AIN SHAMS UNIVERSITY
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GROWTH RESPONSES AND METABOLIC ACTIVITIES OF SOYBEAN PLANTS AS INFLUENCED BY THE HERBICIDE "PROMETRYN"

THESIS
SUBMITTED FOR THE MASTER DEGREE IN SCIENCE TEACHER′S PREPARATION
(BOTANY)

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ABBREVIATIONS

Abbreviations	Meaning
A / Bis	Acrylamide / Bisacrylamide
ABA	Abscisic acid
APS	Ammonium per sulphate
b.p.	Boiling point
ccs.	Cubic centimeter solution
cv.	Cultivar
DAS	Days
DEGS	Di-ethyl glycol succinate
DNA	Deoxyribonucleic acid
DPA	Diphenylamine
DW	Dry weight
et al.	And other authors (workers)
F.A.A	Formalin Acetic Alcohol
fed	Feddan
FID	Flame ionization detector
F.wt.	Fresh weight
Fig.	Figure
GA_3	Gibberellic acid
GLC	Gas liquid Chromatography
IAA	Indole acetic acid
IAN	Indole acetonitrile
KDa	Kilo Dalton
L. S. D	Least significant differences
M.wt	Molecular weight
NADP	Nicotinamide adenine dinucleotide phosphate

Abbreviations	Meaning
PAM	Pesticide Analytical Manual
PMSF	Phenol methyl sulphonyl fluoride
ppm	Part per million
PRE	Pre-emergence
PS	Photosystem
R	Recommended dose
RNA	Ribonucleic acid
rpm	Revolutions per minute
SDS-PAGE	Sodium dodecyl sulphate - polyacrelamide gel electrophoresis
T.C.A	Trichloro acetic acid
T.C.S.	Total cross section area
TEMED	N, N, N, N-Tetramethylethylene - diamine
Tris/ HCl	Tris hydroxyl methylamine hydrochloride
var.	Variety
V.B.	Vascular bundle
v/v	Volume / volume
w/v	Weight/ volume

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INTRODUCTION

Soybean (*Glycine max* L. var. Giza 21) is one of an important leguminous crops raised for seed production in Egypt. The importance of this crop is due to its high nutritional value. It was introduced to Egypt from some years ago to help solving the problems of protein and oil production. The seeds provide rich source of protein, for public as well as for animal feeding.

Nour El-Dein *et. al.*, (1986) studied the seed index and chemical composition of soybean seeds cv. var. Clark. They found that, the weight 100 seed was 16.97 g and chemical composition of seed contained 33.0% crude protein, 23.4% crude oil and 15.7% total carbohydrates, 0.8% monosaccharide and 2.1% disaccharide. Therefore, it is an excellent source for human and animal nutrition.

Soybean has many different uses, foliage could be used as forage for animals, oil could be extracted and used in many industries and may be added to flour in order to enrich its nutrient value. Protein and oil are the primary products of the soybean processing industry, the protein products has represented the major protein value of the seed although the unit value of the oil is greater. Seed quality, which is both genetically and environmentally controlled, is the major determinant of product yield and product quality.

The relative proportion of seed components-protein, oil, carbohydrate and fibers is critical to yield and production of products with the desired levels. Oil content, therefore, must be consistent with levels that are acceptable to the economics of processing and a minimal of carbohydrate is desirable.

In addition, soybean plants increases the fertility of the soil through the activity of *Rhizobium japonicum* accompanying soybean plants in fixing nitrogen.

Increasing the production of soybean is of great importance, which may be achieved by using high yielding varieties and/or improving the agronomic practices among which weed control.

Weeds have been a part of the agricultural scene, since man first started cultivating crops, more than 1000 years ago and they are still a major problem today. Weeds are harmful to crops as they compete for water, light and nutrients, for space above and below ground. They also reduce the productivity per acre. Weeds also increase the difficulty of harvesting and entail seed cleaning. Even in area not under crops they may be harmful, for example in railway tracks, canal and open grazing country.

Obviously, anything that we can do to reduce this heavy toll must be done to face the problem of feeding not only our present population but that which is rapidly increasing. The mechanical revolution completely altered agricultural methods and now the chemical revolution is carrying on to new heights of efficiency. A major component of the chemical revolution is the use of herbicides to control undesirable plants.

Chemical weed control is a miracle of our technological age. Long known as one of the most arduous of agricultural operations, weed killing has taken on an entirely new aspect as chemical after chemical is added to our arsenal of herbicides.

This century has shown an increase in both the production and use of herbicides and as a result yields of cereals, soybean, cotton, sugar beets and many other crops have increased in some cases of 100% or more. Thus, while the use of fertilizers and new high-yielding crop varieties have contributed greatly to the "green-revolution", chemical weed control has been at the forefront in technological achievement, **Ashton and Crafts (1981)**.

