J. Agric. Sci. Mansoura Univ., 29(5): 2459 - 2474, 2004

EFFECT OF STIGMASTEROL ON MORPHOLOGICAL, ANATOMICAL AND YIELD CHARACTERS OF SOYBEAN PLANT [*Glycine max* (L.) Merrill]

Nassar, Dalia M. A.
Department of Agricultural Botany, Faculty of Agriculture, Cairo University, Giza, Egypt.

ABSTRACT

Field experiments were performed at the Agricultural Experiments and Researches Station, Faculty of Agriculture, Cairo University, Giza, Egypt during the two growing seasons of 2002 and 2003 to study the effect of foliar application with stigmasterol at various concentrations of 0,25,50,100 and 200 ppm on morphological, anatomical and yield characters as well as on seed quality of soybean cv. Giza 35.

Results revealed that foliar application with stigmasterol at the relatively low used concentration of 25ppm or at the relatively high used concentration of 200 ppm showed no significant effect on all studied morphological characters of vegetative growth of soybean cv. Giza 35. By contrast, foliar application with any of the two assigned median concentrations of 50 and 100 ppm stigmasterol induced significant promotive effects on main stem length, number of branches and leaves per plant, total leaf area per plant and shoot dry weight per plant of soybean cv. Giza 35. Worthy to mention that the maximum promotive effect induced in vegetative growth of soybean was detected at 100 ppm stigmasterol.

As to the effect of foliar application with 100ppm stigmasterol on anatomical structure of vegetative growth of soybean cv. Giza 35, it could be stated that such treatment increased stem diameter due mainly to the prominent increase in the thickness of epidermis, cortex and vascular cylinder although a slight reduction in pith diameter was observed. Likewise, spraying stigmasterol at concentration of 100 ppm increased thickness of both medvein and lamina of leaflet blades of soybean cv. Giza 35. The increase in lamina thickness was accompanied with increments in thickness of palisade and spongy tissues. Also, the main vascular bundle of the midvein was increased in size as a result of spraying stigmasterol.

Concerning the effect of stigmasterol on yield characters and seed quality of soybean cv. Giza 35, it was found that all adopted concentrations of stigmasterol showed no significant effect on number of seeds per pod and percentage of total lipids in seeds of soybean cv. Giza 35. Number of pods per plant, number of seeds per plant and yield of seeds per plant were increased significantly and linearly with increasing the concentration of stigmasterol up to 100 ppm and then decreased sharply when using stigmasterol at concentration of 200ppm. Moreover, foliar application with any of the two assigned median concentrations of 50 and 100 ppm stigmasterol induced significant promotive effects on specific weight of seeds and percentage of crude protein in seeds of soybean cv. Giza 35, and the difference between these two median concentrations proved indifferent in this respect. The maximum significant increase in seed yield per plant was recorded at 100 ppm stigmasterol, being 44.4% more than seed yield per untreated plant of soybean cv. Giza 35.

Keywords: Soybean, Stigmasterol, Morphology, Anatomy, Yield, Seed quality.

INTRODUCTION

The family Fabaceae (Papilionaceae) consists of about 440 genera and 12000 species. It ranks second only to the Poaceae (Gramineae) in agricultural importance (Cronquist, 1981). The family is of considerable importance as a source of high-protein food, oil, and forage as well as ornamentals and other uses. It occurs all over the world, but particularly in the warm temperate regions of both the Northern and Southern hemispheres.

Glycine is a well known genus of the family with ten species. *Glycine max* (L.) Merrill, soybean or soya is becoming the most important species of them because it is a source of oil and high-protein meal (Jones and Luchsinger, 1987). It has manifold uses, both in the orient and in temperate regions, and has become a highly essential and vital crop. It is an important aid to agriculture, a valuable commercial crop, a good feed for livestock, and the source of numerous raw material for use in industry. Soybean protein is extensively used to produce the foam liquid used for extinguishing oil fires and as the source of a synthetic fibre, similar to the casein fibres. The soybean flour, with a low carbohydrate and high protein content, is an excellent food for diabetics. Soybean milk, extracted from the seed, is used in cooking and is recommended for infants and invalids. The sprouts are a favourite food. The oil can be used as a salad or cooking oil and for other food purposes; it had great versatility (Caldwell *et al.*, 1973).

