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Effect of Nitrogen Fertilizer Sources and Some Biocontrol Agents on Growth, Yield and Rust Disease Incidence of Some Snap Bean Cultivars Grown in Sandy Soil

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THIS WORK was conducted during the two successive autumn seasons of 2012/2014 at the Experimental Farm of El-Kassasein, Hort. Res. Station, Ismaelia Governorate, Egypt. The effect of three different of nitrogen fertilizer sources, *i.e.*, ammonium sulphate (20.5 % N) at 390.2 kg / fed. (fed. = 0.42 ha.) botanical compost at 6.667 ton/fed. and chicken manure at 2.787 ton/fed. (each equal 80 kg N/fed.) and five biocontrol agents (*Trichoderma harzianum*, *Trichoderma viride*, mixture of *Trichoderma harzianum* + *Trichoderma viride* and *Bacillus subtilis*) were tested on growth and yield as well as rust disease incidence and severity of snap bean cultivars (Paulista and Xera) were evaluated under sandy soil conditions.

Paulista cv. gave the highest dry weight of shoots/ plant and total yield/fed. compared to Xera cultivar. Chicken manure application increased dry weight of shoots and total yield of snap bean. Foliar application with mixture of *Trichoderma harzianum* + *Trichoderma viride* increased number of both leaves and branches/ plant, dry weight of shoots/ plant, pod length and total yield/feddan. Fertilizing of Paulista cv. with chicken manure combined with foliar application with *Trichoderma harzianum* + *Trichoderma viride* increased number of both leaves and branches/ plant, plant height, dry weight of branches, leaves and shoots/ plant, pod length and total yield.

Xera cv. plants gave the lowest value of rust disease severity compared to Paulista plants. Botanical compost application recorded the minimum values of rust disease incidence and severity of snap bean plants, followed by chicken manure treatment, whereas ammonium sulphate at 390.2 kg/fed. recorded maximum values. Foliar application of snap bean plants with biocontrol agents decreased rust disease incidence and severity on leaves compared to control. Mixture of *Trichoderma harzianum* + *Trichoderma viride* decreased rust disease incidence, whereas *Trichoderma harzianum* decreased rust disease severity.

Keywords: Snap bean cultivars, Nitrogen fertilizer sources, Rust disease, Biocontrol agents and Yield.

Snap bean (*Phaseolus vulgaris* L.) is one of the most important vegetable crops grown in Egypt not only for local consumption, but also for export purpose.

In contrast to cases where a low (N) supply predisposes crops to disease, research on snap bean crops has demonstrated that an excessive (N) supply increases disease or damage caused by some pathogens**.** Pathogen attack of above ground parts of the plant may be encouraged by high (N) in the presence of low (K) and (P)**.** A number of studies with cereals and other crops have shown that obligate pathogens in particular, such as *Puccinia* ssp. causing rust and other biotrophs, can be encouraged by a high N supply. Possibly excess (N) might also favor the development of infections by obligate fungal parasites in plants although there is little evidence for this. Nitrogen supplied can be a significant factor in plant disease. A supply of ammonium-N may predispose plants to certain diseases, while nitrate-N is favorable for the development of others (Palti 1981).

In Egypt the cultivated area of green beans plants at 2012 was 58.336 fed. produced 251.279 tons with average 4.307 ton/fed (FAOSTAT, 2013) .Snap bean plants did not grow well or produce high yield under low soil N availability (Salinas *et al*., 2011).It is well known that sandy soil is low fertile, low water retention, poor soil properties, (physical, chemical and biological) and had high soil pH. Addition of organic fertilizers can improve soil aggregation stability, soil fertility, and increase caution exchange capacity and microbe activate. Also, organic fertilizer was used to decrease soil pH and hence increases the availability of major and minor nutrients. It also increases the water holding capacity of soil (Tahoun *et al*., 2000). Convert organic nutrients forms to mineral forms, which become available to plants as slow-release fertilizers (Marschner, 1995).

Feleafel and Mirdad (2014) reported that, chicken manure (equivalent 100kg N/ fed.) significantly increased the number of leaves and branches, pod number and pod yield of snap bean cv. Super Stryke grown in sandy soil. It also contains higher levels of relatively nutritional elements especially N, which is essentially required for plant growth (Amanullah *et al*., 2007).

Rust disease caused by *Uromyces appendeculatus* (Pers.) is one of the important fungal diseases. Rust usually reach epidemic scale in most regions of the world, include of bean rust in Egypt (Thurston, 1998).

The use of specific biological control microorganisms that interfere with plant pathogens and pests is a nature –friendly. These approaches overcome the problems caused by chemical pesticides (Harman *et al*., 2004). Bacteria and fungi are involved in biocontrol activity and the fungal genus Trichoderma plays a major role in controlling the plant diseases.

Application of the fungicides is not sustainable in the long term because they pollute the environment, leave harmful residues and can lead to the development of pathogen resistant strains with frequent uses (Vinale *et al*., 2008).

Replacement of fungicides with biocontrol agents is an alternative manage the plant pathogens, produce safety food and reduce the environment pollution (Barakat and Al-Masri, 2005).

The use of *Trichoderma* spp. in agriculture can provide numerous advantages, colonization of the root and rhizosphere of plant, control several plant pathogens by different mechanisms such as parasitism, antibiosis production and induce resistance stimulation of root growth improvement plant health by promote plant growth (Harman *et al.*, 2004).

Mixing bioagents with each others may be lead to antagonistic effect consequently decrease efficacy of treatment (Robinson *et al.*, 2009) or lead to synergistic effect and increase the efficacy. This increase or decrease is due to harmony and compatibility between bioagents.

Bacillus subtilis Cohn. is known as effective antagonist bacteria against several plant pathogens. These antagonist acts through antibiosis, secretion of volatile toxic metabolites, destructive enzymes and competition for space and nutrition. (Intana *et al.*, 2008) found that applications of *B. subtilis* are an important tool not only for organic growers, but also for conventional growers. They are using *B. subtilis* in integrated pest management programs allow reducing the risk of both the development of strains resistant and reduce toxic residues in the final product.

The objective of this work is to study the effect of different nitrogen fertilizer sources and some biocontrol agents on growth , yield and rust diseases of snap bean cultivars (Paulista and Xera) grown in sandy soil during autumn plantations.

Material and Methods

This work was carried out during the two successive autumn seasons of 2012/2014 in the Experimental Farm at El-Kassasein, Hort. Res. Station, Ismaelia Governorate, to study the effect of three nitrogen fertilizer sources *i.e.*, ammonium sulphate, botanical compost and chicken manure (equivalent 80 kg N/fed. each) and five biocontrol agents treatments (control, *Trichoderma harzianum* Rifai, *Trichoderma viride* Harz., mixture of *Trichoderma harzianum* + *Trichoderma viride* and *Bacillus subtilis* Cohn. on growth, yield and leaf rust disease incidence of two snap bean cultivars (Paulista and Xera) grown under sandy soil conditions.

Seeds of snap bean cvs. