

RESPONSE OF SOME FABA BEAN GENOTYPES TO DROUGHT CONDITIONS

By

**RAAD MOHAMMED SAEED SALMAN
AL- JUBOORI**

Diploma Agric. Sci. (Agronomy), Found. of Tech. Inst. Baghdad- Iraq, 1977
B.Sc. Agric. Sci. (Agronomy), Fac. Agric and forestry, Mosul Univ., Iraq, 1983
M.Sc. Agric. Sci. (Agronomy), Fac. Agric., Baghdad Univ., Iraq, 2001

THESIS

Submitted in Partial Fulfillment of the Requirements for the
Degree of

DOCTOR OF PHILOSOPHY

In

**Agricultural Sciences
(Agronomy)**

**Department of Agronomy
Faculty of Agriculture
Cairo University**

EGYPT

2016

APPROVAL SHEET

RESPONSE OF SOME FABA BEAN GENOTYPES TO DROUGHT CONDITIONS

Ph.D. Thesis
In
Agric.Sci.(Agronomy)
By

RAAD MOHAMMED SAEED SALMAN
AL- JUBOORI

Diploma Agric. Sci. (Agronomy), Found. of Tech. Inst. Baghdad- Iraq, 1977
B.Sc. Agric. Sci. (Agronomy), Fac. Agric and forestry, Mosul Univ., Iraq, 1983
M.Sc. Agric. Sci. (Agronomy), Fac. Agric., Baghdad Univ., Iraq, 2001

Approval Committee

Dr. ABD EL- HAMEED E. EL – KARAMITY.....
Professor of Agronomy, Fac. Agric., Minia University

Dr. AHMED MONGED SOLIMAN.....
Professor of Agronomy, Fac.Agric., Cairo University

Dr. SAIED ABDEL- RAHMAN SHRIEF.....
Professor of Agronomy, Fac.Agric., Cairo University

Dr. DARWISH SALEH DARWISH.....
Professor of Agronomy, Fac.Agric., Cairo University

Date:10 / 12 /2016

SUPERVISION SHEET

RESPONSE OF SOME FABA BEAN GENOTYPES TO DROUGHT CONDITIONS

Ph.D. Thesis
In
Agric.Sci.(Agronomy)
By

**RAAD MOHAMMED SAEED SALMAN
AL- JUBOORI**

Diploma Agric. Sci. (Agronomy), Found. of Tech. Inst. Baghdad- Iraq, 1977
B.Sc. Agric. Sci. (Agronomy), Fac. Agric and forestry, Mosul Univ., Iraq, 1983
M.Sc. Agric. Sci. (Agronomy), Fac. Agric., Baghdad Univ., Iraq, 2001

SUPERVISION COMMITTEE

Dr. DARWISH SALEH DARWISH

Professor of Agronomy, Fac. Agric., Cairo University, Egypt

Dr. SAIED ABDEL- RAHMAN SHRIEF

Professor of Agronomy, Fac. Agric., Cairo University, Egypt

Dr. GAMAL MOHAMMED FAHMY

Professor of Plant Ecology, Fac. Sci., Cairo University, Egypt

ACKNOWLEDGEMENT

*The author wishes to express his sincere appreciation, deepest gratitude to **Prof. Drs. Darwish Saleh Darwish and Saied Abdel- Rahman Shrief**, Agronomy Department, Faculty of Agriculture, Cairo University for suggesting the problem, supervision, continued advices and guidance during the course of study and preparation the manuscript.*

*Sincere thanks and gratitude to **Prof. Dr. Gamal Mohammed Fahmy**, Faculty of Science, Cairo University for supervision, continued advices and guidance during the course of study and preparation of the manuscript.*

Grateful appreciation is also extended to all staff members of Agronomy Department, Faculty of Agriculture, Cairo University, and the co-workers in the Agricultural experiments and research station, Faculty of Agriculture, Cairo University for assistances, sincere efforts and supports.

*The sincere helps and supports offered by Drs. Mahmoud Madany and Ahmed Saleh, Botany Dept., Faculty of Science, Cairo University are highly acknowledged. Also, I wish to thank **Prof. El-Metwally Abdalla and Dr. Ibrahim Arif**, Agronomy Dept., Fac. Agric., Cairo University for their helps during statistic analysis and preparing tables and figures.*

Special deep appreciation is given to my family, wife, my sons Zaid, Mohannad and Rami for their patience. Also feel deeply grateful to my beloved country, Iraq.