Increase of soybean yield in Egypt is highly recommended to meet the demand of human needs and livestock. Plant growth and development is known to be under the control of extremely minute quantity of endogenous hormones produced within the plant. Recently, a great attention has been focused on the possibility of using natural and safety substances in order to improve plant growth, flowering and fruit setting. Stigmasterol is considered as one of the mostly free or conjugated sterols that plays essential functions in plant growth such as structure component of lipid core of cell membrane and biogenetic precursor of numerous metabolites including steroid hormones (Genus, 1978). It promoted assimilation of C^{14} in leaves and successive translocation of the assimilate into rice panicles (Fujii *et al.*, 1991). Brassinolide and many other related compounds have been found to be widely distributed in the plant kingdom and have many effects on plant growth and development (Cutler *et al.*, 1991). It was found that brassinosteroid caused pronounced elongation of hypocotyls, epicotyls and peduncles of dicots as well as coleoptile and mesocotyls of monocots (Sasse, 1991). Brassinosteroid promoted cell wall formation and resulted in hyperpolarization of cell membranes and accelerated growth cycle (Clouse and Sasse, 1998). In this regard, Abd-El-Wahed *et al.* (2000 and 2001) and Abd-El-Wahed (2001) reported that sitosterol had a stimulatory effect on growth, yield, photosynthetic pigments and some chemical composition of wheat and maize plants. Also, Ali *et al.* (2002) stated that stigmasterol had promotive effect on growth, yield and structure of rice plants.

Thus, the present investigation is an attempt to bring to light more information about the effect of foliar application with stigmasterol on morphological, anatomical and yield characters as well as on seed quality of soybean cv. Giza 35. This would be an effort to trace the beneficial effect for stigmasterol on productivity of soybean, if any.

MATERIALS AND METHODS

This study was performed at the Agricultural Experiments and Researches Station, Faculty of Agriculture, Cairo University, Giza, Egypt during the two growing seasons of 2002 and 2003.

Seeds of soybean cv. Giza 35 were secured from Legume Research Division, Field Crops Institute, Agricultural Research Centre, Giza.

The growth promoter stigmasterol (Stigmasta-5,22- Diene-3B-OL; (24S)-24 Ethylcholesta-5,22- Diene-3B-OL) was obtained from Merck-Co. Four concentrations; namely, 25, 50, 100 and 200 ppm were used as foliar application. The control plants were sprayed with tap water.

Field work procedure:

Soybean seeds of the selected cultivar were sown on 6th May, 2002 in the first season, and replicated on 9th May, 2003 in the second one to provide the experimental plant materials. The experiment was made in a randomized complete block design with three replicates. The four levels of stigmasterol beside the control required that the experimental land of each replicate be divided into five plots, each contained one treatment. The plot was five ridges, 3.5 meters long, 60 cms apart; *i.e.*, each plot comprised 1/400 of feddan. The hills were spaced at 20 cms distance on the southern side of the ridge. Seeds were inoculated before sowing with the recommended strain of *Rhizobium japonicum* provided by the Ministry of Agriculture, Giza. Four seeds were sown in each hill, and the stand was later thinned to two plants per hill. Land preparation, fertilizer application and agricultural operations followed the normal practices of soybean cultivation in the vicinity.

Stigmasterol concentrations were applied twice by means of an atomizer sprayer. The first application was 30 days from sowing (the age of 6- leaf stage) and the second application was two weeks from the first one; *i.e.*, 45 days from sowing (the age of first flower bud open for control plants). Volume of spraying solution per plot was two and three litres for first and second application; respectively. This volume was adequate to wet plants of the plot thoroughly with excess dripping solution.

Recording of data:

The present investigation involved studies pertaining to morphological, anatomical, yield and chemical characters of soybean cv. Giza 35 as affected by different levels of stigmasterol in both studied seasons.

Morphological characters of vegetative growth:

A random sample of 15 plants for each tested treatment (5 plants from each replicate) was assigned for investigation. Vegetative characters were recorded after 75 days from sowing; *i. e.*, one month after the second application of stigmasterol. The following characters were studied:

- Length of the main stem (cm), was measured from the cotyledonary node to apex of the stem.
- Number of lateral branches per plant.
- Number of leaves per plant.
- Total leaf area (cm^2) per plant, leaf area was measured by means of LI-3000 A portable area meter, LI-3050 A Transparent belt conveyer- of LI- Cor, Inc., Lincoln, Nebraska, U.S.A.
- Shoot dry weight (g) per plant, all above ground parts of the plant were chopped and placed in paper bags. The bags with its contents were dried in an electric oven at 105°C till a constant weight was reached, almost 48 hours.

Anatomical studies:

A comparative microscopical examination was performed on plant material for treatments which showed remarkable response. In addition to the control, plants of soybean cv. Giza 35 treated with 100 ppm stigmasterol were considered in details. Tested material included the main stem at its median portion (internode number seven) and lamina of the terminal leaflet of the compound leaf corresponding to the median internode of the main stem; *i.e.*, the seventh developed leaf. Specimens were taken throughout the second season of 2003 at the age of 75 days. Specimens were killed and fixed for at least 48 hrs. in F. A. A. (10 ml formalin, 5 ml glacial acetic acid and 85 ml ethyl alcohol 70%). The selected materials were washed in 50% ethyl alcohol, dehydrated in a normal butyl alcohol series, embedded in paraffin wax of melting point 56°C, sectioned to a thickness of 20 microns, double stained with crystal violet-erythrosin, cleared in xylene and mounted in Canada balsam (Nassar and El-Sahhar, 1998). Sections were read to detect histological manifestations of noticeable responses resulted from application wih stigmasterol and photomicrographed.

