RESPONSE OF SNAP BEAN PLANTS TO FOLIAR APPLICATION OF GIBBERELLIN AND ZINK

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ABSTRACT

Snap bean plants were grown to study the effect of gibberellin and zinc sulphate spraying at such concentrations on plant behaviour.

Gibberellin, at all tested concentrations (20, 40 and 60 ppm), linearly increased free water, transpiration rate and coefficient hydric in plant leaves, but reduced bound water. Zinc sulphate spraying (100 and 200 ppm) increased bound water and reduced transpiration and coefficient hydric.

Photosynthetic pigments and total soluble sugars in plant leaves positively responded to GA_3 and Zn spraying that also increased amino acids content.

The effect of studied treatments on Mn, Zn and Fe in plant leaves as well as on yield components was also studied.

GA_3 and Zn exerted, in general, increases in total green pods yield, but GA_3 reduced the early yield while Zn increased it. Protein, fats and total soluble sugars in dry seeds in relation to applied treatments were also studied.

Several interactions between GA_3 and Zn were recorded.

Key words: Gibberellins, Zinc sulphate, Coefficient hydric.

INTRODUCTION

Gibberellin was frequently reported in the literature to affect water relations and amino acids synthesis (Midan, 1978) and to enhance the synthesis of chlorophyll and total sugars in treated plants (Richard, 1996).

Besides, Zinc was reported by Midan *et al.* (1981) to promote the synthesis of auxins and to affect several physiological processes within plant (Richard, 1996).

In addition, both gibberellin and Zinc were reported to improve flowering, fruit setting and finally plant production (Iyengar and Raja, 1988).

This investigation was aimed at studying to what extent gibberellin and Zinc can be used as spraying treatments to improve the behaviour of snap bean plants.

MATERIALS AND METHODS

Two split plot experiments in a completely randomized design with four replicates were conducted to determine the effect of gibberellin and zinc sulphate spraying, along with their interaction, on the behaviour of snap bean plants.

The experiments were performed in two successive summer seasons, i.e. 2004 and 2005 at the Experimental Farm, Faculty of Agriculture, Minufiya University.

Giza-3 snap bean cv. was used, as seeds were sown in hills 10 cm apart on March 13 and 15, 2004 and 2005, respectively.

Every sub-plot contained six ridges each having 50 cm width and 5 m long with an area of 15 m^2.

Gibberellin at 0, 20, 40 and 60 ppm occupied the main plots, as zinc sulphate ($ZnSO_4$ – $7H_2O$) at 0, 100 and 200 ppm was distributed in sub-plots.

The plants in the two outer ridges were used for the determination of water relations and chemical constituents. The green pods of two ridges were picked at four days interval, as the early, the first three pickings, and total green pods yield were determined. The later ridges were left to determine the dry seeds yield.

Plants were sprayed with gibberellin 35 days from sowing, as zinc sulphate was sprayed 10 days later.

All agricultural practices were performed as recommended by Ministry of Agriculture

Ten days from zinc sulphate spraying, randomized plant samples, five plants each, were collected from each sub-plot to determine free and bound water as well as to calculate co-efficient hydric in leaves and to determine chlorophyll content, total soluble solids and total free amino-acids. Zn, Mn, Fe were also determined in the plants of these samples.

Free and bound water content were determined in fresh leaves under laboratory light and temperature conditions using the methods of Barrs and Weatherley (1962).

The coefficient hydric was calculated as the poropartion of total water content to leaves dry weight.

Chlorophyll was determined according to the method of Wettestein (1957). The method of Dubois et al. (1956) was adopted to determine total soluble sugars, whereas that of Hais and Macek (1960) was used for the total free amino acids determinations.

The total Zn, Mn and Fe in leaves were determined spectormetrically using Phillips PU 9100 Atomic spectrometer according to Doll and Luces (1973).

Transpiration rate was determined for plants in the field, ten days from zinc spraying using a portable steady state poromoter (LI-COR, Model LI 1600).

At the end of experiment, i.e. 115 days from seed sowing, the plants had been harvested, as the yield of dry seeds was calculated as Kg/fed. A random sample of dry seeds were under taken from each treatment to determine total N as it was utilized in calculating total proteins (multiplying total nitrogen × 6.25), fats and soluble sugars (Dubois *et al* 1956). All data were subjected to statistical analysis according to the procedures(ANOVA) reported by Snedecor and Cohran(1980). Treatments were compared using Duncan's Multiple range test (Duncan,1955).

RESULTS AND DISCUSSION

1- Effect of gibberellin and zinc sulphate spraying on water relations.

1.1. Free and bound water:

Free and bound water in plant cell affect plant resistance to the unfavourable conditions specially drought. Besides, free water content is the most important fraction as it aids in enhancing the physiological and chemical processes in plant cells. Thus, it was necessary to determine these water relation parameters in relation to the applied treatments.

Gibberellin at all tested concentrations linearly increased free water percentage but reduced bound water (Table 1). The highest free water content being obtained due to the highest applied gibberellin concentration that caused the least value of bound water.

Similarly, gibberellin was noticed long time ago by Chirilei *et al.* (1964) and Midan (1978) to increase free water and to reduce bound water in plant cell .