CONTENTS

	Page
INTRODUCTION	1
REVIEW OF LITERATURE	5
1. Faba bean production and drought effects	5
2. Genotypic variation for drought tolerance	13
3. Water use efficiency (WUE)	20
4. Alleviation of drought effects.....	22
1- Effect of drought on chemical compositions	26
MATERIALS AND METHODS	29
RESULTS AND DISCUSSION	47
Field Trials:	47
1. Significance of mean squares of combined over seasons.....	47
2. Variation among faba bean genotypes across watering regimes.....	49
3. Stability analyses of faba bean genotypes across watering regimes and seasons.....	68
4. Criteria of drought tolerance/ susceptibility of faba bean genotypes.....	79
Pot Experiments	87
1. Significance of mean squares.....	87
2. Mean Performance and extent of variation	91
3. Rates of change due to reduction of soil moisture.....	94
SUMMARY	103
REFERENCES	123
ARABIC SUMMARY	

LIST OF TABLES

No.	Title	Page
1.	Codes, sources and some features of the investigated faba bean genotypes	30
2.	Sowing dates and irrigation scheduling as well as the total added water quantities to treatments of field trials during 2013/2014 and 2014/2015 seasons	32
3.	Characteristics of the soil for the experimental field at Giza in 2013/2014 seasons	33
4.	Climatic parameters during both field experiments of 2013/2014 & 2014/2015 seasons at 15 days intervals from med-November to the end of April.....	34
5.	The expectation of mean squares for the combined analysis across both seasons of each watering regime .	40
6.	Significance of mean squares due to watering regimes (W.R), faba bean cultivars (CVs) and their interaction of combined analysis over 2013/14 and 2014/15 seasons (S) for studied traits under field conditions, except seed protein% and protein yield per ridge (PYR), determined only at second season.....	48
7.	Mean, ranges, broad sense heritability (BSH) and coefficients of genotypic (GCV %) and phenotypic (PCV %) variation of faba bean genotypes under each watering regime combined over 2013/2014 and 2014/2015 seasons.....	50
8.	Means, ranges, broad sense heritability (BSH) and coefficients of genotypic (GCV %) and phenotypic (PCV %) variation for protein% and protein yield/ridge (PYR) of 014/015 season	51

9. Mean performance of faba bean varieties under normal (N) and stressed (S) watering regimes and the rates of change due to increasing the quantity of irrigation water one m^{-3} , for studied traits combined over 2013/2014 and 2014/2015 seasons.....	59
10. Mean performance of faba bean varieties under normal (N) and stressed (S) watering regimes and the rates of change due to increase the quantity of irrigation water 1 m^{-3} , for seed protein% and protein yield per ridge, g (PYR) in 2014/2015 season.	61
11. Relative depression (R.D) of various traits of faba bean genotypes due to stressed watering regime for the important traits of combined data except PYR (in 2014/2015)	62
12. Significance of mean squares of combined analysis for some traits under fields conditions, over six environments (three watering regimes across 2013/2014 and 2014/2015 seasons).....	70
13. Means and environmental indices for traits of stability analysis.....	71
14. Mean performance and different five stability parameters across 6 environments of studied faba bean genotypes for the height of first podded node, cm (FPN).....	75
15. Mean performance and different five stability parameters across 6 environments of studied faba bean genotypes for 100- seed weight, g (S.I)	76
16. Mean performance and different five stability parameters across 6 environments of studied faba bean genotypes for seed yield per ridge, g (SYR).....	77

17. Mean seed yield under normal (N), stressed (S) and mean of both and derivative tolerance parameters of studied faba bean genotypes for seed yield per ridge, g (SYR).....	85
18. Rank correlation coefficients among yields performance and estimates of drought resistance/ tolerance and stability parameters of seed yield per ridge	86
19. Significance of mean squares due to moisture levels (M.L.), faba bean cultivars (CVs) and their interaction under first pot experiment during 2014/2015 season.....	89
20. Significance of mean squares of combined analysis over both pot trials (E) using the data of 5 common faba bean cultivars (CVs) under 3 moistures levels (M.L).....	90
21. Means of climatic parameters during the periods (50 days) of first (T1) and second (T2) pot trials in addition to growing degree days (G.D.D) during 2014/2015	90
22. Mean, ranges, broad sense heritability (BSH) and coefficients of genotypic (GCV %) and phenotypic (PCV %) variations of faba bean genotypes under each M.L for traits at first pot experiment.....	92
23. Mean, ranges, broad sense heritability (BSH) and coefficients of genotypic (GCV%) and phenotypic (PCV%) variations of 5 faba bean genotypes under each M.L combined over both trials	93
24. Performance of investigated faba bean genotypes under normal (N)and stressed (S) watering levels for some parameters and the regression coefficients (b) of performance to moisture levels in first pot trial during 2014/2015.....	96

LIST OF FIGURES

No.	Title	Page
1.	High, Low and average of air temperatures dominated at Giza location (experimental fields) during 2013/2014 and 2014/2015 in 15-day intervals from Med-November to Med-April	35
2.	High, Low and averages of relative humidity (RH%) dominated at Giza location (experimental fields) during 2013/2014 and 2014/2015 in 15-day intervals from Med-November to Med-April	35
3.	High (H), low (L) and average (A) of air temperatures dominated during 1 st (T1) and 2 nd (T2) pot trials of 2014/2015 season in 5-day intervals	44
4.	Averages relative humidity (RH%) dominated during 1 st (T1) and 2 nd (T2) pot trials of 2014/2015 season in 5-day intervals	45
5.	High (H.W) and average (A.W) wind speeds (km/h) dominated during 1 st (T1) and 2 nd (T2) pot trials of 2014/2015 season in 5-day intervals	45
6.	Relative mean of faba bean traits under medium (M) and stressed (S) irrigation to normal one (N) of combined data over both seasons	52
7.	Mean heights of first podded node, cm (FPN) of faba bean varieties combined across seasons of normal (N), medium (M) and stressed (S) regimes	63
8.	Relative height of first podded node, cm (FPN) of faba bean varieties combined across seasons of medium (M) and stressed (S) regimes to normal (N) one.....	63
9.	Mean performance of faba bean varieties combined across seasons of normal (N), medium (M) and	64

No.	Title	Page
	stressed (S) regimes for number of pods/plant (Pods).....	
10.	Relative mean performance of faba bean varieties combined across seasons of medium (M) and stressed (S) regimes to normal (N) one for number of pods/plant (Pods).....	64
11.	Mean seed yield per plant (SYP) of faba bean varieties combined across seasons of normal (N), medium (M) and stressed (S) regimes.....	65
12.	Relative seed yield per plant (SYP) of faba bean varieties combined across seasons of medium (M) and stressed (S) regimes to normal (N) one	65
13.	Mean plant dry weight (PlDwt) of faba bean varieties combined across seasons of normal (N), medium (M) and stressed (S) regimes.....	66
14.	Relative plant dry weight (PlDwt) of faba bean varieties combined across seasons of medium (M) and stressed (S) regimes to normal (N) one	66
15.	Mean seed yield per ridge (SYR) of faba bean varieties combined across seasons of normal (N), medium (M) and stressed (S) regimes.....	67
16.	Relative seed yield per ridge (SYR) of faba bean varieties combined across seasons of medium (M) and stressed (S) regimes to normal (N) one	67

استجابة بعض التراكيب الوراثية من الفول البلدي لظروف الجفاف

رسالة مقدمة من

رعد محمد سعيد سلمان الجبوري

دبلوم علوم زراعية (محاصيل)- المعهد الزراعي- بغداد- مؤسسة المعاهد الفنية 1977
بكالوريوس علوم زراعية (محاصيل)- كلية الزراعة والغابات- جامعة الموصل- العراق-
1983

ماجستير علوم زراعية (محاصيل)- كلية الزراعة- جامعة بغداد- العراق- 2001

للحصول على درجة

دكتوراه الفلسفة

في

العلوم الزراعية (محاصيل)

كلية الزراعة

جامعة القاهرة

مصر

2016

استجابة بعض التراكيب الوراثية من الفول البلدي لظروف الجفاف

رسالة دكتوراه الفلسفة
في العلوم الزراعية
(محاصيل)