However, the increment in the number of chemical compounds which are proven to be efficient in weed control, refer to that the use of the chemical means is still of major importance. Thus, several compounds belonging to the triazines proved to be effective in weed control.

Selectivity as the most important character of the herbicides is not absolute but selectivity is a relative effect. The term selectivity refer to the fact that, under a given set of conditions certain species of plants (weeds) are killed or seriously injured, whereas other species of plants are not injured (crop). However a given herbicide is selective to a particular crop only within certain limits of rate, environmental conditions and method of application. The desired selectivity is the result of favourable interaction of three components (1) the plant, (2) the herbicides, and (3) the environment, **Ashton and Crafts (1981)**.

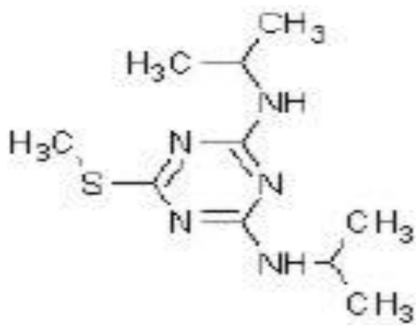
Also, absorption and translocation of herbicides are of major interest, since a compound must enter the plant and move to its site of action to be effective as a herbicide. Such processes depend primarily on its molecular configuration, which in turn determines its chemical and physical properties, **Fletcher and Kirkwood (1992).**

Keeping the above reports in mind together with the recommendation provided by the producing company, prometryn (herbicidal triazine used in the present work) was applied as pre-planting one.

Prometryn (Caparol or Gesagard) is one of the s-triazine derivatives which include several compounds such as, ametryn, atrazine, cyanazine, propazine, metribuzine, simazine, simetryn, terbutryn and terbuthylazine.

The chemical name of prometryn is 2, 4-Bis (isopropyl-amino)-6-(methylthio)-s-triazine. Its molecular formula is $C_{10}H_{19}N_5S$ and its structural formula is:

Molecular Structure of Prometryn Herbicide:



N-alkylated diamine -s-triazine is from an important class of herbicides and consequently they are widely investigated. In fact, as a result of herbicidal soil treatments, the absorption and translocation of sub-lethal doses of these herbicides make them able to interfere on the physiological and biochemical processes in plants.

Effect of Prometryn on Growth Characteristics and Yield Components:

Growth Characters:

The information derived from morphological, anatomical and metabolic changes during growth and development can provide data that may suggest the physiological and biochemical events that are modified by the herbicides.

Ebert and Dumford (1999) reviewed the effect of the triazine herbicides on plant growth and its morphological appearance extensively. They reported that application of the triazine herbicides at the relatively higher rates; inhibit the growth of all organs of plants. They attributed this result to a deficiency of photosynthesis which is a pre-requisite for growth as a result of a blockage of the photosynthetic process at certain sites. However, at sub-toxic concentrations certain triazine herbicides have been shown to stimulate growth. Thus, obvious increases in the shoot length, leaf blade area, fresh and dry weights of shoot of the plants were obtained. However, **Ploszynski and Zurawski (1984)** found that sandy soil treatment with the triazine herbicides at relatively higher doses inhibited plant growth, decreased the fresh and dry weights of plants, yield and reduced the rate of transpiration of the treated flax and buck wheat plants.

Thus, depending on the applied dose of the herbicide, experimental methods, species involved, the rate of its penetration and translocation, the triazines were observed to inhibit, stimulate or have no effects on the different growth criteria of the treated plants, **Ebert and Dumford (1999)**.

Furthermore, **Domanska *et. al.*, (1985)** investigating the effects of different herbicides belonging to triazine group on different plants was reduced the shoot growth of the treated plants. They attributed this result to the beneficial effects of the triazine herbicides on the activity of nitrifying bacteria.

Consistent results were obtained by **Lorenzoni (1982)** who showed that the rate of growth and dry weight accumulation in maize plants increased in response to treatments with the relatively lower concentrations of simazine.

Similarly, **Freney (1983)** reported that, lower doses of simazine increased the dry weight and growth of maize shoots by 27%. In addition, **Jordan and Day (1983)** reported that *Chenopodium sp.* seed germination was also increased by applying lower concentrations of simazine. **Singh *et. al.*, (1984)** found that using sub-lethal doses of s-triazine herbicides induced obvious increases in the height of the shoots and in the fresh and dry weight of leaves.

Moreover, **Paromenskaya and Lebskii (1985)** found that treatment of 6 kg pre-emergence prometryn / kg on pea cultivar *(Uladouskii yubileinyl)* caused reduction of plant weight.

Moraes *et. al.*, (1989) found that soybean treated with 0.3, 0.6 and 0.9 kg/ha metribuzin (a triazine herbicide) suffered injury from the lowest herbicide rate but higher rates caused increasing toxicity. At 0.3 kg/ha metribuzin the relative dry weight of shoots and relative leaf area increased.

