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Response of Snap Bean Plants to Mineral Fertilizers and Humic Acid Application

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Abstract: Two field experiments were carried out in the experimental station of the National Research Centre at EL-Nubaria, EL-Behira Governorate, Northern Egypt, to study the effect of 12 treatments, which were the combinations of three levels of mineral fertilizers application (100%, 65% and 35% of the recommended dose) with four levels of humic acid spraying (0, 1, 2 and 3 g humic acid/l.) on snap bean plant growth, pod yield and quality. Results showed that the vegetative growth of snap bean plants (plant height, number of leaves and branches as well as fresh and dry weight of whole plant), green pod yields and its quality (pod length, weight, pod content of chlorophyll, fiber, total protein as well as N, P, K content) were improved by increasing the levels of mineral fertilizers application (100%). Results also clear that the vegetative growth of snap bean plants, green pod yields and its quality were improved by increasing the levels of humic acid spraying.

Key words: Snap Bean, mineral fertilizers, humic acid, growth and yield.

INTRODUCTION

Mineral fertilizers application is essential for plant growth, development and yield productivity of snap bean plants. Nitrogen is essential for synthesis of chlorophyll, enzymes and proteins. Phosphorus is essential for root growth, phospho-proteins, phospho-lipids and ATP, ADP formation. Potassium plays an important role on promotion of enzymes activity and enhancing the translocation of assimilates and protein synthesis[1]. Many investigators reported that increasing NPK levels application improved the plant growth, yield and green pod quality of snap bean[2-5].

Humic acid is a commercial product contains many elements which improve the plant growth. Many investigators reported that spraying snap bean plants with humic acid improved plant growth and productivity[6-8]. Moreover, Kaya *et al.,*[9] reported that spraying snap bean plants at three to six leaf stage significantly increased plant growth, yield and yield components of snap bean (number of pods per plant, pods weight and protein content).

MATERIAL AND METHODS

A field experiment was carried out at the experimental station of National Research Centre, at EL-Nubaria, EL-Behira Governorate, Northern Egypt, during two successive summer seasons of 2008 and 2009 to study the effect of the interaction between 3-rates of mineral fertilizers application, NPK (100%, 65% and 35% of the recommended dose of NPK application) and 4-rates of humic acid (0, 1, 2 and 3 g/l.) application on growth, yield and pods quality of snap bean (*Phaseolus vulgaris* L.) cv. Paulesta.

Seeds of bean were sown on the first weak of April in 2008 and 2009, respectively. Seeds were sown on two sides of ridge, ridge was 80 cm width and 4 m length and 10 cm apart. Each plot included 4 ridges and the plot area was 12.8 m^2. NPK fertilizer were applied with fertigation three times in week. Regarding foliar application bean plants were foliar sprayed 30 and 45 days after sowing.

The soil of the experimental field was sandy soil and the physical and chemical analyses were presented in Table (A). The normal agricultural practices required for bean production were applied as commonly followed in the farm.

Data Recorded: Vegetative growth: A random sample of 5 plants from each plot was taken at 45 days after sowing and the following vegetative characters were recorded: plant height, number of leaves and number of branches as well as fresh and dry weight of whole plant.

Pods yield: At harvest stage the mature pods of bean for each experimental plot were collected along the harvesting season and the total pods yield was recorded as ton/fed.

Pods quality: Random sample of 50 pods from each plot was taken and the physical properties (average pod weight and pod length) were recorded.

Chemical constituents: Pod content of N, P, K, total protein, chlorophyll and fiber content were

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recorded in green bean pods. N, P and K content were determine according to the methods mentioned by Black[10], Troug and Mayer[11] and Brown and Lilleland [12], respectively. The protein percentages in pods were accounted by multiplying nitrogen content by 6.25. Moreover, Total chlorophyll content in leaves was measured as SPAD units using Monitor chlorophyll meter (SPAD 501). Fibers percentage in pods was determined according to Rai and Mudgal[13].

The treatments were arranged in a split plot design with four replicates where, NPK fertilizers rates were arranged in main plots, while humic acid foliar application treatments were distributed in the sub plots. The obtained data were statistically analyzed according to the method described by Gomez and Gomez[14].