مقدمة من

رعد محمد سعيد سلمان الجبوري

دبلوم علوم زراعية (محاصيل)، المعهد الزراعي، بغداد، مؤسسة المعاهد الفنية ، 1977
بكالوريوس علوم زراعية (محاصيل)، كلية الزراعة والغابات، جامعة الموصل، العراق، 1983
ماجستير علوم زراعية (محاصيل)، كلية الزراعة، جامعة بغداد، العراق، 2001

لجنة الحكم

دكتور/ عبد الحميد السيد القراميطي.....
أستاذ المحاصيل، كلية الزراعة، جامعة المنيا

دكتور/ أحمد منجد سليمان.....
أستاذ المحاصيل، كلية الزراعة، جامعة القاهرة

دكتور/ سعيد عبد الرحمن شريف.....
أستاذ المحاصيل، كلية الزراعة، جامعة القاهرة

دكتور/ درويش صالح درويش.....
أستاذ المحاصيل، كلية الزراعة، جامعة القاهرة

التاريخ 10 / 12 / 2016

استجابة بعض التراكيب الوراثية من الفول البلدي لظروف الجفاف

رسالة دكتوراه الفلسفة
في العلوم الزراعية
(محاصيل)

مقدمة من

رعد محمد سعيد سلمان الجبوري

دبلوم علوم زراعية (محاصيل)- المعهد الزراعي- بغداد- مؤسسة المعاهد الفنية 1977
بكالوريوس علوم زراعية (محاصيل)- كلية الزراعة والغابات- جامعة الموصل- العراق- 1983
ماجستير علوم زراعية (محاصيل)- كلية الزراعة- جامعة بغداد- العراق- 2001

لجنة الإشراف

دكتور/ درويش صالح درويش

أستاذ المحاصيل- كلية الزراعة- جامعة القاهرة

دكتور/ سعيد عبد الرحمن شريف

أستاذ المحاصيل- كلية الزراعة- جامعة القاهرة

دكتور/ جمال محمد فهمي

أستاذ البيئة النباتية- كلية العلوم- جامعة القاهرة

Name of Candidate: Raad Mohammed Saeed Aljuboori **Degree:** Ph.D.
Title of Thesis: Response of Some Faba Bean Genotypes to Drought Conditions.

Supervisors: Dr. Darwish Saleh Darwish
Dr. Saied Abdel- Rahman Shrief
Dr. Gamal Mohammed Fahmy

Department: Agronomy

Branch: Agronomy

Approval: 20 /12 / 2016

ABSTRACT

The objectives were to explore the response and variation among some faba bean genotypes to variable soil drought-prone conditions. The elucidation of interrelationships among yield performances, stability parameters and drought tolerance/resistance are of great benefit for breeding to drought.

Ten faba bean genotypes were evaluated under three watering regimes under field and pot experiments during 2013/2014 and 2014/2015 seasons. The ten faba bean genotypes were evaluated under normal ($2100 \text{ m}^3/\text{fad}$), medium ($1680 \text{ m}^3/\text{fad}$) and stress ($1260 \text{ m}^3/\text{fed}$) irrigation regimes. However, the two pot experiments comprised the ten cultivars (in first) and five of them (in 2nd trial) using three moisture levels. When the plants were 30 days old, they were subjected to three moisture levels for 20 days. The levels were: 70% of the available water (as normal treatment), 45%, and 20% of the AW as medium (M) and stressed (S) treatments, respectively.

The most important results could be summarized as follow:

The tested faba bean genotypes could be classified into three categories to water use efficiency for SYR. The first group as low efficient for water use comprised N.1 which has $b = 0.193$. Only two varieties (G. 843 and C.5) may be considered as higher water use efficient. However, the remainder genotypes were considered an intermediate water use efficient group.

Water stress progressively significantly reduced the growth, dry matter accumulation and RWC and the increase of the proline contents in the leaflets during the early stage of the faba bean. The tested faba bean genotypes possessed intrinsic variation of responses to water deficit during the early stage of growth. The genotypes M.1, M.3, C.4 and N.1 appeared to be the most sensitive ones, since their lower RWCs corresponded to high rates of reductions under stress conditions. Cultivar C.5 maintained significantly higher RWC and proline under stress and thus is less sensitive to drought. G.843 and C. 49 cultivars exhibited lower declines of RWCs due to AW reductions corresponded to higher RWC under moisture stress may be considered as tolerant to water stress.

Key words: Faba bean, drought tolerance, varietal stability, water use efficiency, relative water content, proline content.