Yield Characters:

A random sample of 30 plants for each tested treatment (10 plants from each replicate) was taken at harvest time, about 120 days after sowing, to investigate the following characters in each of the two studied seasons:

- Number of pods per plant.
- Average number of seeds per pod.
- Number of seeds per plant.
- Specific weight of seeds (g), using ten random seed samples from each of the three replicates, each comprised of 100 seeds.
- Yield of matured dried seeds (g) per plant.

Chemical analysis of seeds (seed quality):

Percentages of total lipids and crude protein were determined in mature dried seeds, at harvest time in each of the two studied seasons, of soybean cv. Giza 35 subjected to different levels of stigmasterol. Samples resembling various treatments were finely ground.

- Total lipids as petroleum ether soluble fraction was determined according to the method mentioned in Anon. (1990) as follows: A known weight of dried seed samples (10g) was extracted in a Soxhelt extraction apparatus using petroleum ether (b.p. 60-80°C) as a solvent for 24 hrs. Petroleum ether was then evaporated to dryness. The residue was weighed and percentage of total lipids was calculated.
- For determination of crude protein, total nitrogen content was determined using the modified micro-Kjeldhahl method described by Pregl (1945). Nitrogen content of seeds was multiplied by 6.25 to calculate the crude protein (Anon., 1990).

Statistical analysis:

Data on morphological and yield characters as well as on seed quality of the two seasons were subjected to conventional methods of analysis of variance according to Snedecor and Cochran (1982). The combined data of both experimental seasons were used for results presentation. The least significant difference (L.S.D.) at 0.05 level of probability was calculated for each determined character under different assigned treatments.

RESULTS AND DISCUSSION

I- Morphological characters of vegetative growth:

Data on morphological characters of vegetative growth of soybean cv. Giza 35 as affected by spraying various levels of stigmasterol in two seasons are presented in Table (1).

1- Length of the main stem:

Data given in Table (1) clearly show that the length of the main stem of soybean cv. Giza 35 was increased with increasing the concentration of stigmasterol up to 100 ppm. The significant increase in the main stem length was detected at the relatively median used concentration of 50 or 100 ppm stigmasterol and the maximum increase in main stem length occurred at 100 ppm stigmasterol, being 22.6% more than length of the main stem of untreated plants. It is worthy to note that the difference between the two used median concentrations (50 and 100 ppm) of stigmasterol proved insignificant. It is clear that the relatively high used concentration of 200 ppm stigmasterol showed no significant effect on length of the main stem of soybean cv. Giza 35.

Table (1): Morphological characters of vegetative growth of soybean cv. Giza 35, at the age of 75 days, as affected by foliar application with stigmasterol (Average of two seasons, 2002 and 2003 combined)

Treatments	Conc. ppm	Vegetative growth characters: Main stem length (cm)		No. of branches per plant		No. of leaves per plant		Total leaf area (cm^2) per plant		Shoot dry weight (g) per plant	
Control	0	86.4	B	4.2	C	36.9	B	1478	C	44.7	B
Stigmasterol	25	89.3	B	4.2	C	36.7	B	1529	C	45.6	B
	50	102.7	A	5.1	B	47.3	A	1752	B	54.9	A
	100	105.9	A	5.6	A	51.5	A	1886	A	58.4	A
	200	88.5	B	4.3	C	39.1	B	1457	C	43.8	B
L.S.D. (0.05)		8.9 cm		0.4 branch		4.5 leaves		126.2 cm^2		4.7 g	

Means having the same letter are not significantly different at 0.05 level.

2- Number of branches per plant:

It is realized from Table (1) that the untreated plants of soybean cv. Giza 35 recorded a mean number of 4.2 branches per plant which proved significant difference with any of the two assigned median concentrations (50 and 100 ppm) of stigmasterol. While, the relatively low used concentration of 25 ppm as well as the relatively high used concentration of 200 ppm stigmasterol showed no significant effect on number of branches developed per plant of soybean cv. Giza 35. It is obvious that foliar application with stigmasterol at concentrations of 50 and 100 ppm increased significantly number of branches developed per plant of soybean cv. Giza 35 with significant difference between these two median concentrations. The highest number of 5.6 branches per plant was recorded at treatment of 100 ppm stigmasterol, being 33.3% more than number of branches developed per untreated plant of soybean cv. Giza 35.

3- Number of leaves per plant:

Data presented in Table (1) reveal that the control plants recorded a mean number of 36.9 leaves per plant which proved indifferent with the treatment of 25 ppm stigmasterol (36.7 leaves) and with that of 200 ppm stigmasterol (39.1 leaves). It is clear that foliar application with stigmasterol at concentrations of 50 and 100 ppm increased significantly number of leaves developed per plant of soybean cv. Giza 35 with no significant difference between these two concentrations. The highest number of 51.5 leaves per plant was achieved at treatment of 100 ppm stigmasterol, being 39.6% more than number of leaves developed per untreated plant of soybean cv. Giza 35.