RESULTS AND DISCUSSIONS

1: Vegetative Growth:

1.1. Effect of NPK-fertilizers: Data in Table (1) show the effect of NPK fertilizers application on vegetative growth of snap bean plants, i.e., plant height, number of leaves and branches as well as fresh and dry weight of whole plant. Results clear that all vegetative growth parameters were significantly affected by application of mineral fertilizers except for number of branches in both growing season, which variances failed to reach the level of significance. Using NPK-fertilizers at 100% of the recommended dose gave the highest vegetative growth as compared with adding 65% or 35% of the recommended dose. This result was true in both growing seasons.

This increment in vegetative growth of bean plants by increasing the level of NPK-fertilizers from 53% up to 100% may be due to the role of NPK on plant growth development i.e. Nitrogen is essential for synthesis of chlorophyll, enzymes and proteins. Phosphorus is essential for root growth, phospho-proteins, phospho-lipids and ATP, ADP formation. Potassium plays an important role on promotion of enzymes activity and enhancing the translocation of assimilates and protein synthesis. This result are harmony with those reported by Singer *et al.,*[2], Saxena *et al.,*[3], Abdel-Mawgoud *et al.,*[4], Souza *et al.,*[5], they reported that the vegetative growth of snap bean plants was improved by increasing the levels of NPK-fertilizers application.

1.2. Effect of Humic Acid Application: Data in Table (2) show the effect of humic acid spraying on vegetative growth of snap bean plants. Results clear that all the vegetative growth parameters were significantly affected by spraying with humic acid except for number of branches per plant which variances failed to reach the level of significance. The highest values of vegetative growth were recorded with spraying snap bean plants by humic acid at 2 g/l. followed by those received 3 or 1 g/l. However, the lowest values were recorded without spraying by humic acid. These results were true in both growing seasons.

This increment in vegetative growth of bean plants by spraying with humic acid may be due to that Humic acid contains many elements which improve the plant growth. These results are in harmony with those reported by[6-8]. Moreover, Kaya *et* al.,[9] reported that spraying snap bean plants at three to six leaf stage significantly increased plant growth, yield and yield components of bean (number of pods per plant, pods weight and protein content).

1.3. Effect of the Interaction Treatments Between NPK-fertilizers and Humic Acid Application: Data in Table (3) show that the vegetative growth parameters of snap bean plants were significantly affected by the interaction treatments between mineral fertilizers and humic acid application. Results also clear that the highest values of vegetative growth parameters were recorded with plants received NPK-fertilizers at 100 % of the recommended dose with spraying by humic acid at 2g/l., followed by those received NPK-fertilizers at 65% and 35% of the recommended dose with spraying by humic acid at 2g/l. level. However, the lowest values were recorded with plants received the lowest level of mineral fertilizers (35% of the recommended dose) without humic acid spraying. The results were true in both growing seasons of study.

2: Green Pod Yield and its Quality:

2.1. Effect of NPK Fertilizers: Data in Table (4) show the effect of minerals fertilizers application on green pod yield and quality. Results clear that pods yield was significantly and gradually increased by increasing the level of mineral fertilizers application from 35%, 65% up to 100% of the recommended dose of NPK-fertilizers application. Green pods quality, i.e. pod length, weight, chlorophyll content, protein percentage as well as NPK content were significantly increased with increasing the level of NPK-fertilizers application. However, fiber content was increased with decreasing the level of minerals fertilizers application. These results were true in both growing seasons.

This increment in green pods yield and improving pod quality by increasing the level of minerals fertilizers application may be due to the role of mineral fertilizers on improving the vegetative growth of snap bean plants (Table, 1) which in turn affect on improving pods yield and its quality. These results are in harmony with those reported by Singer *et al.,* [2], Saxena *et al.,* [3], Abdel-Mawgoud *et al.,* [4], Souza *et al.,*[5].

Table A: Physical properties and chemical analysis of the experimental soil.