Besides, Zinc spraying increased bound water, as significances were noticed due to both levels, i.e., 100 and 200 ppm, (Table 1). Zinc spraying have a negative effect on free water percentage, as

Table (1): The effect of gibberellin and zinc sulphate spraying, along with their interactions,on some water relations in snap bean leaves.

Zn SO₄ ppm / GA3 ppm	0	100	200	means	0	100	200	means
	2004 season				2005 season			
1- Free water (g free water/100g leaves F.wt.)								
0	90.85^{b}	91.12^{c}	90.88^{b}	90.95^{c}	91.45^{b}	90.22^{c}	89.96^{c}	90.54^{c}
20	91.10^{ab}	90.98^{d}	90.95^{b}	91.01^{b}	91.67^{b}	90.64^{c}	90.42^{c}	90.91^{c}
40	92.86^{a}	91.65^{b}	91.10^{b}	9187^{a}	92.86^{a}	91.75^{b}	90.01^{c}	91.37^{b}
60	92.96^{a}	92.26^{a}	91.86^{a}	92.36^{a}	92.97^{a}	92.76^{a}	91.34^{b}	92.36^{a}
Means	91.94^{a}	91.50^{a}	91.20^{a}		92.24^{a}	91.22^{a}	90.43^{b}	
2- Bound water (g bound water/100g leaves F.wt.)								
0	1.89^{a}	1.88^{a}	1.92^{a}	1.90^{a}	1.86^{a}	1.92^{a}	1.95^{a}	1.91^{a}
20	1.42^{f}	1.70^{bc}	1.75^{b}	1.62^{b}	1.45^{b}	1.75^{ab}	1.80^{a}	1.67^{b}
40	1.33^{fg}	1.55^{de}	1.60^{cd}	1.49^{c}	1.36^{c}	1.60^{b}	1.71^{a}	1.56^{b}
60	1.25^{g}	1.40^{f}	1.45^{def}	1.37^{d}	1.22^{d}	1.38^{c}	1.42^{b}	1.34^{c}
Means	1.47^{b}	1.63^{a}	1.68^{a}		1.47^{b}	1.66^{a}	1.72^{a}	
3- Coefficient hydric (%)								
0	10.62^{c}	10.85^{bc}	11.10^{b}	10.86^{b}	11.16^{b}	11.86^{ab}	12.76^{a}	11.93^{b}
20	11.12^{b}	11.76^{ab}	12.45^{a}	11.78^{a}	11.56^{ab}	12.36^{a}	12.85^{a}	12.26^{ab}
40	11.88^{ab}	11.89^{ab}	12.60^{a}	12.12^{a}	12.45^{a}	12.85^{a}	12.87^{a}	12.72^{a}
60	12.26^{a}	12.46^{a}	12.96^{a}	12.56^{a}	12.44^{a}	13.06^{a}	13.17^{a}	12.89^{a}
Means	11.47^{b}	11.74^{b}	12.28^{a}		11.91^{b}	12.53^{a}	12.91^{a}	
4- Transpiraion rate (mg / 10 cm²/S)								
0	6.18^{i}	6.70^{h}	6.88^{g}	6.59^{d}	6.27^{c}	6.50^{c}	6.62^{c}	6.46^{c}
20	6.72^{h}	7.12^{f}	7.50^{e}	7.11^{c}	7.45^{b}	8.06^{b}	7.84^{b}	7.78^{b}
40	7.59^{e}	7.78^{d}	8.80^{c}	8.06^{b}	7.98^{b}	8.20^{ab}	8.65^{a}	8.28^{a}
60	8.76^{c}	8.94^{b}	9.16^{a}	8.95^{a}	8.18^{ab}	8.18^{ab}	8.86^{a}	8.41^{a}
Means	7.31^{c}	7.64^{b}	8.09^{a}		7.47^{b}	7.74^{ab}	7.99^{a}	

Means followed by the same alphabetical letters are not statistically different at 5% level of significance .

the highest sprayed concentration gave the lowest free water content, although significances were noticed in the second season only. Similar reduction in free water content was noticed by Chaoui *et al.* (1995) to follow Zn SO_4 application on snap bean.

Similar results were noticed by Midan (1978) who found an increase in the viscosity of plant cell protoplasm due to increasing bound water content of snap bean leaves.

An interactive effect of gibberellin and Zinc treatments was also noticed, as plants received no gibberellin × that received Zn SO_4 at 200 ppm exhibited the highest bound water content in both seasons. However, GA_3 at 60 ppm × Zn SO_4 at zero showed the least value of bound water. In addition, both concentrations of 40 and 60 ppm GA_3 were interacted with zero Zn SO_4 to attain the highest free water content in plant leaves.

1.2. Coefficient hydric:

Coefficient hydric represent the proportion of total water content (free and bound) in leaves to leaves dry weight. Thus, increasing coefficient hydric means a reduction in dry weight of leaves or increasing in total water content.

Gibberellin at all tested concentrations favourably affected coefficient hydric (Table 1), as significances were only noticed in the first season due to all tested concentrations and in the second one due to 40 and 60 ppm only. Gibberellin was previously noted to increase free water content, thus it is reasonable to favour coefficient hydric.

Zinc sulphate spraying at all tested levels exerted unsignificant increases in coefficient hydric in both seasons (Table 1). Zinc increased leaves dry weight in a high proportion comparing to increasing total water, thereby, it could increase coefficient hydric. In conformity with obtained results, Midan (1978) obtained neglible increases in coefficient hydric due to $ZnSO_4$ spraying on snap bean.

As for the interaction of gibberellin × Zinc, results indicate that GA_3 at 60 ppm × $ZnSO_4$ at 200 ppm significantly achieved the highest coefficient hydric value. Besides, plants received neither GA_3 nor $ZnSO_4$ spraying showed the least values.

1.3. Transpiration rate:

Transpiration is an important physiological process in plant as it related to nutrients absorption and maintaining plant temperature at normal degree, thus it was important to study the relation of applied treatments to transpiration rate.

Gibberellin seems to affect transpiration rate in a positive manner (Table 1). The highest the gibberellin concentration (60 ppm) caused the highest transpiration rate. Results could be easily explained as gibberellin increased free water, the most easily water form to be lost by any way. These results agree with these reported by Richard (1996).

As for zinc effect, it was noticed that transpiration rate was significantly reduced in the treated plants (Table 1), as the concentration of 200 ppm gave the least value. Results could be explained as zinc improved the colloidal status in plant cell, consequently it could reduce water loss via transpiration. Also, zinc nutrient could act as a stomatal aperture and in accordingly to reduce the loss of water through transpiration. Helony *et al.* (1993) suggested similar interpretation. Furthermore, reducing water loss may be a result of Zn effect on biochemical reaction that influences turgidity the guard cells, this was reviewed by Levitt (1980). Similar results were obtained by Annanurova *et al.* (1992) working on tomato.

As for the interaction effect (Table 1), plants received no zinc spraying and gibberellin at 60 ppm exhibited the highest transpiration rate, while, no GA_3 spraying × $ZnSO_4$ at 200 ppm showed the lowest value.

2- Effect of gibberellin and zinc sulphate spraying on some biochemical constituents in snap bean plant leaves.

2.1. Photosynthetic pigments:

With slight exceptions, all determined photosynthetic pigment fractions mutually increased with increasing gibberellin concentrations, although the more pronounced increase was generally noticed due to 60 ppm (Fig. 1).

Results may be interpreted as GA_3 activates the synthesis of chlorophyll. Midan (1978) working on snap bean drawn similar conclusion. Additionally, GA_3 may increase chlorophyll content through enhancing the accumulation of fresh and dry matter in treated plants (Poskuta *et al.*, 1975).

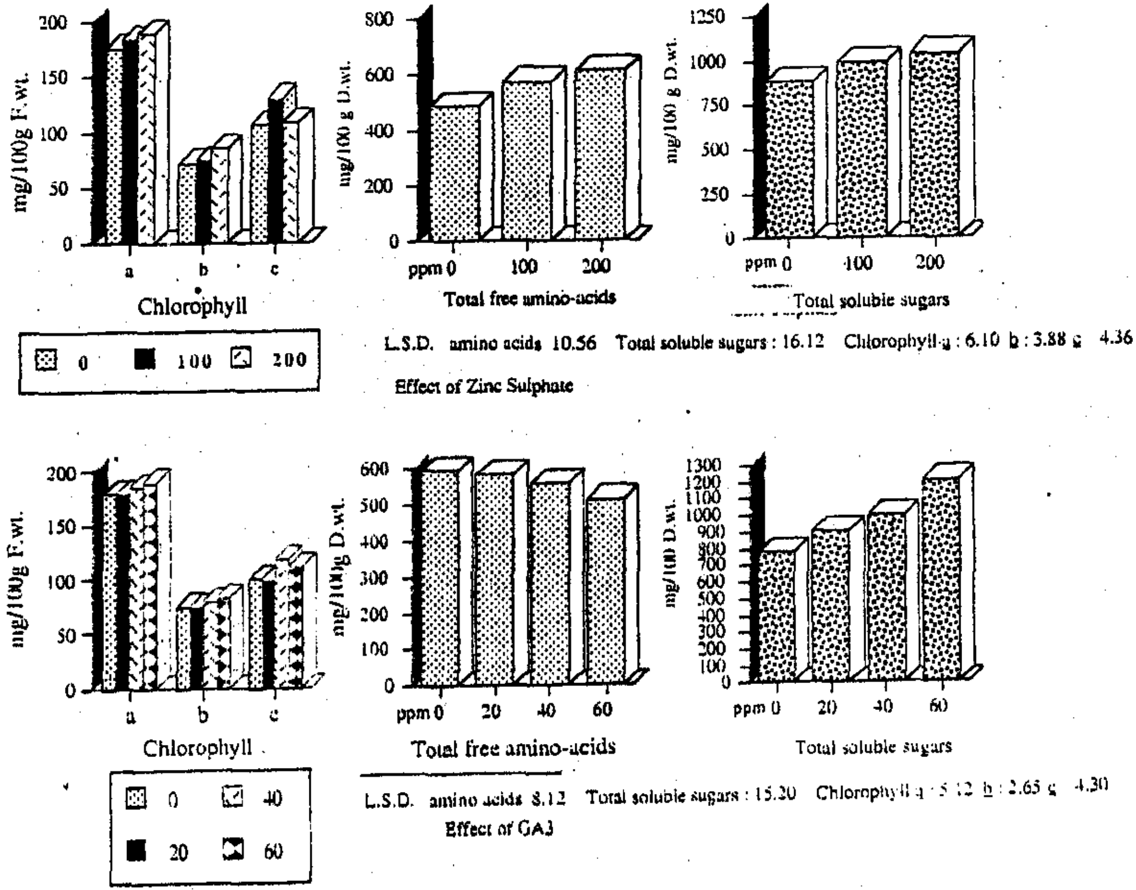


Fig. (1) : The effect of gibberellin and Zinc sulphate sprayings on some biochemical componants in snap bean leaves (combined data of 2004 and 2005).