Omokaro and Ajakaiya (1989) showed that treatment of prometryn at several concentrations (1.25 kg/ha) to cowpeas cv. 60 Day (IT82-E60) and Ife Brown caused an increase in crop growth significantly in both cultivars throughout the growth period except at flowering and pod filling (35-49 DAS).

Klimont (1991) reported that pre-emergence treatment of soybeans with prometryn at (2.0-3.6 kg/ha) decreased plant height, ear length, number of kernels / ear and weight of 1000 kernels. Higher dose of herbicide exerted a greater effect than lower dose applied.

Omokaro and Ajakaiya (1991) showed that treatment of cowpea (36 DAS, IT82-E60 cultivars) with 5 ppm prometryn decreased shoot growth. At lower rates, the shoot growth was unaffected during the early growth stages.

El-Shafey and Nafie (1992) stated that soil treatment with the herbicide topogard at half recommended and recommended doses (½R and R) induced a high significant increase of the different growth parameters of broad bean plants. Conversely, application of double recommended dose (2R) induced a significant decrease of most of the growth criteria of the treated plants.

Molin and Khan (1996) showed that application of prometryn (at 0.3 to 13.4 kg/ha) to cotton cultivars [Pima S-7 (*Gossypium barbadense* L.)] representative of prometryn-tolerant cultivars, was reduced growth by 40% at a preplant incorporated rate of 13.4 kg/ha; and Delta pine-5415 (*G. hirsutum* L.), a representative of susceptible cultivars, was inhibited by 60% at 1.3 kg/ha and seedlings died at 2.7 kg/ha.

Klimont (1998)[(b)] found that prometryn at (1.5 or 3kg/ha) application to soybean cultivars (Polan, Aladan and Dornburg), He found that the plants were taller and had greater pod, seed numbers and 1000 seed weight than untreated (control). **Singh and Wright (1999)** revealed that application of prometryn as a seed treatment decreased leaf area, root and shoot dry weights of pea (*Pisum sativum*).

Singh and Wright (2002)[(a)] found that pre-emergence application of prometryn at 1.70 and 3.40 kg/ha on peas (*Pisum sativum* varieties Rex and Guido) shoot growth was adversely affected by the herbicide in both cultivars.

Yield Components:

Concerning yield components, **Belyaev (1981)** noted that yield of fresh fodder increased 2 folds with prometryn applied pre-emergence.

Nassib *et. al.,* (1982) found that Igran (terbutryn) at 4.76 kg/ha treatments increased significantly seed and straw yields of *Vicia faba*.

Mostafa (1985) noticed that linuron plus prometryn gave the highest straw yield per feddan and linuron at 2 kg/fed gave the highest 100 seed weights.

Hassan (1987) reported that application of (prometryn) at 1 kg/fed., sencor (metribuzin) at 1 kg/fed and sencor **+** tobogard at 0.05 + 1 kg/fed respectively gave a 43.0-59% increase in yield, increased plant height and numbers of branches and pods with no damage to *Vicia faba* per plants.

Tiwari *et. al.,* (1988) stated that application of 0.35 kg/ha metribuzin increased seed numbers and seed yield per plant above the control values. **Klimont (1991)** reported that application of prometryn at concentrations (2.0 and 3.6 kg/ha) decreased the crop yield of soybean.

Henderson and Webber (1993) stated that post-emergence cyanazine, metribuzin, prometryn and terbutryn at concentrations required for weed control either killed the

Phaseolus vulgaris plants within a few days or resulted in complete yield loss.

Klimont (1996) found that applied prometryn at (1.5 and 3 kg/ha) in the forecrop (soybean) caused inhibition in yield components.

Mohammed *et. al.*, (1997) found that application of prometryn at (1kg/ha) provided good weed control and increased the yield of lentils at Wad Hamid. Application of a higher dose (1.5 kg/ha) of prometryn caused phytotoxicity.

Klimont (1998)[(b)] reported that treatment of soybeans cv. Polan, Aldana and Dornburg with prometryn (1.5 or 3 kg/ha), He found that average seed yields of Aldana, Dornburg and Polar were 1.28, 1.58 and 1.68 t/ha.

Singh and Wright (1999) showed that application of pre-emergence prometryn decreased seed yield of pea (*Pisum sativum*). The effect of herbicides increased with increasing rate of application.

Guriqbal *et. al.*, (2002) showed that spraying of prometryn at 1.70, 3.40 and 6.80 kg/ha decreased seed yield of pea (*Pisum sativum*) particularly at higher rates. The yield of the herbicide-treated plots was greater than the yield of the unweeded control, but less than that of hand weeded treatment.

Erman *et. al.*, (2004) found that treatment of winter lentil (*Lens culinaris* L.) with prometryn resulting in a control of weed and high yield.

Concerning the effect of triazines on nodulation, **Paromenskaya *et. al.*, (1985)** showed that treatment of pea