Physical properties	
Sand	90.08
Clay	9.26
Silt	0.66
Texture	Sandy
F.C. %	16.57
W. P. %	5.25
E. C. (ds/m)	1.7
PH	8.2
Chemical analysis	
Ca (Mg/L)	7.02
Mg (Mg/L)	0.527
Na (Mg/L)	0.982
K (Mg/L)	0.31
HCO_3 (Mg/L)	1.3
Cl (Mg/L)	0.566

Table 1: Effect of NPK fertilizers application on vegetative growth of snap bean plants in 2008 and 2009 seasons.

NPK	Plant height (cm)	No. of leaves / plant	No. of branches / plant	Fresh weight (g)	Dry weight (g)
First season					
100 %	42.50	16.75	5.25	65.03	7.51
65 %	39.25	13.25	4.75	53.57	6.56
35 %	36.25	15.13	5.13	52.45	6.58
LSD at 0.05	2.13	1.62	N. S.	8.24	0.46
Second season					
100 %	38.60	14.75	5.50	64.28	7.42
65 %	38.38	13.50	5.88	55.03	6.95
35 %	36.13	14.13	5.38	51.30	5.92
LSD at 0.05	0.92	0.77	N.S.	2.73	0.33

Table 2: Effect of humic acid spraying on vegetative growth of snap bean plants in 2008 and 2009 seasons.

Humic acid	Plant height (cm)	No. of leaves / plant	No. of branches / plant	Fresh weight (g)	Dry weight (g)
First season					
0	35.00	10.50	3.50	32.39	5.09
1 g/l.	38.00	14.50	5.50	51.63	6.40
2 g/l.	45.33	18.67	7.33	96.23	9.25
3 g/l.	39.00	16.50	3.83	47.82	6.81
LSD at 0.05	1.16	2.24	NS	3.67	1.37
Second season					
0	32.83	10.67	4.00	40.97	5.53
1 g/l.	36.13	13.50	5.17	49.08	6.48
2 g/l.	41.60	16.67	7.33	77.26	8.08
3 g/l.	40.23	15.67	5.83	60.17	6.96
LSD at 0.05	3.34	2.23	NS	11.15	1.27

Table 3: Effect of the interaction treatments between NPK-fertilizers and humic acid application on snap bean plants in 2008 and 2009 seasons.

NPK	Humic acid	Plant height (cm)	No. of leaves / plant	No. of branches / plant	Fresh weight (g / plant)	Dry weight (g / plant)
First season						
100 %	0	36.00	12.50	3.50	39.72	6.40
	1 g/l.	41.00	18.00	6.00	55.74	6.33
	2 g/l.	50.00	20.00	7.50	112.82	10.37
	3 g/l.	43.00	16.50	4.00	51.85	6.95
65 %	0	35.00	9.00	3.00	27.86	4.62
	1 g/l.	36.00	11.00	6.50	54.15	6.45
	2 g/l.	47.00	17.00	6.50	89.08	8.52
	3 g/l.	39.00	16.00	3.00	43.19	6.66
35 %	0	34.00	10.00	4.00	29.59	4.24
	1 g/l.	37.00	14.50	4.00	45.01	6.43
	2 g/l.	39.00	19.00	8.00	86.79	8.85
	3 g/l.	35.00	17.00	4.50	48.42	6.81
LSD at 0.05		7.18	3.35	NS	10.46	1.37
Second season						
100 %	0	33.50	12.00	4.00	45.12	6.13
	1 g/l.	37.40	15.00	5.00	53.73	6.77
	2 g/l.	42.30	17.00	7.00	92.15	9.35
	3 g/l.	41.20	15.00	6.00	66.13	7.42
65 %	0	34.00	10.00	4.50	36.42	5.32
	1 g/l.	35.00	12.00	5.50	44.35	6.72
	2 g/l.	43.00	16.00	7.50	76.12	8.14
	3 g/l.	41.50	16.00	6.00	63.22	7.63
35 %	0	31.00	10.00	3.50	41.37	5.14
	1 g/l.	36.00	13.50	5.00	49.17	5.95
	2 g/l.	39.50	17.00	7.50	63.52	6.74
	3 g/l.	38.00	16.00	5.50	51.15	5.83
LSD at 0.05		3.32	2.17	2.25	7.55	1.37

Table 4: Effect of NPK fertilizers application on green pod yield, quality, chlorophyll content, total protein, N, P and K content of snap bean plants in 2008 and 2009 seasons.

