35 (3): 1383-1401.

Noufal, E.HA. (2006). Studies on cultivation and reclamation of soil. Annals of Agricultural Science, Moshtohor, Faculty of Agriculture, Zagazig Univ., Egypt; 44 (2): 775-797.

O'Keefe, D.M. and D.M. Sylvia (1993). Chronology and mechanisms of mycorrhizal mediated (P) uptake in sweet potato plants. New-Phytol. 122: 651-659.

Ortas, J,; D. Ortakei; Z. Kaya; A. Ciar and N. Onelge (2002). Mycorrhizal dependency of sour orange in relation to phosphorus and zinc nutrition. J. Plant Nutr. 26: 1263-1279.

Osman, A. Z. M.S. Saber and A.F. El-Sherif (1974). Studies on microbial fertilizers II: Effect of phosphate dissolving bacteria on the uptake of phosphorus from calcareous soils. Isot Radiat Res. 6.

Parasuraman, P. (2005). Growth, grain yield, economics and residual soil fertility of rainfed sorghum (*Sorghum bicolor* L.) as influenced by sources and levels of phosphorus in entisols. Mysore Journal of Agricultural Sciences. Editor, communications centre university of agricultural sciences; 39 (4): 484-489.

Patidar, M. and A.L. Mali (2001). Integrated nutrient management in sorghum (*Sorghum bicolor* L.) and it residual effect on wheat (*Triticum aestivum*). Indian Journal of Agricultural Sciences. Indian Council of Agricultural Research, New Delhi, India, 71 (9): 587-591.

Patil, N.D.; B.S. Shinde and P.B. Shinde (1984). Response of sorghum to various combinations of water and citrate soluble forms of phosphorus in black soil. Journal of Maharashtra Agricultural Univ.; 9 (2): 166-168.

Patterson, G. (2002). New soil test information. Fact sheet No. 4. A and L Canada Laboratories, London, Ontario, Canada, (519) 457-2575. www alcaada.com.

Pattis Lande and B.R Hamaker (1994). Antigenic properties of albumin, globulin, and protein concentrate fractions from bran. Cereal Chem. 71 (5) 409-411.

Piper, C.S. (1950). Soil and plant analysis inter. Science Publishers. Inc., New York.

Piper, C.S. (1950). Soil and plant analysis interscience Publishers. Inc., New York.

Pizarro, C.; M. Escudey; J. Fabris and A. Almeida (2001). Iron rich spinel phases from sand fraction of three chilean soils developing on volcanic materials. Communications in soil science and plant analysis; 32 (17/18): 2741-2754.

Rabindra, B.; Y. Bhaskararao and S. Swamygowda (1986). Rice yield as influenced by rock phosphate pyrite mixture in a calcareous soil. Oryza; 23 (3): 152-156.

Richards, L.K. (1954). Diagnosis and improvement of saline and alkaline soils Agriculture Ham. D book, No. Bou. S. Salinity Laboratory Staffs F. Dept. Agric.

Saber, M.S.; A.G. El-Sherif and A.Z. Osman (1975). Studies on microbial fertilizers III: Effect of phosphate and silicate dissolving bacteria on uptake of phosphorus and potassium from calcareous soil by *Sorghum helepensi*. Z. Pflanzenernaehr. Bodenkd. 6, 613-619.

Salih, H.M.; A.I. Yahya; A.M. Abdul-Rahem and B.H. Munam (1989). Availability of phosphorus in a calcateous soil treated with rock phosphate or super phosphate as affected by phophate-dissolving fungi. Plant and Soil, 120 (2): 181-185.

Santhy, P.; P. Muthuvel and D. Selvi (2001). Status and impact of organic matter fractions on yield, uptake and available nutrients in a long term fertilizer experiment. Journal of the Indian Society of Soil Science. Indian Society of Soil Science, New Delhi, India; 49 (2): 281-285.

Sarir, M.S.; M.M. Sharif; Z. Ahmed and M. Akhlaq, (2005). Influence of different levels of humic acid application by various methods on the yield and yield components of maize. Sarhad Journal Agriculture. NWFP Agricultural Univ., Peshawar, Pakistan: 21, I: 75-81.