Further interpretation could be done, as GA_3 retard chlorophyll loss in leaves (Richard, 1996) .As regard to zinc, it was found that both used levels, with some exceptions, increased all photosynthetic pigment fractions in leaves (Fig. 1).

Zinc may increase chlorophyll content via increasing nitrogen and Mg uptake, that participate in chlorophyll synthesis. This conclusion was previously suggested by Midan *et al.* (1982).

Zinc was also mentioned by Ramadan (1997) to activate chlorophyll synthesis. Similar increases in chlorophyll content was also recognized by Annanurova (1992) to follow zinc sulphate sprayings on bean plants. As for the interactive effect of GA_3 and Zinc sulphate, it was found that GA_3 at 60 ppm × $ZnSO_4$ at 100 ppm gave the highest chlorophyll a content. Besides, plants received GA_3 at 60 ppm and $ZnSO_4$ at 200 ppm showed superior chlorophyll b and carotenoids value. GA_3 at 20 ppm × zero $ZnSO_4$ exhibited the least record of chlorophyll a, b and carotenoids.

2.2. Total free amino acids:

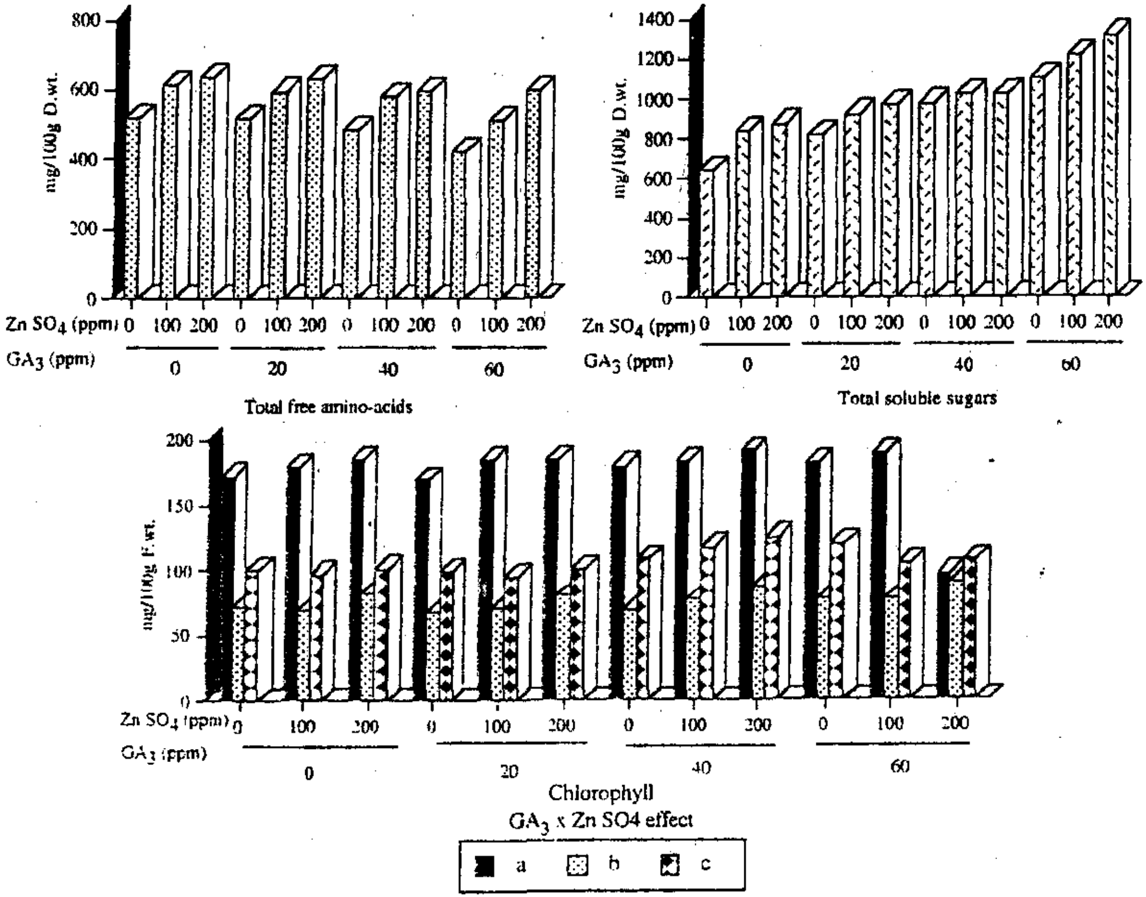
It is evident from data in (Fig. 1) that GA_3 at all tested concentrations reduced total free amino acids in plant leaves. Gibberellin stimulates protein synthesis utilizing free aminoacids, as units, thus its reduction became expected. Obtained results go along with those of Midan (1978) on beans.