NPK	Pods yield (ton / fed.)	Pod length (cm)	Pod weight (g)	Fiber content (%)	Chlorophyll SPAD	Total protein (%)	N(%)	P(%)	K(%)
First season									
100 %	3.54	12.73	3.58	11.91	37.98	11.59	1.86	1.07	1.83
65 %	2.77	11.71	3.19	13.35	34.36	9.00	1.44	0.84	1.24
35 %	2.59	10.00	2.78	13.89	30.82	7.02	1.12	0.61	1.18
LSD at 0.05	0.33	1.05	0.63	1.23	2.18	1.36	0.10	0.16	0.12
Second season									
100 %	2.97	12.89	3.43	12.01	36.57	12.11	1.94	1.03	1.82
65 %	2.73	11.93	3.23	14.48	33.22	9.67	1.55	0.84	1.29
35 %	2.61	10.34	2.99	13.89	32.37	7.88	1.26	0.63	1.21
LSD at 0.05	0.17	0.87	0.13	1.02	1.54	1.45	0.09	0.13	0.16

2.2. Effect of Humic Acid Application: Data in Table (5) show the effect of humic acid spraying on green pod yield and pod quality. Results clear that green pod yield was significantly increased by increasing the level of humic acid spray from 0, 1 up to 2 g/l. and then decreased with spraying by 3 g/l. as shown in both growing seasons.

Pods quality, i.e. pod length, weight as well as pod content of fiber, chlorophyll, total protein, N, P and K were significantly affected by humic acid spraying except for pod length in the second season, as well as pod weight, total protein, N-content in both seasons, or P-content in the first season which variances failed to reach the level of significance. Generally, pod length, weight, N, P, K and total protein content were increased with increasing the level of humic acid spraying up to 2 g/L. and then decreased. However, chlorophyll content was gradually and significantly increased with increasing the level of humic acid application. On the other hand, fiber content was significantly decreased with increasing the level of humic acid spray.

This improving of green pod yield and its quality by spraying snap bean plants with humic acid may be due to that humic acid contains many elements which improve the plant growth (Table, 2). These results are in harmony with those reported by David, [6]; Owino-Gerroh*et al.*, [7] and Abd-El-Kareem,[6-8]. Moreover, Kaya *et al.,*[9] reported that spraying snap bean plants at three to six leaf stage significantly increased plant growth, yield and yield components of bean (number of pods per plant, pods weight and protein content).

2.3. Effect of the Interaction Treatments Between NPK Fertilizers and Humic Acid Application: Data in Table (6) show that the green pod yields of snap bean and its quality were significantly affected by the interaction treatments between mineral fertilizers and humic acid application, except for pod weight at the two growing seasons which variances failed to reach the level of significance. Results clear that the highest values of green pod yield and its quality, i.e. pod length and weight as well as pod content of chlorophyll, total proteins, N, P and K were recorded

Table 5: Effect of humic acid spraying on green pod yield, quality, chlorophyll content, total protein, N, P and K content of snap bean plants in 2008 and 2009 seasons.

Humic acid	Pods yield (ton / fed.)	Pod length (cm)	Pod weight (g)	Fiber content (%)	Chlorophyll SPAD	Total protein (%)	N(%)	P(%)	K(%)
First season									
0	2.49	10.93	3.04	13.87	32.84	9.06	1.45	0.82	1.32
1 g/l.	3.05	11.38	3.14	13.37	34.22	9.17	1.47	0.78	1.38
2 g/l.	3.28	11.83	3.29	12.70	35.09	9.33	1.49	0.84	1.45
3 g/l.	3.04	11.78	3.25	12.26	35.40	9.25	1.48	0.92	1.53
LSD at 0.05	0.17	1.12	NS	0.17	1.35	NS	NS	NS	0.09
Second season									
0	2.55	11.14	3.09	14.38	32.25	10.19	1.63	0.77	1.32
1 g/l.	2.65	11.69	3.17	13.66	33.70	9.63	1.54	0.79	1.38
2 g/l.	3.00	12.05	3.31	13.16	34.96	9.79	1.57	0.85	1.48
3 g/l.	2.87	11.99	3.29	12.63	35.30	9.94	1.59	0.91	1.58
LSD at 0.05	0.11	NS	NS	0.56	1.13	NS	NS	0.03	0.05

Table 6: Effect of the interaction treatments between NPK-fertilizers and humic acid application on green pod yield, quality, chlorophyll content, total protein, N, P and K content of snap bean plants in 2008 and 2009 seasons.