Schmidt, M.W. and G. Gleixner, (2005). Carbon and nitrogen isotope composition of bulk soil, particale size fractions and organic material after treatment with hydrofluoric acid. European Journal of Soil Science, 56: 407-416.

Sharif, M.; M. Ahmed; M. Sarir and R. Khattak (2004). Effect of organic and inorganic fertilizers on the yield and yield components of maize. Pakistan Journal of Agriculture, Agricultural engineering, veterinary sciences. Sindh Agriculture Univ., Tandojam; 20 (1): 11-16.

Sharif, M.; R. Khattak and M. Sarir (2002). Effect of different levels of lignitic coal derived humic acid on growth of maize plants. Communications in Soil Science and Plant Analysis. Marcel Dekkar, Inc., New York, USA; 33 (19/20): 3567-3580.

Sharif, M.; R. Khattar and M.Sarir (2003). Residual effect of humic acid and chemical fertilizers on maize yield and nutrient accumulation. Sarhad Journal of Agriculture. NWFP Agricultural Univ., Peshawar, Pakistan, 19 (4): 543-550.

Shinde, B.N. and A.J. Patil (1985). Use of solubilising cultures and rock phosphate on P availability to wheat in black calcareous soil – Current. Research. Reporter; 1 (1): 105-106.

Silva, S.R.; V.H. Alvarez; A.S. Ferreira and L.G. Martins (2004). Response of sorghum to phosphorus fertilization with FOSMAG in two granule sizes and triple super phosphate in two soils of Minas Gerais. Revista cates. Universidade Federal de Vicose, Vicosa, Brazil; 51 (296): 511-520.

Silvia, D.M.; L.C. Hammond; J.M. Bennett; J.H. Haas and S.B. Linda (1993). Field response of maize to a VAM fungus and water mamagment. Agron. J. 85: 183-198.

Singh, S.; E. Frossard; L. Morel; C. Fardeau and A. Dubali, (1993). Phosphate availability in Albanian Soils. Proceedings Second Congress of the European Society for Agronomy, Warwick Univ. 23-28 August; 306-307.

Smith, S.E. and D.J. Read (1997). Mycorrhizal symbiosis. Academic, Cambridge, UK.

Soltanpour, P.N. and A.P. Schwab (1977). A new soil test for simultaneous extractions of macro- and micro nutrients in lkaline soils. Commun. Soil Sci. Plant Anal. 8: 195-207.

Steel, R.G. and J.H. Torrie (1960). Principles and prcedure of statistics. M. Graw-Hill Book Company Inc., New York, London.

Subbiah, K. and N. Thenmozhi (2001). Interaction effect of phosphatic and biofertilizers on P use efficiency, yield and quality of fruits in bhendi (Abel Moschus esculentus L. Moench.). South Indian horticulture, 49: 168-170.

Tomar, N.K.; A.P. Gupta and S.S. Khanna (1984). Evaluation of rock phosphate- Superphosphate mixtures by incubation in organic matter for efficient use in wheat. Fertilizer News; 29 (2): 37-38.

Vadiya, .; Sh. Shrestha, K.; B.R. Khadge; C.J. Nancy, and H. Wallander (2003). Study of biodiversity of arbuscular mycorrhizal fungi in addition with different organic matter in different seasons of kavre district (Central Nepal). Scientific World, 5, (5): 75-80.

Venkateswarlu, B.; A.V. Rao and P. Raina (1984). Evaluation of phosphrus solubilization by micro-organisms isolated from aridsol. J. Ind. Soc. Soil Sci. 32, 273-277.

Vodyanitskii, Yu, K.; A.S. Nikiforova and F.R. Zaidelman, (1997). Magnetic susceptibility of concretions in soil of the southern taiga zone. Pochvovedenie; (12): 1445-1453.

Vodyanitskiy, N. Yu. and L.V. Rogovneva (1994). Iran oxides I vertic solonetzic chernozems of the stravropol area. Eurabian Soil Science, 26 (3): 1-17.

Wafaa, M.T.; H.Y. Gehan and K.M. Laila (2006). Plant growth and nutrients uptake as influenced by application of farmyard manure and some natural minerals to sandy soils. Arab Universities Journal of Agricultural Sciences, Faculty of Agriculture, Ain-Shams Univ., Cairo, Egypt; 14 (1): 213-234.