4- Total leaf area per plant:

Results given in Table (1) indicate that foliar application with stigmasterol at relatively low used concentration of 25 ppm or at relatively high used concentration of 200 ppm showed no statistical effect on total leaf area per plant of soybean cv. Giza 35. On the other hand, any of the two assigned median concentrations of 50 and 100 ppm stigmasterol induced significant increase in total leaf area per soybean plant and the difference between these two median concentrations proved significant in this respect. It is clear that the highest total leaf area per soybean plant (1886 cm^2) was recorded at 100 ppm stigmasterol, being 27.6% more than total leaf area per untreated plant of soybean cv. Giza 35 (1478 cm^2).

5- Shoot dry weight per plant:

It is obvious from Table (1) that shoot dry weight per plant of soybean cv. Giza 35 was increased with increasing the concentration of stigmasterol up to 100 ppm. The significant increase in shoot dry weight per plant was recorded at the relatively two assigned median concentrations of 50 and 100 ppm stigmasterol. The highest weight (58.4 g) was detected at 100 ppm stigmasterol, being 30.7% more than shoot dry weight per untreated plant (44.7 g). It is worthy to note that the difference between the two assigned median concentrations (50 and 100 ppm stigmasterol) proved insignificant in this respect. It is realized that the relatively low used concentration of 25 ppm stigmasterol as well as the relatively high used concentration of 200 ppm stigmasterol showed no significant effect on shoot dry weight per plant of soybean cv. Giza 35.

From the above mentioned results concerning the effect of foliar application with different concentrations of stigmasterol on morphological characters of vegetative growth of soybean cv. Giza 35, it could be stated that stigmasterol at relatively low used concentration of 25 ppm or at relatively high used concentration of 200 ppm showed no significant effect on all studied morphological characters. By contrast, foliar application with any of the two assigned median concentrations of 50 and 100 ppm stigmasterol induced significant promotive effects on main stem length, number of branches and leaves per plant, total leaf area per plant and shoot dry weight per plant of soybean cv. Giza 35.

These results are in harmony with those reported by Krizek and Mandava (1982) on bean plants and by Braun and Wild (1984) on wheat and mustard plants as well as by Wang and Wang (1997), Chon *et al.* (2000) and Ali *et al.* (2002) on rice plants. Likewise, Abd-El-Wahed *et al.* (2000) confirmed these findings on maize plants.

II-Anatomical studies:

It was aimed in this investigation to follow the internal structure of vegetative parts which exhibited the most noticeable response to adopted treatments. The aforementioned findings concerning the vegetative growth characters of soybean plant under investigation proved that foliar application with 100 ppm stigmasterol achieved the most remarkable effects among various tested concentrations of stigmasterol. This may justify a further study on the effect spraying with 100 ppm stigmasterol on the internal structure of soybean.

Microscopical characters were examined through specimens of the seventh internode of the main stem of soybean cv. Giza 35 as well as of the terminal leaflet of the corresponding leaf. Sampling was carried out during the second season of 2003 at the age of 75 days from sowing date; *i.e.*, one month after the second application with stigmasterol.

1- Anatomy of the main stem:

Microscopical measurements of certain histological characters of the seventh internode which resembled the median internode of the main stem of soybean cv. Giza 35 sprayed with 100 ppm stigmasterol and those of control are given in Table (2). Likewise, microphotographs depict these treatments are shown in Figure (1).

Table (2): **Measurements in microns of certain histological features in transverse sections through the middle part of the seventh internode of the main stem of soybean cv. Giza 35, at the age of 75 days, as affected by foliar application with 100 ppm stigmasterol**
(Means of three sections from three specimens)

Characters	Treatments		
	Control	100 ppm stigmasterol	± % to control
Stem diameter.	5914	6673	+12.8
Thickness of epidermis.	23	26	+13.0
Thickness of cortex.	197	285	+44.7
Thickness of vascular cylinder.	1118	1446	+29.3
Thickness of fibrous tissue.	131	164	+25.2
Thickness of phloem tissue.	302	343	+13.6
Thickness of xylem tissue.	685	939	+37.1
Pith diameter.	3238	3159	-2.4

It is realized from Table (2) and Figure (1) that foliar application with stigmasterol at concentration of 100 ppm increased the diameter of the main stem, at the seventh internode, of soybean cv. Giza 35 by 12.8% more than that of the control. The increase in stem diameter, due to foliar application with 100 ppm stigmasterol, could be attributed mainly to the prominent increase in all included tissues except that of pith which showed slight decrease of 2.4% in its diameter less than that of the control. The thickness of epidermis, cortex and vascular cylinder were 13.0, 44.7 and 29.3% more than those of the control; respectively. It is clear that the prominent increase which was observed in the thickness of vascular cylinder of the main stem of soybean cv. Giza 35 as affected by foliar application with 100 ppm stigmasterol could be attributed mainly to the increase in thickness of fibrous tissue, phloem tissue and xylem tissue by 25.2, 13.6 and 37.1% more than those of the control; respectively.