As for Zinc effect on the total free aminoacids, it was noticed to be linearly increased in treated plants (Fig. 1). Similarly, Zinc was also mentioned to stimulate amino acids synthesis (Cakmak *et al.*, 1989).

The interactive effect of GA_3 and $ZnSO_4$ spraying on amino acids content in treated plants was also noticed (Fig. 2). Plants received no gibberellin in addition to $ZnSO_4$ at 200 ppm achieved the highest total free amino acids. The least values being obtained due to GA_3 at 60 ppm and no zinc sulphate spraying. It could be concluded that the presence of zinc in the combination is responsible for increasing amino acids and vise versa is true in the presence of GA_3.

2.3. Total soluble sugars:

Significant increases in total soluble sugars in plant leaves were associated with GA_3 spraying at all tested concentrations (Fig. 1). Gibberellin was also reported by Richard (1996) to stimulate photosynthesis and photosynthesates accumulation.



L.S.D. amino acids 15.36 Total soluble sugars : 17.31 Chlorophyll a : 7.18 b : 4.20 c 8.45

Fig. (2) : The intractive effect of gibberllin and Zinc sulphate on some by biochemical components in snap bean leaves (combined data of 2004 and 2005)

As for sugars response to zinc application, it could be concluded that zinc sulphate spraying flourished total soluble sugars in treated plants (Fig. 1). Zinc was reported by Midan (1978) to enhance photosynthesis, thereby it could increase sugars content. Obtained results are coincide with those of Midan *et al.* (1982) on snap bean.

Gibberellin at 60 ppm × $ZnSO_4$ at 200 ppm exhibited the highest total sugars content in treated plants. The lowest content of total soluble sugars was noticed in plants received neither GA_3 nor $ZnSO_4$.

3- Effect of gibberellin and zinc sulphate spraying on Mn, Zn and Fe content in plant leaves.

It is evident that, with slight exceptions, GA_3 spraying at all tested concentrations negatively affected Mn contents in plant leaves (Fig. 3). In addition, Zn and Fe contents showed a positive response.

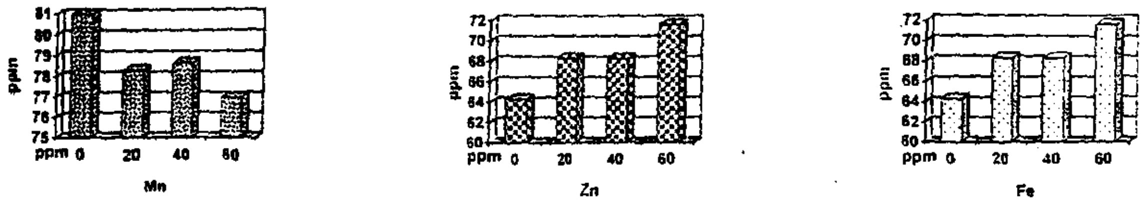
The reduced amount of Mn in plant leaves may be a result of the dilution effect of increasing growth. Reducing Mn content in plant leaves was also suggested by Midan *et al* (1982) to be a result of the dilution effect.

Similar reduction in Mn content was also noticed by Omar *et al.* (1988) to follow increasingGA_3 concentration. They added, with accordance with obtained results, that GA_3 application increased Zn and Fe concentrations in treated plants. Results could be explained as gibberellin improved water supplying to plants, thereby it increased Zn and Fe absorption.

Zinc spraying, generally, led to increase Mn, Zn and Fe contents in plant leaves (Table 3). Zinc was previously mentioned by Boaretto *et al* (1998) and Mohamed and Fozea (1999) to promote the absorption of Mn, Zn and Fe by snap bean plants.

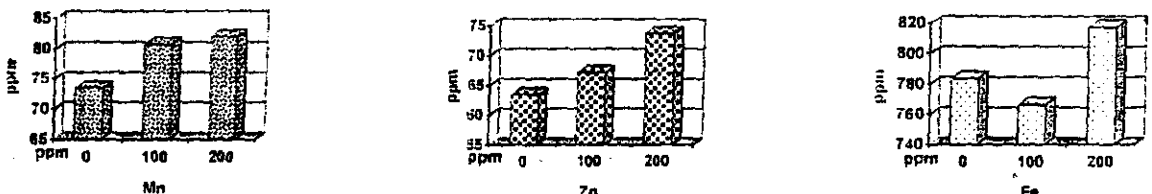
Results may be explained due to somehow synergitic or antagonism effect of applied Zn in which such nutrients may encourage or inhibit the absorption and translocation of others in plant. Khalil *et al.* (1988) working on onion drawn similar conclusion.

The interaction of GA_3 and Zn caused also a noticeable variation in Mn, Zn and Fe content in treated plants. Plants received no GA_3 or GA_3 at 40 ppm with $ZnSO_4$ at 200 ppm attained the highest Mn content in plant leaves (Fig. 3). The lowest value of these micronutrients being obtained in plants received no Zinc application



L .S. D Mn:2.15 Zn:3.13 Fe:15.20

Effect Of GA_3



L .S. D Mn:3.22 Zn:3.28 Fe:20.35

Effect Of zinc sulphate

Fig (3) : The effect of gibberellin and Zinc sulphat spraying on some micronutrients concentration in snap bean leaves (combined data of 2004 and 2005).

with GA_3 at 60 ppm. Besides, Zinc sulphate spraying at 200 ppm was interacted with GA_3 at 60 ppm to give the highest Zn and Fe contents.

