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Effect of Foliar Spray of Asparagine on Growth, Yield and Quality of Two Snap Bean Varieties

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Abstract

Two field experiments were carried out in two successive seasons of 2013 and 2014 at the Agricultural Experimental Station of the National Research Centre, EL-Nubaria, Elbehira Governorate, Egypt, to study the effect of three levels of Asparagine (25ppm, 50ppm and 100ppm) spraying in addition the control on growth, yield and pods quality of two bean cultivars (Paulesta and Oxzira). Results showed that using Oxzira cv. gave the highest values of the vegetative growth (number of leaves and number of branches as well as fresh and dry weight of whole plant), total yield, quality and Chemical constituents (Total Free amino acids in leaves and total phenolic acids in pod). Whereas, Paulesta cv. resulted the highest values of plant length and Total Free amino acids in pods. Spraying bean plants by Asparagine (25ppm, 50 ppm) increased vegetative growth, total yield and quality with no significant difference between 50 and 25 ppm. Whereas, using Asparagine as (25ppm) increased Total Free amino acids in leaves and total phenolic acids in pod but Total Free amino acids in pods highest when using Asparagine (100ppm).

Keywords

Snap Bean, Foliar Spray, Growth, Asparagine, Yield, Chemical Composition

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1. Introduction

Snap Bean, *Phaseolus vulgaris* L. which commonly known in Egypt as Phasolia is a member of family Fabaceae. It is also known as Common, Snap, Kidney, French or Haricot beans (Bisby *et al.,* 2011). It is one of the most important food crops in Egypt and consumed as a cooked vegetable either as dry seeds or green pods. It plays an important role in human nutrition as a cheap source for protein, carbohydrates, vitamins and minerals.

Many investigators reported that the vegetative growth, total and exportable yield as well as pod quality of snap bean (*Phaseolus vulgaris*, L) are greatly affected by genotype of the variety Nassar (1986), Abou El Hassan *et al,.* (1993), Mohamed (1997), Amer *et al.,* (2002), Abdul Mawgoud *et al.,* (2007).

Intensive farming practices, which produce high yields and quality, require the extensive use of chemical fertilizers that are both costly and create environmental problems. Therefore, there has been a recent resurgence of interest in environmentally friendly, sustainable and organic agricultural practice (Orhan *et al.,* 2006). Therefore, more recently there has been a resurgence of interest in environmentally friendly, sustainable and organic agricultural practices (Esitken *et al.,* 2005).

Thus, it is necessary to supply the plant requirement to nutrient through proper procedure. One of the best methods is foliar application. On the other hands, foliar feeding is an effective method for improving soil deficiencies and overcoming the soils inability to transfer nutrients to the

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plant. It has reported the foliar feeding can be 8 to 10 times more effective than soil feeding and up to 90 % of a foliar fed nutrient solution can be found in the smallest root of a plant within 60 minutes of application (Garcia and Hanway, 1976).

Amino acids is a well-known biostimulant which has positive effects on plant growth, yield and significantly mitigates the injuries caused by abiotic stresses (Kowalczyk and Zielony 2008). Saeed *et al*., (2005) on soybean found that treatments of amino acids significantly improved growth parameters of shoots and fresh weight as well as pod yield. El- Zohiri and Asfour (2009) on potato found that spraying of amino acids at 0.25 ml/L significantly increased vegetative growth expressed as plant height and dry weight of plant.

Amino acids are fundamental ingredients in the process of protein synthesis, formation of vegetable tissue and chlorophyll synthesis, similar effect and findings about amino acids were indicated by Abo Sedra *et al.,*2010 on strawberry and El-Desouky *et al.,* 2011) on tomato.

Amino acids are precursors or activators of phytohormones and growth substance (i.e., alternative routes of IAA synthesis exist in plants, all from Tryptophan (Marschner, 1995). The biosyntheses of cinamic acids (which are the starting materials for the synthesis of phenols) are derived from phenylalanine and tyrosine. Tyrosine is hydroxy phenyl amino acid that is used to build neurotransmitters and hormones). Amino acids are important for pollination and fruit formation (Stitt *et al.,* 2002).