In this respect, Ali *et al.* (2002) recorded favourable anatomical effects for stigmasterol at concentration of 100 or 150 ppm when foliarly sprayed twice to rice plants at leaf tube and tillering stages. Such favourable effects resulted in increasing stem diameter due mainly to increasing in number and thikness of ground tissue layers, diameter of pith cavity and number of vascular bundles.

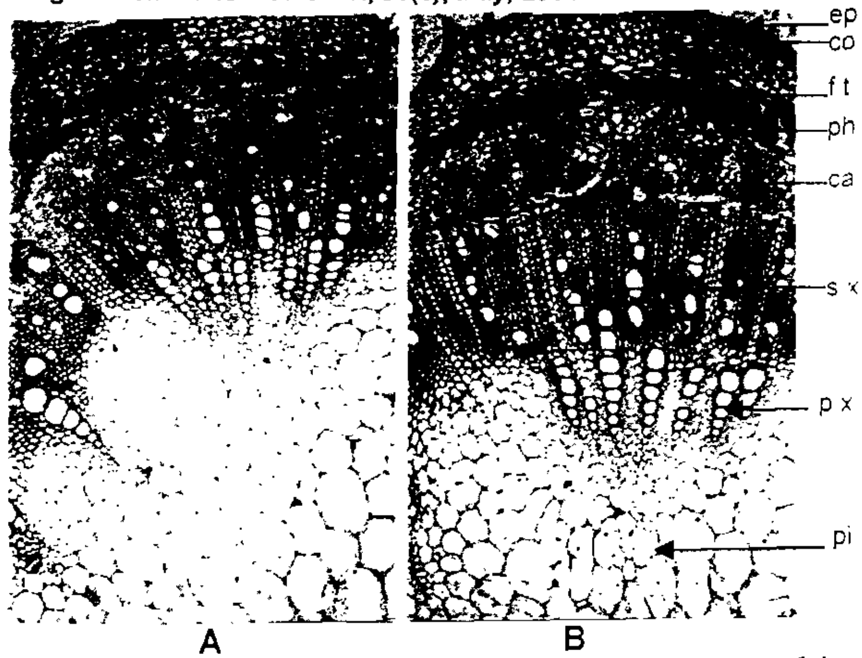

Fig. (1): Transverse sections through the seventh internode of the main stem of soybean cv. Giza 35, at the age of 75 days, as affected by spraying with stigmasterol. (X 52)

A- From untreated plant.
B- From plant treated with 100 ppm stigmasterol.

Details: ca, cambium; co, cortex; ep, epidermis; f t, fibrous tissue; ph, phloem; pi, pith; p x, primary xylem and s x, secondary xylem.

2- Anatomy of the leaf:

Microscopical counts and measurements of certain histological characters in transverse sections through the blade of the terminal leaflet of the seventh leaf developed on the main stem of control plants of soybean cv. Giza 35 and of those sprayed with 100 ppm stigmasterol are presented in Table (3). Likewise, microphotographs illustrating these treatments are shown in Figure (2).

It is noted from Table (3) and Figure (2) that spraying stigmasterol at concentration of 100 ppm increased thickness of both midvein and lamina of leaflet blades of soybean cv. Giza 35 by 15.3 and 38.3% more than the control; respectively. It is clear that the increase in lamina thikness was accompanied with 34.1 and 47.1% increments in thickness of palisade and spongy tissues compared with the control; respectively. The main vascular bundle of the midvein increased in size as a result of spraying stigmasterol. The increment was mainly due to the increase in length by 29.9% and in width by 38.8% more than the control. Also, average number of vessels per midvein bundle was increased by 40.0% over the control. Moreover, xylem vessels had wider cavities, being 6.5% more than the control, which amounted to more total active conducting area to cope with vigorous growth resulting from treatment with 100 ppm stigmasterol.