Wang, X.; Y. Zhang; J. Lu and X. Fan (2000). Effect of long term different fertilization on properties of soil organic matter and humic acids. Scientia agricultura Sinica, 33 (2): 75-81.

Wang-Yang, P.U.; W. Huang; H. Jiang; L. Xingai and L. Xinglong, (1999). A new cultivation technique for intercropped maize. Journal of Henan Agricultural Sciences, 4: 18-19,

Wilson, H.W. (1992). Processes for the preparation of acid fortified paramagnetic iron sulfate salt campounds for use in the treatment of agricultural soils. United States Patent; (US 5, 129, 936): 6 pp.

Wu, F.Y.; Z.H. Ye; S.C. Wu and M.H. Wong (2007). Metal accumulation and arbuscular mycorrhizal status in metallicolous and non-metallicolous populations of *Pteris vittata* L. and *Sedum alfredii* Hance. Planta 226: 1363-1378.

Xiong, L.M.; R.K. Lu and B. Truong (1994). An evaluation of the agronomic potential of partially acidulated rock phosphates in calcareous soil. Fertilizer Research; 38 (3): 205-212.

Xue, S.C.; D.C. Liu; D.Y.Tong; J.M. Han and Y. R. Ali (1994). Studies on the effects and mechanism of humic acid (HA) compound fertilizer. Journal of Hebei Agricultural Univ.; 17 (1): 24-27.

Zhu, J.; M.B. Miller; R.E. Vance; M. Dziejman; B.L. Bassler and J.J. Mekalanos (2002). Quorum-sensing negulators control virulence gene expresson in vibio cholerae. Proc. Natl. Acad. Sci, USA, 99: 3129-3134.

الملخص العربى

تهدف هذه الدراسة الى تقييم تأثير بعض مصادر الفوسفور المختلفة لنباتات سورجم العلف مزروعة فى أرض جيرية بهدف استخدامه كمحصول علف صيفى وكذا دراسة مدى استخدامه فى إنتاج الحبوب سواء لتغذية الإنسان أو الحيوان ولهذا فقد تم استخدام سماد سوبر فوسفات الكالسيوم (مقارنة) كما هو متبع أو أضيف الفوسفور رشاً على هيئة فوسفات أحادى الأمونيوم أو أضيف إضافة أرضية على هيئة صخر الفوسفات فى وجود الميكروهيزا أو الفوسفورين ، هذا مع رش النباتات بحامض الهيوميك لتحسين نموها ، وقد تم تنفيذ هذه المعاملات الثمانية على حدى أو فى وجود الحديد المغناطيسى .

ولتحقيق هذا الهدف أجريت تجربتين حقليتين ناجحتين بمزرعة مركز بحوث الصحراء بمنطقة كنج مريوط بالساحل الشمالى الغربى خلال موسم الصيف لعامى 2004 ، 2005 وكانت المعاملات كما يلى :

- تم إضافة سماد سوبر فوسفات الكالسيوم بمعدل 200 كجم/فدان أثناء إعداد الأرض للزراعة (المقارنة) .
- فوسفات أحادى الأمونيوم رشاً بمعدل 2000 جزء فى المليون .
- صخر الفوسفات بمعدل 150 كجم/فدان أثناء إعداد الأرض للزراعة ، والذى عومل بمعاملتين أحداهما بالفوسفورين والأخرى بالميكروهيزا .
- وقد تمت معاملة الحبوب بالمخصب الحيوى فوسفورين قبل الزراعة أو معاملتها بالميكورهيزا خلطاُ مع التربة .
- كذلك تمت إضافة الحديد المغناطيسى بمعدل 100 كجم/فدان إلى جميع المعاملات المذكورة ومجموعة أخرى بدون إضافة (مقارنة) . وقد تم المعاملة بحامض الهيوميك بتركيز 2000 جزء فى المليون ، هذا وكانت المعاملة الرئيسية بالحديد المغناطيسى أو بدون ثم تحت الرئيسية بالهيوميك أو بدون وتحت تحت الرئيسية هى المعاملة الفوسفاتية .
- تمت دراسة استجابة النباتات الكاملة والمحشوشة لهذه المعاملات السابقة والتداخل فيما بينها وتأثير ذلك على النمو ومحصول الحبوب والحشات الخضراء (محصول العلف الأخضر) وكذلك محتوى المجموع الخضرى

من العناصر الكبرى والصغرى خلال أعمار 60 ، 90 ، 120 يوم من الزراعة سواء على مستوى النبات الكامل أوالحشات الناتجة .