The possibilities of using amino acid in modern agriculture have been studied by many researchers (Fawzy *et al.,* 2010; Abdel-Mawgoud *et al.,* 2011; El Awadi *et al.,* 2011; Razieh *et al.,* 2012).

The aim of the present study is to investigate the effects of Foliar Spray of Asparagine on growth, yield and quality of two snap bean varieties

2. 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 2013 and 2014 to study the differences between two bean cultivars (Paulesta and Oxzira) and three levels of Asparagine (25 ppm, 50ppm and 100ppm) spraying in addition the control on growth, yield and pods quality of snap bean (*Phaseolus vulgaris* L.). Seeds of bean were sown on the last week of April in 2013 and 2014, 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. Asparagine foliar application sprayed 30 and 40 days after sowing.

The soil of the experimental field was sandy soil and the physical and chemical analyses were presented in Table (1). The normal agricultural practices required for bean production were applied as commonly followed in the farm.

Table (1). Physical properties and chemical analysis of the experimental soil.

Physical properties		Chemical analysis	
Sand	90.08	Ca (Mg/L)	7.02
Clay	9.26	Mg (Mg/L)	0.527
Silt	0.66	Na (Mg/L)	0.982
Texture	Sandy	K (Mg/L)	0.31
F.C. %	16.57	HCO3 (Mg/L)	1.3
W. P. %	5.25	Cl (Mg/L)	0.566
E. C. (ds/m)	1.7		
PH	8.2		

2.1. 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 length, 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.

2.2. Pods Quality

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

2.3. Chemical Constituents

Protein percentage was determined according to A.O.A.C. (1990). Total Free amino acids were determined using the ninhydrin colorimetric method defined by Plummer (1978). Following the method reported by Snell and Snell (1952), total phenolic compounds were estimated.

The treatments were arranged in a split plot design with four replicates where, bean cultivars were arranged in main plots, while Asparagine foliar application treatments were in addition the control distributed in the sub plots. The obtained data were statistically analyzed according to the method described by Gomez and Gomez (1984).

3. Results and Discussion

3.1. Vegetative Growth Parameters

3.1.1. Effect of Snap Bean Varieties

Data in Table (2) show that, snap bean varieties in both

seasons have no significant effect in their vegetative growth parameters. Meanwhile, the highest values of all parameters (plant length, number of branches, number of leaves as well as fresh and dry weight of leaves) were recorded in cv. Oxzira .However, cv. Paulesta gave the lowest values of vegetative growth parameter. These results held true in the two seasons of the study. The observed differences in vegetative growth of cultivars are mainly due to the genotype of each cultivar. This result was in harmony with previous findings (Abou El –Hassan *et al*., 1993, Mouhamed. F.M., 1998, Amer *et al*., 2002 and Abdel – Mawgoud *et al*., 2005) on snap bean plants.

3.1.2. Effect of Foliar Application of Asparagine:

Data of the measured vegetative growth parameters of snap bean plants in relation to the applied Asparagine are presented in Table (2). Generally, application of Asparagine had a significant effect in the vegetative growth parameters (plant length, number of leaves, number of branches and fresh and dry weight of leaves) in both seasons of study. Meanwhile, the highest values plant height parameter was obtained from the application of Asparagine at a rate of 100 ppm in the first season and by 50 ppin the second season as compared with those obtained from the control and other treatments. Moreover, the highest leave number was found by using Asparagine at rate of 50 ppm in both seasons. Furthermore, the highest amount of number of branches and fresh and dry weights of leaves of snap bean were found by application of Asparagine as a rates of 25 ppm . On the other hand, the lowest values of vegetative growth parameters were found by control. The superiority of foliar application by foliar spray of Asparagine (amino acids) may be referred to the role of Asparagine (amino acids) content required to proteins synthesis. These findings were true in the two seasons. These results are in agreement with those obtained by many investigators Saeed *et al*., (2005) on soy bean and El- Zohiri and Asfour (2009) on potato.

Table (2). Effect of cultivars and Asparagine foliar application on vegetative growth parameters of bean plants.