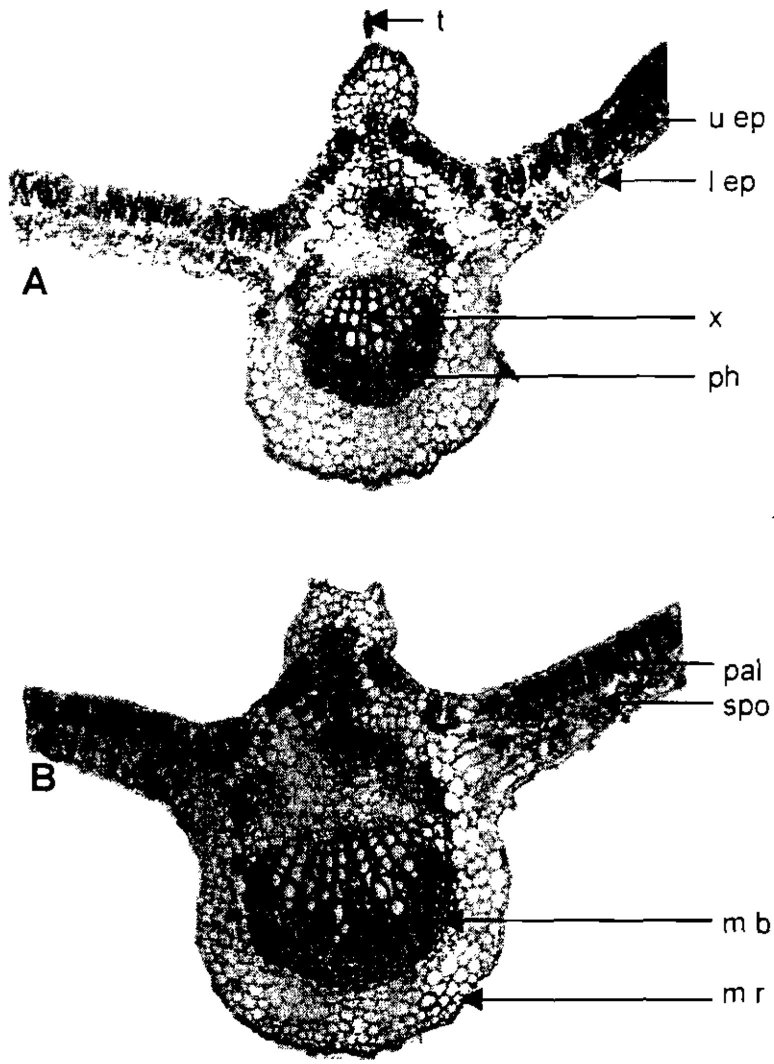

Fig. (2): **Transverse sections through the blade of terminal leaflet of the seventh compound leaf developed on the main stem of soybean cv. Giza 35, at the age of 75 days, as affected by spraying with stigmasterol. (X 52)**

A- From untreated plant.

B- From plant treated with 100 ppm stigmasterol.

Details: l ep, lower epidermis: m b, midvein bundle; m r, midrib region; pal. palisade tissue: ph, phloem; spo, spongy tissue; t, trichome: u ep, upper epidermis and x, xylem.

Table (3): Counts and measurements in microns of certain histological features in transverse sections through the blade of the terminal leaflet of the seventh leaf developed on the main stem of soybean cv. Giza 35, at the age of 75 days, as affected by foliar application with 100 ppm stigmasterol (Means of three sections from three specimens)

Characters	Treatments		
	Control	100 ppm stigmasterol	± % to control
Thickness of midvein.	1225	1412	+15.3
Thickness of lamina.	214	296	+38.3
Thickness of palisade tissue.	85	114	+34.1
Thickness of spongy tissue.	104	153	+47.1
Dimensions of the main vascular. bundle of midvein:			
Length.	348	452	+29.9
Width.	503	698	+38.8
No. of vessels/ midvein bundle.	30	42	+40.0
Vessel diameter.	46	49	+6.5

In this connection, Ali *et al.* (2002) stated that histological examination of flag leaf cross sections revealed favourable anatomical effects for stigmasterol treatments at the concentrations of 100 and 150 ppm when foliarly sprayed twice to rice plants at leaf tube and tillering stages. Such favourable effects resulted in increasing leaf thickness, upper and lower epidermal layers, mesophyll tissue and dimensions of both main and smaller leaf vascular bundles.

III- Yield characters:

The mean values of yield characters of soybean cv. Giza 35 as affected by foliar application with different concentrations of stigmasterol in two seasons are given in Table (4).

1- Number of pods per plant:

It is realized from Table (4) that number of pods per plant of soybean cv. Giza 35 was increased significantly and gradually with increasing the concentration of stigmasterol up to 100 ppm and then decreased sharply when using stigmasterol at concentration of 200 ppm. It is clear that the differences among the tested four concentrations of stigmasterol were significant. Foliar application with stigmasterol at the relatively high used concentration of 200 ppm showed no significant effect in this respect. The highest number of pods per plant of soybean cv. Giza 35 (187.5 pods) was recorded at 100 ppm stigmasterol, being 35.5% more than the number of pods per untreated plant (138.4 pods).

2- Average number of seeds per pod:

Data presented in Table (4) clearly show that foliar application with stigmasterol at any of the four assigned concentrations (25, 50, 100 and 200 ppm) had no significant effect on average number of seeds per pod of soybean cv. Giza 35.

3- Number of seeds per plant:

It is noted from Table (4) that the effect of foliar application with stigmasterol on number of seeds per plant of soybean cv. Giza 35 showed the same trend that previously mentioned about the effect of stigmasterol on number of pods per plant. Number of seeds per plant showed significant gradual increases with increasing the concentration of stigmasterol up to 100 ppm, then a sharp significant decrease in number of seeds per plant of soybean cv. Giza 35 was observed when using stigmasterol at concentration of 200 ppm compared to the treatment of 100 ppm. It is worthy to note that foliar application with stigmasterol at concentration of 200 ppm showed no significant effect on number of seeds per plant. The highest number (555 seeds) was detected at 100 ppm stigmasterol, being 35% more than number of seeds per untreated plant of soybean cv. Giza 35 (411.1 seeds).

4- Specific weight of seeds (average weight of 100 seeds):

It is clear from Table (4) that foliar application with stigmasterol at concentrations of 25, 50 and 100 ppm increased average weight of 100 seeds of soybean cv. Giza 35, and the differences among these three concentrations were insignificant. The significant increase in specific weight of seeds was observed at 50 or 100 ppm stigmasterol. The highest weight (23.3g) was achieved at 50 ppm stigmasterol, being 7.9% more than specific weight of seeds of untreated plants (21.6 g). It is worthy to note that foliar application with the relatively high used concentration of 200 ppm stigmasterol induced significant decrease in average weight of 100 seeds of soybean cv. Giza 35, being 14.4% less than the control in this respect.

5- Yield of seeds per plant:

It is obvious from Table (4) that seed yield was increased significantly and gradually with increasing the concentration of stigmasterol up to 100 ppm, then a sharp significant decrease in seed yield per plant of soybean cv. Giza 35 was recorded when stigmasterol was applied at the relatively high concentration of 200 ppm. The decrease in seed yield per plant due to foliar application with stigmasterol at high used concentration reached 14.9% less than the control. The highest seed yield per plant of soybean cv. Giza 35 (128.2g) was achieved at 100 ppm stigmasterol, being 44.4 % more than seed yield per untreated plant (88.8 g).

Referring to the aforementioned results concerning the effect of foliar application with various concentrations of stigmasterol on yield characters of soybean cv. Giza 35, it could be stated that seed yield per plant, being the outcome of various components; i.e., number of pods per plant, number of seeds per plant and specific weight of seeds showed high response to investigated treatments. It in noted that stigmasterol at any of the two assigned median concentrations of 50 and 100 ppm had a significant promotive effect on yield and yield components of soybean cv. Giza 35. Similar results were also reported by Abd-El-Wahed *et al.* (2000) on maize plants and by Ali *et al.* (2002) on rice plants.

Table (4):Yield characters and seed quality of soybean cv. Giza 35, at harvest time (120 days from sowing date), as affected by foliar application with stigmasterol (Average of two seasons, 2002 and 2003 combined)

Treatments	Conc. ppm	Yield characters					Seed quality	
		No. of pods per plant	No. of seeds per pod	No. of seeds per plant	Weight of 100 seeds (g)	Yield of seeds (g)/plant	Total lipids %	Crude protein %
Control	0	138.4 D	2.97	411.1 D	21.6 B	88.8 D	19.2	39.7 B
Stigmasterol	25	152.6 C	2.98	454.8 C	22.4 AB	101.9 C	19.4	40.5 B
	50	169.8 B	2.96	502.6 B	23.3 A	117.1 B	19.1	43.8 A
	100	187.5 A	2.96	555.0 A	23.1 A	128.2 A	19.2	43.9 A
	200	133.9 D	3.05	408.4 D	18.5 C	75.6 E	20.1	40.3 B
L. S. D. (0.05)		12.3 pods	N.S.	39.7 seeds	1.2 g	9.6 g	N S.	2.5 %

Means having the same letter are not significantly different at 0.05 level.

IV- Seed quality:

Chemical analysis was performed on mature dried seeds, at harvest time of each of the two studied seasons, of soybean cv. Giza 35 as affected by different treatments of stigmasterol. For each treatment, chemical analysis was done to determine the percentage of total lipids and crude protein. Such quantitative determinations were used to disclose the qualitative changes in soybean seeds as a result of spraying plants with stigmasterol.

The percentages of these fractions in seeds of treated and untreated plants of soybean cv. Giza 35 are given in Table (4).

1- Total lipids:

It is clear from Table (4) that foliar application with stigmasterol at any of the four used concentrations (25, 50, 100 and 200 ppm) showed no statistical effect on the percentage of total lipids in seeds of soybean cv. Giza 35.

2- Crude protein:

Data presented in Table (4) reveal that the relatively low used concentration of 25 ppm stigmasterol as well as the relatively high used concentration of 200 ppm stigmasterol showed no statistical effect on the percentage of crude protein in seeds of soybean cv. Giza 35. By contrast, foliar application with stigmasterol at any of the two assigned median concentrations (50 and 100 ppm) increased significantly the percentage of crude protein in seeds of soybean cv. Giza 35. It is noted that the percentage of crude protein in seeds of untreated plants was 39.7%. The highest percentage of crude protein (43.9%) was recorded in seeds of plants sprayed with 100 ppm stigmasterol, which in turn being statistically indifferent with that recorded in seeds of plants sprayed with 50 ppm stigmasterol (43.8%).

In this connection, Abd-El-Wahed *et al.* (2000) stated that foliar application with stigmasterol at concentration of 20, 40 and 80 ppm on maize plants increased the percentage of crude protein in grains of treated plants and the percentage of crude protein was increased with increasing the level of stigmasterol. Likewise, Ali *et al.* (2002) using stigmasterol at concentrations of 50, 100 and 150 ppm on rice plants found that total protein content of rice grains were increased with all stigmasterol concentrations especially at treatments with higher concentrations of 100 and 150 ppm, being generally in accordance with the present findings.

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تأثير الإستيجماستيرول على الصفات المورفولوجيـــة والتشـــريحية والمحصوليـــة لنبات فول الصويا

داليا محمد عبد العزيز نصار
قسم النبات الزراعى- كلية الزراعة - جامعة القاهرة- الجيزة - مصر

أجريت تجارب حقلية بمحطة البحوث والتجارب الزراعية بكلية الزراعة جامعـــة القـــاهرة خـــلال موسمى النمو ٢٠٠٢ و٢٠٠٣ لدراسة تأثير الرش بتركيزات مختلفة من الإستيجماســـتيرول (صفـــر، ٢٥، ٥٠، ١٠٠ و٢٠٠ جزء فى المليون) على الصفات المورفولوجية والتشريحية والمحصولية وكذلك علـــى صفات جودة البذور لنبات فول الصويا صنف جيزة ٣٥.

أوضحت النتائج المتحصل عليها أن رش الإستيجماستيرول بالتركيز المنخفض نسبيا (٢٥ جزء فـــى المليون) أو بالتركيز المرتفع نسبيا (٢٠٠ جزء فى المليون) لم يكن له أى تأثير معنوى على جميع الصفـــات المورفولوجية تحت الدراسة لنباتات فول الصويا صنف جيزة ٣٥. وعلى العكس من ذلك، أدى الرش بـــأى من التركيزين المتوسطين (٥٠ و١٠٠ جزء فى المليون إستيجماستيرول) إلى حدوث تأثيرات معنوية منشطة مرغوبة على صفات طول الساق الرئيسية وعدد الأفرع والأوراق للنبات والمساحة الكلية لـــلأوراق علـــى النبات والوزن الجاف للمجموع الخضرى للنبات.

وقد تم الحصول على أقصى تأثير منشط للنمو الخضرى عند رش نباتات فول الصويا صنف جـــيزة ٣٥ بتركيز ١٠٠ جزء فى المليون إستيجماستيرول، لذلك تم دراسة تأثير الرش بهذا التركيز على الـــتركيب التشريحى للمجموع الخضرى لنبات فول الصويا صنف جيزة ٣٥ حيث أظهرت هذه المعاملة زيادة فى قطـــر الساق الرئيسية نتيجة حدوث زيادة واضحة فى سمك كل من البشرة والقشرة والإسطوانة الوعائيـــة علـــى الرغم من حدوث نقص بسيط فى قطر النخاع. كما أدى الرش بهذا التركـــيز (١٠٠ جـــزء فـــى المليـــون استيجماستيرول) إلى حدوث زيادة واضحة فى سمك كل من العرق الوسطى ونصل الوريقة، وقـــد صـــاحب الزيادة فى سمك النصل زيادة فى سمك كل من النسيج العمادى والإسفنجى، كذلك كان هناك زيادة فى حجـــم الحزمة الوعائية الرئيسية للعرق الوسطى كنتيجة للرش بالإستيجماستيرول.

فيما يتعلق بتأثير الإستيجماستيرول على الصفات المحصولية وجودة البذور، وجد أن كل التركـــيزات المستخدمة لم يكن لها أى تأثير معنوى على صفة عدد البذور فى القرن وأيضا على النسبة المئويـــة للزيـــت فى البذور. وعلى العكس من ذلك فقد كانت هناك زيادة معنوية وخطية فى صفات عدد القرون على النبـــات وعدد البذور للنبات ومحصول النبات من البذور وذلك بزيادة تركيز الإستيجماستيرول حتى ١٠٠ جزء فـــى المليون بعدها يحدث نقص حاد عند استخدام الإستيجماستيرول بتركيز ٢٠٠ جزء فـــى المليـــون. وقـــد أدى الرش بأى من التركيزين المتوسطين (٥٠ و ١٠٠ جزء فى المليون استيجماستيرول) إلى حـــدوث تـــأثيرات معنوية منشطة على الوزن النوعى للبذور والنسبة المئوية للبروتين الخام فى بذور نبات فول الصويا صنـــف جيزة ٣٥ ولم يكن هناك فرق معنوى بين التركيزين المتوسطين فى هذا الشأن.

وكانت أقصى زيادة معنوية تم الحصول عليها فى محصول النبات من البذور عند استخدام تركـــيز ١٠٠ جزء فى المليون إستيجماستيرول حيث وصلت الزيادة فى محصول النبات من البذور إلى ٤٤,٤% فـــى النباتات المعاملة مقارنة بالنباتات غير المعاملة.