أ - النبات الكامل :

أولاً : صفات النمو والمحصول :

1 - تمت دراسة التغيرات الموسمية على طول النبات وعدد الأوراق ومساحة الورقة والوزن الرطب والجاف للمجموع الخضرى لنبات السورجم خلال 60 ، 90 ، 120 بوم من الزراعة .

2 – حققت المعاملة بصخر الفوسفات + الميكروهيزا + حامض الهيوميك عندما عوملت بالحديد المغناطيسى أعلى قيمة معنوية فى إرتفاع النبات لكلا الموسمين مقارنة بباقى المعاملات الأخرى .
كما سجلت نفس المعاملة بدون حامض الهيوميك نفس النتائج فى العينة 90 ، 120 يوم من الزراعة وذلك فى الموسم الثانى للزراعة.

3 - أدت المعاملة بصخر الفوسفات + الميكورهيزا الى زيادة معنوية فى عدد الأوراق فى عينات 60 ، 90 ، 120 يوم مقارنة بنباتات المقارنة "سوبر الفوسفات" فى كلا الموسمين . كما أظهرت المعاملة نفس الإتجاه فى العينة الأولى والثالثة للموسم الأول من الزراعة .

4- حققت المعاملة بـ (صخر الفوسفات + الميكروهيزا) + حامض الهيوميك خاصة مع الحديد المغناطيسى زيادة معنوية فى مساحة الأوراق فى المواعيد الثلاثة لكلا الموسمين .

5- حققت المعاملة بالـ (صخر الفوسفات + الميكروهيزا) + حامض الهيوميك + الحديد المغناطيسى أعلى زيادة معنوية فى الوزن الرطب والجاف للمجموع الخضرى فى الثلاث أعمار لكلا الموسمين .

6- أدت المعاملة بالـ (صخر الفوسفات + الميكروهيزا + حامض الهيوميك) عندما يضاف معه الحديد المغناطيسى إلى تحقيق أعلى معنوية فى إنتاجية محصول الحبوب فى كلا الموسمين عن المعاملات الأخرى تليها المعاملة بـ (صخر الفوسفات + الفوسفورين + حمض الهيوميك + الحديد المغناطيسى تليها المعاملة بصخر الفوسفات + الميكروهيزا + حامض الهيوميك بدون الحديد المغناطيسى فى كلا الموسمين . وكانت المعاملة بالسوبر فوسفات (المقارنة) منفرداً أو بإضافة حامض الهيوميك أقل إنتاجية فى محصول الحبوب .

6- نفس النتائج السابقة والمتحصل عليها فى محصول الحبوب كانت نفسها عند مقارنة وزن الـ 100 حبة عند نفس المستوى للمعنوية .

ثانياً : المحتوى الكيماوى :

1- عند دراسة محتوى الحبوب من البروتين الكلى والألبيومين والجلوبيولين كانت الزيادة المعنوية مشابهة لمحصول الحبوب . وكانت المعاملات مرتبة تنازلياً من حيث القيم كالتالى الميكورهيزا + الصخر الفوسفاتى ثم الفوسفورين + الصخر الفوسفاتى يليها فوسفات أحادى الأمونيوم ثم أخيراً سوبر فوسفات الكالسيوم وذلك عندما عوملت هذه النباتات مع أو بدون حامض الهيوميك والحديد المغناطيسى . وقد كان محتوى الحبوب من الألبيومين ضعف الجلوبيولين فى كل المعاملات المختلفة .

2- زادت نسبة الفوسفور الكلى وصوره المختلفة فى المجموع الخضرى للنبات الكامل (ذائب وغير ذائب وعضوى) بزيادة عمر النبات حيث وصلت أقصاه فى العمر الثانى (90 يوم من الزراعة) ثم إنخفضت بوضوح فى العمر الثالث (120 يوم من الزراعة) حيث وصلت نسبة الزيادة 30% فى العمر الثانى ونسبة الإنخفاض من العمر الثانى للثالث وصلت إلى 61% فى الموسم الأول . وكانت فى نفس الإتجاه فى الموسم الثانى .