4- Effect of gibberellin and Zinc sulphate sprayings on some yield components.

Green pods and dry seeds, both as g/plant, and number of pods/plant were considered in this study as yield components.

Comparing to control, gibberellin at all tested concentrations significantly increased all of the studied. yield component parameters (Table 2). Results were insistently observed in both seasons. In this connection, the higher gibberellin concentration, the larger values of yield components.

Gibberellin stimulates metabolic activities within plant, thereby it could also enhance the parameters of yield components. In conformity with this suggestion, Kalloo (1988) mentioned that GA_3 could affect number of flowers and improved fruit set factors that well known to affect yield components.

Besides, Gibberellin increased plant height (Lalloo, 1986) and number of internodes (Richard, 1996), thereby it could increase number of flowers and pods.

Zinc sulphate spraying, at both tested concentrations, caused significant increases in all studied yield components in both seasons (Table 2). In this connection, the highest sprayed zinc level approved, with slight exceptions to be more effective.

Zinc have a key role in plant metabolism and functions as an activator of certain physiological processes such as production of auxin, protein and carbohydrates, thus its favourable effect on some yield components is quite expected. Similar conclusion was also suggested by Richard (1996).

As for the interaction, data in (Table 3) show that GA_3 at 60 ppm × $ZnSO_4$ at 200 ppm gave the highest values of dry seeds weight/plant. In addition, superior green pods weight and number of pods/plant were noticed in plants received GA_3 at 60 ppm and zinc sulphate at 200 ppm at the first season and 100 ppm at the second one.

5- Effect of gibberellin and zinc sulphate spraying on the early and total green pods yield as well as on dry seeds yield.

Gibberellin spraying at all tested concentrations exerted, in general, significant increases in total green pods (ton/fed.) and dry

Table (2): The effect of gibberellin and zinc sulphate spraying, along with their interactions, on some yield components in snap beans plants.

$ZnSO_4$ ppm / GA3 ppm	0	100	200	means	0	100	200	means
	2004 season				2005 season			
	Dry seeds weight (g/plant)							
0	14.50^{e}	15.70^{d}	17.50^{c}	15.90^{d}	15.7[illegible]	15.92^{fg}	15.70^{g}	15.77^{d}
20	16.30^{d}	17.70^{c}	17.94^{c}	17.31^{c}	16.5[illegible]^{f}	17.68^{e}	17.90^{e}	17.37^{c}
40	19.70^{b}	19.98^{b}	20.02^{b}	19.90^{b}	20.2[illegible]	19.92^{d}	20.70^{c}	20.29^{b}
60	19.92^{a}	20.30^{b}	22.72^{a}	20.98^{a}	20.7[illegible]^{c}	22.44^{b}	23.72^{a}	22.29^{a}
Means	17.61^{c}	18.42^{b}	19.55^{a}		18.3[illegible]	18.99^{b}	19.51^{a}	
	Green pods weight (g/plant)							
0	65.98^{l}	71.42^{k}	75.45^{i}	70.95^{d}	66.75^{j}	76.65^{f}	73.17^{h}	72.19^{d}
20	72.92^{j}	76.65^{h}	80.46^{f}	76.69^{c}	69.57^{i}	82.64^{b}	74.25^{d}	75.49^{c}
40	78.18^{g}	85.14^{d}	87.65^{b}	83.66^{b}	73.17^{h}	81.66^{c}	77.96^{e}	77.60^{b}
60	81.56^{e}	86.57^{c}	91.46^{a}	86.53^{a}	78.50^{e}	84.05^{a}	80.47^{d}	81.01^{a}
Means	74.67^{c}	79.95^{b}	83.76^{a}		72.00^{c}	81.25^{b}	76.46^{a}	
	Number of pods/plant							
0	22.28^{l}	26.05^{k}	28.82^{i}	25.92^{d}	22.24^{f}	28.32^{d}	28.11^{d}	26.22^{d}
20	26.47^{j}	32.26^{f}	32.47^{e}	30.40^{c}	24.66^{e}	30.85^{c}	28.25^{d}	27.92^{c}
40	30.26^{h}	32.85^{d}	34.26^{c}	32.46^{b}	28.24^{d}	32.48^{b}	30.66^{c}	30.46^{b}
60	30.85^{g}	34.48^{b}	34.80^{a}	33.38^{a}	32.87^{b}	34.20^{a}	32.70^{b}	33.26^{a}
Means	27.47^{c}	31.56^{b}	32.59^{a}		27.00^{c}	31.46^{a}	29.93^{b}	

Means followed by the same alphabetical letters are not statistically different at 5% level of significance.

Table (3): The effect of gibberellin and zinc sulphate spraying, along with their interactions, on green pods and dry seeds yield of snap beans .