Characters		Plant length (cm)		Leaf number		Branch number		Leaves fresh weight (g)		Leaves dry weight (g)	
		2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
		Effect of Cultivars									
Paulesta		47.85	44.06	23.34	21.63	13.53	12.63	45.17	43.76	8.12	8.19
oxzira		47.98	44.14	27.57	25.50	14.89	13.88	45.51	44.08	8.32	8.38
LSD at 5%		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		Effect of Asparagine									
Control		42.20	38.93	17.48	16.25	10.94	10.25	30.96	30.73	6.78	6.96
25ppm		47.75	43.93	25.11	23.25	17.21	16.00	60.20	57.55	10.25	10.15
50ppm		53.28	49.00	35.20	32.50	16.39	15.25	54.12	51.98	8.91	8.92
100ppm		48.43	44.55	24.02	22.25	12.31	11.50	36.08	35.43	6.95	7.12
LSD at 5%		2.11	7.21	12.86	12.01	5.17	4.96	8.14	9.78	1.95	2.53
		Effect of the interaction									
Control	Paulesta	44.09	40.75	15.58	14.50	9.58	9.00	30.22	30.05	6.20	6.43
	oxzira	40.31	37.10	19.39	18.00	12.31	11.50	31.70	31.40	7.35	7.49
25ppm	Paulesta	47.83	44.00	27.57	25.50	18.30	17.00	66.69	63.50	11.25	11.06
	oxzira	47.67	43.85	22.66	21.00	16.12	15.00	53.71	51.60	9.25	9.23
50ppm	Paulesta	46.20	42.50	25.39	23.50	13.94	13.00	50.99	49.10	8.36	8.42
	oxzira	60.37	55.50	45.01	41.50	18.85	17.50	57.26	54.85	9.45	9.42
100ppm	Paulesta	53.28	49.00	24.84	23.00	12.31	11.50	32.79	32.40	6.67	6.87
	oxzira	43.58	40.10	23.21	21.50	12.31	11.50	39.38	38.45	7.22	7.37
LSD at 5%		5.18	5.19	3.92	3.81	3.25	3.19	4.18	4.32	1.66	1.35

3.1.3. Effect of the Interaction

The results of the interaction effects of varieties and different concentrations of Asparagine were found statistically significant at 5 % level (Table 2) in the two seasons. The highest plant high of snap bean plants was recorded by foliar spray of Asparagine at a rate of 25 ppm with Paulesta cv. in the first season and by foliar spray of Asparagine with Oxzira cv. in the second one. On the country, the lowest amount of plant high was found by control (foliar spray with water) with Oxzira cv. in both seasons However, the highest amount of number of branches and leaves of snap bean were found by using Asparagine as a foliar spray at rates of 50 ppm with Oxzira cv. in both seasons of study. Furthermore, the highest values of fresh and dry weight of snap bean plant were recorded by foliar application of Asparagine at rates of 25 ppm with Pauleta cv. in both seasons of study. On the other hand, the lowest amount of number of branches and leaves as well as fresh and dry weight of snap bean plants were found by control treatment (foliar spray with water) with Paulesta cv. These results were true in the both seasons of study.

3.2. Yield and Quality Parameters

3.2.1. Effect of Snap Bean Varieties

Data in Table (3) show that, snap bean varieties in both seasons has a significant effect about total yield of snap bean and no significant effect about length and weight of pod parameters .Meanwhile, the highest values of all parameters (total yield, length and weight of pod of snap bean plants) were recorded in Oxzira cv. .However, Paulesta cv. gave the lowest values of total yield and pod quality parameters. These results held true in the two seasons of the study. The observed differences in vegetative growth of cultivars are mainly due to the genotype of each cultivar. This result was in harmony with previous findings (Abou El –Hassan *et al* 1993, and Abdel – Mawgoud *et al* 2005) on snap bean plants.