وبدراسة تأثير المعاملات المختلفة على محتوى النبات من الفوسفور الكلى ومشتقاته المختلفة (الصور الأخرى الموجود عليها الفوسفور) فى الأعمار 60 ، 90 ، 120 يوم من الزراعة فى كلا الموسمين وجد أن التسميد بالميكروهيزا مع الفوسفات الصخرى أدت الى زيادة فى معدل إمتصاص الفوسفور بنسبة وصلت إلى أكثر من 12% فى الموسم الأول.

3- زاد محتوى النبات من العناصر البوتاسيوم والمغنسيوم والكالسيوم والكبريت والحديد والزنك وسجلت أعلى قيم لهذه العناصر فى العمر الثانى (90 يوم) بينما إنخفضت فى العمر الثالث (120 يوم من الزراعة) .

4- زاد محتوى المنجنيز فى النباتات المعاملة حتى عمر 90 يوم من الزراعة فيما عدا المعاملة بالميكروهيزا + الصخر الفوسفاتى + حامض الهيوميك أو بدونه وكذلك المعاملة بالصخر الفوسفاتى + الفوسفورين + حامض الهيوميك وبدون الحديد المغناطيسى حيث أدت إلى زيادة بسيطة فى

محتوى النبات من عنصر المنجنيز فى العمر الثانى (90 يوم من الزراعة) .

5- بدراسة تأثير مصادر الفوسفور المختلفة على الفوسفور اكلى ومشتقاته لكلا العينات المختلفة خلال الموسمين فان المعاملة بصخر الفوسفات فى وجود الميكروهيزا حافظت على زيادة مقدارها 12% للفوسفور الكلى فى الموسم الأول .
كما وصلت النسبة إلى 25% فى الموسم الثانى عند مقارنتها بنباتات المقارنة ، أما معاملة النباتات بصخر الفوسفات + الفوسفورين أدت إلى زيادة فى معدل إمتصاص الفوسفور بنسبة 10.39% و 13.5% فى كلا الموسمين على التوالى .

6- زاد محتوى العناصر فى نباتات (السورجم) المعاملة بالميكورهيزا + صخر فوسفات + حمض الهيوميك + الحديد المغناطيسى حيث زاد عنصر البوتاسيوم بنسبة 6% والمنجنيز بنسبة 11% عند 120 يوم من الزراعة فى كلا الموسمين عند مقارنته بالنباتات المعاملة بصخر الفوسفات + الفوسفورين + حامض الهيوميك + الحديد المغناطيسى.

7- زاد محتوى النباتات المعاملة بصخر الفوسفات + ميكروهيزا + حامض الهيوميك من عنصر الكبريت بنسبة حوالى 94% وذلك فى وجود الحديد المغناطيسى بعد 60 يوم من الزراعة لكلا الموسمين عند المقارنة بنباتات المقارنة وبلغت هذه الزيادة حوالى 72% فى العمر الثانى والثالث (90 ، 120 يوم من الزراعة) . وكان ترتيب المعاملات لمحتواها من الكبريت كالتالى : (1) صخر الفوسفات + الميكروهيزا ، (2) صخر الفوسفات + الفوسفورين ، (3) فوسفات أحادى الأمونيوم عند معاملتهم بحمض الهيوميك فى وجود أو عدم وجود الحديد المغناطيسى.

8- أدت المعاملة بصخر الفوسفات + الميكروهيزا + حمض الهيوميك + الحديد المغنطيسى إلى زيادة محتوى النباتات من عنصر الحديد فى الأعمار الثلاثة (60 ، 90 ، 120) يوم من الزراعة بنسبة حوالى 3.4 ، 3.6 ، 4% على التوالى للأعمار الثلاثة بالنسبة لنباتات المقارنة فى كلا الموسمين تقريباً.

9- أدت المعاملة بصخر الفوسفات عندما أضيف إليها الميكروهيزا أو الفوسفورين فى وجود أو غياب حامض الهيوميك وكذلك الحديد المغناطيسى إلى تفوقه على باقى المعاملات (فوسفات أحادى الأمونيوم أو

سوبر فوسفات الكالسيوم) فى الأعمار الثلاثة لكلا الموسمين فى محتواها من عنصر الزنك . وبلغت نسبة زيادة النباتات من عنصر الزنك عند معاملتها بالميكروهيزا + صخر الفوسفات إلى 20% للعمرين 60 ، 90 يوم وبلغت 35% فى العمر الأخير (120 يوم من الزراعة) لكلا الموسمين .