Zn SO_4 ppm / GA3 ppm	0	100	200	means	0	100	200	means
	2004 season				2005 season			
	Total green pods yield (Ton/fed.)							
0	5.35^{k}	5.36^{k}	5.48^{j}	5.40^{d}	5.59^{h}	5.38^{i}	6.01^{e}	5.66^{d}
20	5.68^{i}	5.86^{h}	6.67^{c}	6.07^{c}	5.86^{g}	5.97^{ef}	5.88^{g}	5.90^{c}
40	6.01^{f}	5.98^{g}	6.74^{b}	6.24^{b}	5.95^{f}	6.28^{c}	6.36^{b}	6.20^{b}
60	6.22^{e}	6.47^{d}	6.87^{a}	6.52^{a}	6.20^{d}	6.39^{b}	6.88^{a}	6.49^{a}
Means	5.82^{c}	5.92^{b}	6.44^{a}		5.90^{c}	6.01^{b}	6. 28^{a}	
	Early green pods yield (Ton/fed.)							
0	3.18^{e}	3.27^{b}	3.55^{a}	3.33^{a}	3.28^{h}	3.76^{a}	3.82^{a}	3.62^{a}
20	2.26^{k}	3.05^{e}	3.12^{d}	2.81^{b}	3.07^{d}	3.15^{cd}	3.26^{bc}	3.16^{b}
40	2.38^{i}	2.46^{h}	2.88^{f}	2.57^{c}	2.76^{fg}	2.85^{ef}	3.10^{d}	2.90^{c}
60	2.20^{l}	2.35^{j}	2.62^{g}	2.39^{d}	2.49^{h}	2.64^{g}	2.93^{e}	2.69^{d}
Means	2.50^{c}	2.78^{b}	3.04^{a}		2.90^{c}	3.10^{b}	3.28^{a}	
	Dry seeds yield (kg/fed.)							
0	650^{h}	680^{g}	710^{f}	680.00^{c}	660^{h}	670^{g}	716^{f}	682.00^{d}
20	720^{e}	752^{d}	717^{ef}	729.67^{b}	750^{e}	752de	758^{d}	753.33^{c}
40	762^{c}	784^{b}	795^{a}	780.33^{a}	768^{c}	768^{c}	766^{c}	766.67^{b}
60	760^{c}	785^{b}	794^{a}	779.67^{a}	778^{b}	784^{b}	793^{a}	784.00^{a}
Means	723^{b}	750.25^{a}	754^{a}		738.50^{b}	743.50^{b}	758.25^{a}	

Means followed by the same alphabetical letters are not statistically different at 5% level of significance .

seeds (kg/fed) yield (Table 3). In this connection, gibberellin application significantly reduced the early green pods yield in both seasons.

Gibberellin improved number of flowers and fruit set (Richard, 1996), thereby it could increase green pods and dry seeds yield.

The reduction of early green pods yield that noticed to follow GA_3 spraying may be a result of increasing vegetative growth that led to retard flowering.

As fore zinc effect on snap bean yields, it is evident that both early and total green pods yield positively responded to zinc sulphate spraying at both levels in both seasons, although increases did not reach the level of significance. Besides, increases in dry seeds yield were noticed to follow $ZnSO_4$ spraying, but significances were noticed only due to the highest level.

Zinc may exerted its favourable effect via its role in auxin, protein, carbohydrates and some enzymes synthesis (Midan *et al.* 1981).

Similar increases in green pods and dry seeds yield were also reported by El-Shamaa (1998) and Mohamed and Fozea (1999) on beans.

The positive response of early yield to applied zinc may be explained as treatments accelerated flowering (Ramadan, 1997 on peas). Obtained results agree with those of Hewedy *et al*. (2003) on snap beans.

As for the interaction, plants received GA_3 at 60 ppm × $ZnSO_4$ at 200 ppm attained superiority in total green pods yield (Table 4). Besides, plants received neither GA_3 nor $ZnSO_4$ spraying in the first season and no GA_3 spraying with $ZnSO_4$ at 100 ppm in the second one showed the least values of total green pods yield. However, no gibberellin spraying × $ZnSO_4$ at 200 ppm caused superior early green pods yield in both seasons. The least values, in this connection, were noticed in plants received GA_3 at 60 ppm and no zinc spraying.

Dry seeds yield seems also to respond to the interaction, as GA_3 at 40 ppm at the first season and 60 at the second one was interacted with $ZnSO_4$ at 200 ppm to give superior records. Also, plants received neither GA_3 spraying nor $ZnSO_4$ showed the least values.

Table (4): The effect of gibberellin and zinc sulphate spraying, along with their interactions, on some biochemical constituents of dry seeds in snap bean leaves.