3.2.2. Effect of Foliar Application of Asparagine

Data of the measured total yield and pod quality parameters of snap bean plants in relation to the applied Asparagine are presented in Table (3). Generally, application of Asparagine had a significant effect in the total yield and pod quality parameters (pod weight and pod length) in both seasons of study. Meanwhile, the highest values plant height parameter was obtained from the application of Asparagine at a rate of 25 ppm in both seasons as compared with those obtained from the control and other treatments. On the other hand, the lowest values of total yield and pod length parameter were found by control (foliar spray of water) in both seasons of study. However, the lowest amount of weight of pod was found by foliar spray of Asparagine at rates of 100 ppm. The previous studies have proved that amino acids can directly or indirectly influence the physiological activities of the plant These findings were true in the two seasons. Similar results were obtained by Fawzy *et al.,* 2010; Abdel-Mawgoud *et al.,* 2011; El Awadi *et al.,* 2011.

Table (3). Effect of cultivars and Asparagine foliar application on yield and quality of bean plants.

Characters		Total yield ton/fed.		Pod length (cm)		Pod weight (g)	
		2013	2014	2013	2014	2013	2014
		Effect of Cultivars					
Paulesta		3.14	3.19	12.51	12.39	3.14	3.14
oxzira		3.66	3.66	12.76	12.61	3.32	3.31
LSD at 5%		0.26	0.33	NS	NS	NS	NS
		Effect of Asparagine					
Control		2.29	2.41	10.40	10.45	2.74	2.77
25ppm		4.40	4.34	15.06	14.73	4.24	4.14
50ppm		3.79	3.78	13.29	13.10	3.48	3.45
100ppm		3.12	3.17	11.79	11.73	2.47	2.52
LSD at 5%		1.13	1.15	1.50	2.28	0.90	1.08
		Effect of the interaction					
Control	Paulesta	2.20	2.33	9.91	10.00	2.35	2.41
	oxzira	2.38	2.49	10.89	10.90	3.13	3.13
25ppm	Paulesta	3.77	3.76	14.05	13.80	4.23	4.14
	oxzira	5.02	4.91	16.07	15.65	4.24	4.15
50ppm	Paulesta	3.68	3.68	14.16	13.90	3.50	3.47
	oxzira	3.89	3.87	12.42	12.30	3.47	3.44
100ppm	Paulesta	2.92	2.98	11.93	11.85	2.48	2.53
	oxzira	3.33	3.36	11.65	11.60	2.46	2.52
LSD at 5%		0.91	1.14	6.59	6.95	0.52	0.73

3.2.3. Effect of the Interaction

The results of the interaction effects of varieties and different concentrations of Asparagine were found statistically significant at 5 % level (Table 3) in the two seasons. The highest total yield and pod quality (length and weight of pod) of snap bean plants was recorded by foliar spray of Asparagine at a rate of 25 ppm with Oxzira cv. in the both seasons of study. On the country, the lowest amount of total yield and pod quality (length and weight of pod) were found by control (foliar spray with water) with Paulesta cv. in both seasons.

3.3. N, P and K %of Pod of Snap Bean Plants

3.3.1. Effect of Snap Bean Varieties

Data in Table (4) show that, snap bean varieties in both seasons has a significant effect about N% of pod of snap bean and no significant effect about P and K% of pod of snap bean plants .Meanwhile, the highest values of N% and P% of pod of snap bean were recorded by using Oxzira cv. However, Paulesta cv. gave the highest values of K% of pod of snap bean .On the other hand, the lowest amount of N and P% of

pod were recorded by Paulesta cv. However, the lowest value of K% of pod of snap bean was found by using Oxzira cv. These results held true in the two seasons of the study. The observed differences in vegetative growth of cultivars are mainly due to the genotype of each cultivar. This result was in harmony with previous findings (Abou El –Hassan *et al* 1993, Mouhamed. F.M., 1998, Amer *et al* 2002 and Abdel – Mawgoud *et al* 2005) on snap bean plants.

3.3.2. Effect of Foliar Application of Asparagine

Data of the measured of N, P and K % of pod of snap bean plants in relation to the applied Asparagine are presented in Table (4). Generally, application of Asparagine had a significant effect in the N, P and K% in both seasons of study. Meanwhile, the highest values of N% of pod of snap bean were recorded by foliar spray of Asparagine at rates of 25 ppm. However, the lowest amount of N% was found by foliar spray of Asparagine at rates of 100 ppm. This result was true in both seasons. Moreover, the highest values of P and K% of pod of snap ban were recorded by foliar spray of Asparagine at rates of 50 ppm in the both seasons of study. On the country, the lowest values of P and K % were recorded by foliar spray of Asparagine at rates of 25 ppm and 100 ppm, respectively. These findings were true in the two seasons. This result was in harmony with Abdel-Mawgoud *et al.,* 2011; El Awadi *et al.,* 2011.