10- أدت المعاملة بالميكروهيزا مع حامض الهيوميك أو فى غيابه كذلك الحديد المغناطيسى إلى تحقيق أعلى محتوى للنباتات من عنصر النحاس عندما تمت مقارنته بباقى المعاملات . وهذه الزيادة بلغت 87.8% فى كل الأعمار لكلا الموسمين .

11- النباتات المعاملة بصخر الفوسفور مع المخصب الحيوى ميكورهيزا أو الفوسفورين أدت الى زيادة محتوى عنصر البورون بالمقارنة بباقى المعاملات الأخرى . وزاد محتوى النباتات المعاملة بصخر الفوسفات + الميكروهيزا بدون حامض الهيوميك إلى 65% بمقارنته بالسوبر فوسفات عند 60 يوم من الزراعة ووصلت هذه الزيادة 85% عند 90- 120 يوم من الزراعة لنفس المعاملة السابقة .

12- على عكس العناصر الكبرى والصغرى فإن المعاملات (المختلفة بمصادر الفوسفور) والحديد المغناطيسى وحامض الهيوميك قد أثرت بشكل مختلف على محتوى النباتات من عنصر الصوديوم حيث أدت المعاملة بالصخر الفوسفاتى + الميكورهيزا + حامض الهيوميك فى وجود الحديد المغناطيسى إلى خفض محتوى النباتات من عنصر الصوديوم فى كل الأعمار 60 ، 90 ، 120 يوم من الزراعة مقارنة بنباتات المعاملة بالسوبر فوسفات كما لوحظ أن الحديد المغناطيسى قد أثر تأثيراً واضحاً على خفض محتوى النباتات من عنصر الصوديوم فى الأعمار المختلفة لكلا الموسمين .

ب - النباتات التى تم حشها :

أولاً : صفات النمو والمحصول :

1 - حققت المعاملات المختلفة أقصى إرتفاع للنباتات فى العمر الأول للحش (60 يوم من الزراعة) ثم يحدث إنخفاض بشكل عام فى الحشتين التاليتين . بينما حققت صفتى عدد الأوراق ومساحة الأوراق زيادة بتقدم

النباتات فى العمر ووصلت أقصى قيمة لها فى الحشة الثانية (90 يوم من الزراعة) .

2 - أدت المعاملة بصخر الفوسفات + الميكروهيزا + حامض الهيوميك عند معاملتها بالحديد المغناطيسى إلى زيادة إرتفاع النبات ومساحة الورقة مقارنة بالمعاملات الأخرى خلال الثلاث أعمار للحش .

3 - زاد عدد الأوراق معنوياً فى الثلاث أعمار للحش للمعاملات بالصخر الفوسفاتى مع الميكروهيزا أو الفوسفورين عندما أضيف إليها حامض الهيوميك أو الحديد المغناطيسى عند مقارنتهم بباقى المعاملات الأخرى .

4 - حققت المعاملة بالصخر الفوسفاتى عندما أضيف اليها بالميكورهيزا أو الفوسفورين وأضيف إليه حامض الهيوميك أو الحديد المغناطيسى الى زيادة أعلى معنوية فى الوزن الجاف للنباتات خلال الثلاث أعمار للحش (60 ، 90 ، 120 يوم من الزراعة) .

5 - حققت المعاملة بالصخر الفوسفاتى والميكورهيزا فقط أو فى وجود حامض الهيوميك بالإضافة إلى وجود الحديد المغناطيسى زيادة فى عدد الأشطاء معنوياً بالأخص فى الموسم الثانى حيث أن التسميد بصخر الفوسفات + الميكروهيزا + الهيوميك + الحديد المغنطيسى أو بدون حديد مغناطيسى وبدون هيوميك قد أدى إلى زيادة معنوية فى عدد الأشطاء .