ZnSO$_4$ ppm / GA3 Ppm	0			100			200			Means		
	Protein (%)	Fats (%)	Soluble sugars (%)	Protein (%)	Fats (%)	Soluble sugars (%)	Protein (%)	Fats (%)	Soluble sugars (%)	Protein (%)	Fats (%)	Soluble sugars (%)
2004 season												
0	22.16^{b}	1.95^{a}	1.18^{bc}	22.01^{b}	1.98^{a}	1.99^{a}	22.58^{b}	1.89^{ab}	1.99^{a}	22.25^{b}	1.94^{a}	1.72^{b}
20	22.85^{ab}	1.86^{ab}	1.26^{c}	22.96^{ab}	1.76^{b}	2.10^{a}	22.47^{b}	1.78^{b}	1.97^{a}	22.76^{ab}	1.80^{b}	1.78^{ab}
40	23.18^{ab}	1.75^{b}	1.66^{b}	23.98^{a}	1.85^{ab}	1.98^{a}	23.18^{a}	1.99^{a}	2.01^{a}	23.54^{a}	1.86^{ab}	1.88^{a}
60	23.98^{a}	1.75^{b}	1.75^{ab}	23.84^{a}	1.88^{ab}	2.08^{a}	23.96^{a}	1.98^{a}	2.18^{a}	23.93^{a}	1.87^{ab}	2.00^{a}
Means	23.04^{a}	1.83^{a}	1.46^{b}	23.20^{a}	1.87^{ab}	2.04^{a}	23.05^{a}	1.91^{a}	2.04^{a}			
2005 season												
0	21.92^{b}	1.83^{a}	1.25^{b}	21.38^{b}	1.92^{a}	1.40^{e}	22.65^{a}	1.98^{a}	1.66^{cd}	21.98^{c}	1.91^{a}	1.44^{c}
20	22.16^{a}	1.85^{a}	1.18^{b}	23.42^{a}	1.85^{a}	1.76^{bc}	22.78^{a}	1.86^{a}	1.85^{ab}	22.79^{b}	1.85^{a}	1.60^{b}
40	21.95^{b}	1.72^{b}	1.46^{a}	23.86^{a}	1.80^{b}	1.88^{ab}	23.95^{a}	1.85^{a}	1.96^{a}	23.25^{a}	1.79^{b}	1.77^{a}
60	23.32^{a}	1.74^{b}	1.55^{de}	22.48^{a}	1.76^{b}	2.01^{a}	23.93^{a}	1.82^{a}	1.98^{a}	23.24^{a}	1.77^{b}	1.85^{a}
Means	22.34^{b}	1.79^{a}	1.36^{b}	22.79^{b}	1.84^{a}	1.76^{a}	23.33^{a}	1.88^{a}	1.86^{a}			

Means followed by the same alphabetical letters are not statistically different at 5% level of significance .

6- Effect of gibberellin and zinc sulphate spraying on protein, fats and soluble sugars in dry seeds.

An increase in protein and soluble sugars in dry seeds were noticed to follow gibberellin spraying, although significances were only noticed due to 40 and 60 ppm. (Table 4). Besides, fats content showed negative response to all applied GA_3 concentrations, although significances were only noticed due to the lowest applied concentration in the first season and to 40 and 60 ppm in the second one.

Gibberellin is well-known to activate amino acids synthesis (Richard, 1996), the base unit of protein formation, thus its favourable effect on protein content became expected.

Furthermore, gibberellin stimulates photosynthesis (Richard, 1996), thereby it could increase sugars accumulation in different plants. Obtained results agree with those of El-Sayed (1991) who found an increase in sugars content of dry seeds in snap bean due to GA_3 spraying.

The negative response of fats to GA_3 may be explained as a result of increasing lipases enzymes. Farghal and Tantawy (1990), working on cucumber, drawn similar conclusion.

Zinc sulphate spraying caused unsignificant increases in protein and fat contents in the first season and fats content only in the second one (Table 4). Besides, Zinc treatment achieved significant increases in total soluble sugars.

Zinc was frequently reported to encourage protein (Helal, 1995) and fats (Kalloo, 1988) synthesis and to promote photosynthesis and sugars accumulation (Ramadan, 1997), thus its favourable effect on these chemical compounds became logic.

Plants sprayed with GA_3 at 60 ppm companied with no zinc spraying showed the highest protein value in dry seeds, indicating that GA_3 was more effective on protein synthesis. However, GA_3 at 40 ppm and 60 ppm with $ZnSO_4$ at 100 ppm and 200 ppm achieved superior record in fats content. Besides, GA_3 at 60 ppm × $ZnSO_4$ at 200 ppm caused the highest soluble sugars content.

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إستجابة نباتات الفاصوليا للرش الورقي بالجبريلين و الزنك

نميت نباتات الفاصوليا لدراسة تأثير الرش بالجبريلين و كبريتات الزنك ببعض التركيزات على سلوك النباتات.

أدى الرش بالجبريلين بجميع تركيزاته (٢٠، ٤٠ و ٦٠ جزء في المليون) إلى زيادة الماء الحر في الأوراق و كذلك النتح و المعامل الرطوبي ولكن أدى إلى نقص الماء المرتبط وأدى إلى نقص معدل النتح و المعامل الرطوبي.

كانت هناك استجابة إيجابية للصبغات الكلوروفيللية و السكريات الذائبة الكلية للجبريلين و الزنك و التي أدت أيضا إلى زيادة الأحماض الأمينية الكلية.

تم أيضا دراسة تأثير المعاملات المستخدمة على محتوى الأوراق من المنجنيز، الزنك و الحديد وكذلك على مكونات المحصول.

أدى الرش بالجبريلين و الزنك بوجه عام إلى زيادة المحصول الكلي للقرون الخضراء، ولكن أدى الجبريلين إلى نقص المحصول المبكر الذي زاد بالمعاملة بالزنك.

تم دراسة محتوى البذور من البروتين و الدهون و السكريات الكلية وعلاقتها بالمعاملات تحت الدراسة.

تم تسجيل العديد من حالات التفاعل بين تأثير الجبريلين وتأثير الزنك.