NPK	Humic acid (ton / fed.)	Pods yield (cm)	Pod length	Pod weight (g) content (%)	Fiber SPAD	Chlorophyll (%)	Total protein	N(%)	P(%)	K(%)
First season										
100%	0	3.01	12.23	3.34	12.50	35.14	11.75	1.88	1.03	1.75
	1 g/l.	3.67	12.35	3.42	12.22	37.25	11.00	1.76	1.05	1.78
	2 g/l.	3.92	13.14	3.79	11.76	39.66	12.19	1.95	1.12	1.83
	3 g/l.	3.56	13.21	3.75	11.15	39.87	11.44	1.83	1.09	1.97
65%	0	2.32	11.23	3.11	14.44	33.36	8.88	1.42	0.83	1.14
	1 g/l.	2.70	11.65	3.17	13.35	34.15	9.56	1.53	0.76	1.22
	2 g/l.	3.11	12.01	3.32	13.09	34.43	8.56	1.37	0.82	1.26
	3 g/l.	2.93	11.96	3.15	12.50	35.50	9.00	1.44	0.95	1.33

Table 6: Continue

35%	0	2.15	9.32	2.67	14.66	30.02	6.56	1.05	0.61	1.06
	1 g/l.	2.77	10.15	2.84	14.53	31.25	6.94	1.11	0.53	1.13
	2 g/l.	2.81	10.35	2.76	13.25	31.17	7.25	1.16	0.57	1.26
	3 g/l.	2.64	10.17	2.85	13.12	30.82	7.31	1.17	0.72	1.28
LSD at 0.05		0.24	0.72	NS	1.32	3.11	2.15	0.02	0.05	0.03
Second season										
100%	0	2.73	12.35	3.17	13.37	34.47	12.56	2.01	0.99	1.67
	1 g/l.	2.75	12.76	3.35	12.15	36.12	12.06	1.93	0.95	1.84
	2 g/l.	3.24	13.25	3.54	11.33	37.46	11.38	1.82	1.05	1.86
	3 g/l.	3.15	13.18	3.66	11.17	38.21	12.44	1.99	1.11	1.92
65%	0	2.55	11.42	3.24	15.01	31.13	9.75	1.56	0.77	1.17
	1 g/l.	2.56	11.73	3.22	14.86	32.43	9.00	1.44	0.81	1.18
	2 g/l.	2.98	12.27	3.25	14.63	34.56	10.13	1.62	0.83	1.36
	3 g/l.	2.84	12.28	3.21	13.42	34.77	9.81	1.57	0.94	1.43
35%	0	2.36	9.64	2.87	14.75	31.14	8.25	1.32	0.56	1.13
	1 g/l.	2.64	10.57	2.95	13.96	32.55	7.81	1.25	0.62	1.11
	2 g/l.	2.79	10.63	3.15	13.53	32.87	7.88	1.26	0.66	1.23
	3 g/l.	2.63	10.52	2.99	13.31	32.92	7.56	1.21	0.67	1.38
LSD at 0.05		0.06	1.51	NS	2.45	3.36	2.32	0.17	0.03	0.21

with adding mineral fertilizers at 100% of the recommended dose combined with humic acid spraying at 2 g/l. However, the lowest values were recorded with adding mineral fertilizers at 35% of the recommended dose without humic acid application. On the other hand, fiber content recorded the highest values by adding the lowest level of mineral fertilizers (35% of the recommended dose) without humic acid spraying, but the lowest values of fiber content were recorded with plant received the highest level of mineral fertilizers (100% of the recommended dose) with adding the highest level of humic acid (3 g/l.). These results were true in both growing seasons.

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