6 - أدت المعاملة بصخر الفوسفات + الميكورهيزا + حامض الهيوميك + الحديد المغناطيسى إلى زيادة معنوية فى محصول الحشات فى الأعمار الثلاثة للحش . كما حققت أعلى محصول فى العمر الأول (60 يوم من الزراعة) كما حققت أعلى كمية محصول عندما قورن بباقى الأعمار وبباقى المعاملات للمعاملة السابقة .

ثانياً : المحتوى الكيماوى :

1 - زاد محتوى النباتات بشكل عام من الفوسفور الكلى وصور الفوسفور الأخرى خلال الأعمار المختلفة للحش ووصلت أقصى قيمة لها خلال العمر الثانى للحش (90 يوم من الزراعة) كما فى حالة النبات الكامل ثم انخفضت القيمة فى العمر الثالث للحش ولكن مقدار الإنخفاض لم يكن كبير كما فى حالة النبات الكامل .

2 - حققت النباتات أعلى محتوى لها فى النيتروجين الكلى أو البروتين الخام عند الحشة الأولى (60 يوم من الزراعة) ثم إنخفضت فى الحشتين الأخريتين (90 ، 120 يوم) وكان أقصى إنخفاض خلال 120 يوم من الزراعة (الحشة الثالثة) .

3 - سجلت عناصر البوتاسيوم والماغنسيوم والكالسيوم والزنك والنحاس أعلى محتوى لها فى المجموع الخضرى للنباتات فى الحشة الثانية (90 يوم من الزراعة) ثم إنخفضت محتوى النباتات عند العمر الثالث للحش .

4- سجلت المعاملة بالسوبر فوسفات منفرداً أو مع حامض الهيوميك عندما يضاف إليها الحديد أو بدون حديد مغناطيسى زيادة فى محتوى النباتات من عنصر الكبريت فى العمر الثانى للحش فى الموسم الأول. وعموماً فإن كل المعاملات بالسماد الفوسفاتى أدت إلى إنخفاض محتوى الكبريت بالتقدم فى العمر خلال الأعمار المختلفة للحش.

5- حققت المعاملة بصخر الفوسفات + الميكورهيزا + حامض الهيوميك أو الحديد المغناطيسى أعلى إمتصاص لعنصر المنجنيز خلال العمر الثانى للحش . بينما كان تأثير ميعاد الحش طفيفاً على محتوى النباتات من المنجنيز .

6- زاد محتوى النباتات من عنصر البورون وكان أقصى محتوى له فى العمر الثانى خلال الموسم الأول ، ونتيجة لتكرار المعاملة فى نفس القطع التجريبية فإن ذلك أدى إلى التغيير فى هذا الإتجاه حيث زاد محتوى النباتات فى البورون أقصى زيادة له فى العمر الأول من الحش خلال الموسم الثانى .

7- زادت المعاملة بصخر الفوسفات والميكروهيزا عندما أضيف إليها حامض الهيوميك والحديد المغناطيسى من محتوى الفوسفور بالنباتات ليصل لأقصى قيمة له عن بقية المعاملات الأخرى وكانت هذه الحقيقة مؤكدة فى حالة النبات الكامل . بينما فى حالة النباتات المحشوشة فإن معاملة صخر فوسفات والميكروهيزا زادت فى محتوى النباتات بالفوسفور خلال الأعمار المختلفة للحش .

8- المعاملات الفوسفاتية المختلفة عندما أضيف إليها حامض الهيوميك أو الحديد المغناطيسى كان التأثير طبيعياً على محتوى النباتات من البوتاسيوم والماغنسيوم والكالسيوم والحديد حيث زادت زيادة طفيفة.

9- المعاملة بصخر الفوسفات والميكورهيزا فى وجود حامض الهيوميك والحديد المغنطيسى سجلت أعلى محتوى النباتات من عناصر الزنك والمنجنيز والبورون النحاس مقارنة بباقى المعاملات الأخرى.

10- أدت المعاملة بصخر الفوسفات وحمض الهيوميك فى وجود الحديد المغناطيسى إلى خفض وإختزال محتوى النباتات من عنصر الصوديوم فى الثلاث مواعيد للحش عن بقية المعاملات الأخرى . وأكثر من ذلك يلاحظ تأثير الحديد المغناطيسى فى الموسم الثانى من الزراعة بوضوح نتيجة تكرار المعاملات فى نفس القطع التجريبية للموسم الأول .

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