Table (4). Effect of cultivars and Asparagine foliar application on N P and K in bean pods .

Characters		N%		P%		K%	
		2013	2014	2013	2014	2013	2014
		Effect of Cultivars					
Paulesta		2.97	2.99	0.37	0.40	2.18	2.07
oxzira		3.30	3.26	0.41	0.45	1.86	1.86
LSD at 5%		0.15	0.17	NS	NS	NS	NS
		Effect of Asparagine					
Control		3.09	3.09	0.37	0.40	1.64	1.61
25ppm		3.37	3.32	0.33	0.37	2.21	2.10
50ppm		3.33	3.28	0.47	0.51	2.64	2.58
100ppm		2.76	2.81	0.39	0.41	1.59	1.57
LSD at 5%		0.13	0.11	0.03	0.04	0.21	0.19
		Effect of the interaction					
Control	Paulesta	3.19	3.16	0.43	0.45	1.65	1.62
	oxzira	3.00	3.01	0.31	0.35	1.63	1.60
25ppm	Paulesta	3.19	3.16	0.34	0.38	2.77	2.57
	oxzira	3.56	3.48	0.32	0.36	1.65	1.62
50ppm	Paulesta	2.90	2.93	0.30	0.35	2.67	2.48
	oxzira	3.75	3.64	0.65	0.67	2.62	2.68
100ppm	Paulesta	2.62	2.69	0.41	0.40	1.63	1.60
	oxzira	2.90	2.93	0.38	0.41	1.55	1.54
LSD at 5%		0.16	0.19	NS	NS	0.19	0.23

3.3.3. Effect of the Interaction

The results of the interaction effects of varieties and different concentrations of Asparagine were found statistically significant at 5 % level of N and K% (Table 4) in the two seasons. The highest N, P and K% of pod of snap bean plants were recorded by foliar spray of Asparagine at a rate of 50 ppm with Oxzira cv. in the both seasons of study except for K% in first season. On the country, the lowest amount of N% of pod of snap bean plants was found by foliar spray of Asparagine at rates of 100 ppm with Paulesta cv. Moreover, the lowest value of P% of pod was found by foliar spray of Asparagine at rates of 50 ppm with Paulesta cv. On the other hand, the lowest value of K% of pod of snap bean was found by foliar spray of Asparagine at rates of 100 ppm with Oxzira cv. These results were true in the both seasons of study.

3.4. FAA in Leaves and Protein %, Phinolic Acid, FAA in Pod of Bean Plants

3.4.1. Effect of Snap Bean Varieties

Data in Table (5) show that, snap bean varieties in both seasons has a significant effect of all parameters except for FAA in pod of snap bean plants in both seasons .Meanwhile, the highest values of FAA in leaves and phinolic acid were recorded by using Paulesta cv. However, Oxzira cv. gave the highest values protein and FAA in pod of snap bean .On the other hand, the lowest amount of FAA in leaves and phinolic acid were recorded by Oxzira cv. However, the lowest value of protein and FAA in pod of snap bean were found by using Paulesta cv. These results held true in the two seasons of the study. The observed differences in vegetative growth of cultivars are mainly due to the genotype of each cultivar.

This result was in harmony with previous findings (Abou El –Hassan *et al*., 1993, Mouhamed. F.M., 1998, Amer *et al*., 2002 and Abdel – Mawgoud *et al* 2005) on snap bean plants.

3.4.2. Effect of Foliar Application of Asparagine

Data of the measured of FAA in leaves and Protein %, Phinolic acid, FAA in pod of bean plants in relation to the applied Asparagine are presented in Table (5). Generally, application of Asparagine had a significant effect in the all parameters in both seasons of study. Meanwhile, the highest values of FAA in leaves and pods and phinolic acid were recorded by foliar spray of Asparagine at rates of 50 ppm. However, the highest value of protein % was found by foliar spray of Asparagine at rates of 25 ppm. These results are true in both seasons of study. On the country, the lowest value of FAA in leaves was found by foliar spray of Asparagine at rates of 25 ppm in both seasons. Moreover, the lowest value of protein % and phinolic acid were found by foliar spray of Asparagine at rates of 100 ppm in both seasons. However, the lowest values of FAA in pod of snap bean plants was recorded by control treatment (foliar spray of water). These findings were true in the two seasons. Similar results were obtained by Razieh *et al.,* 2012.

3.4.3. Effect of the Interaction

The results of the interaction effects of varieties and different concentrations of Asparagine were found statistically significant at 5 % level of FAA in pod and phinolic acid and no significant effect about FAA in leaves and protein parameters (Table 5) in the two seasons. The highest values of FAA in leaves of snap bean plants was recorded by foliar spray of Asparagine at a rate of 50 ppm with Paulesta cv. in the both seasons of study. Moreover, the highest values of protein and FAA in pods of snap bean plants were recorded by foliar spray of Asparagine at rates of 50 ppm with Oxzira cv.in both seasons. Furthermore, the highest value of phinolic acid was found by foliar spray of Asparagine at rates of 25 ppm with Paulesta cv. On the contrary, the lowest value of FAA in leaves was found by foliar spray of Asparagine at rates of 25 ppm with Oxzera cv. Moreover, the lowest value of protein in pod of snap bean plants was found by foliar spray of Asparagine at rates of 100 ppm with Paulesta cv. However, the lowest value of FAA in pod was found by control plants (foliar spray of pod) with Oxzera cv. Furthermore, the lowest value of phinolic acid in pod was found by foliar spray of Asparagine at rates of 100 ppm with Oxzera cv. These results were true in the both seasons of study.

Table (5). Effect of cultivars and Asparagine foliar application on FAA in leaves and Protein %, Phinolic acid, FAA in pod of bean plants.

Characters		FAA in leaves		Protein % in pod		FAA in pod		Phinolic acid in pod	
		2013	2014	2013	2014	2013	2014	2013	2014
		Effect of Cultivars							
Paulesta		37.04	36.54	18.59	18.67	35.48	35.11	16.09	15.80
oxzira		27.72	27.99	20.65	20.40	35.51	35.14	13.34	13.27
LSD at 5%		2.29	4.66	0.94	1.43	NS	NS	1.31	1.32
		Effect of Asparagine							
Control		30.01	30.10	19.32	19.28	27.93	28.19	15.98	15.70
25ppm		28.41	28.62	21.09	20.77	31.81	31.75	15.65	15.40
50ppm		41.11	40.28	20.79	20.52	43.88	42.82	16.24	15.94
100ppm		29.99	30.08	17.26	17.55	38.35	37.74	10.97	11.10
LSD at 5%		4.36	6.56	0.95	0.73	6.97	8.95	2.30	3.15
		Effect of the interaction							
Control	Paulesta	36.90	36.42	19.91	19.78	35.60	35.22	13.53	13.45
	oxzira	23.12	23.78	18.74	18.79	20.27	21.16	18.44	17.95
25ppm	Paulesta	34.39	34.11	19.91	19.78	35.92	35.51	20.09	19.47
	oxzira	22.43	23.14	22.27	21.76	27.71	27.98	11.21	11.33
50ppm	Paulesta	45.61	44.41	18.15	18.30	38.13	37.55	18.30	17.83
	oxzira	36.61	36.15	23.44	22.75	49.63	48.09	14.18	14.05
100pp	Paulesta	31.26	31.24	16.38	16.81	32.27	32.17	12.42	12.44
m	oxzira	28.72	28.91	18.15	18.30	44.42	43.32	9.51	9.77
LSD at 5%		NS	NS	NS	NS	10.64	12.32	3.16	3.94

4. Conclusion

It could be recommended that all Spraying bean plants by Asparagine (25ppm and 50 ppm) increased vegetative growth, total yield and quality with no significant difference between 50 and 25 ppm.

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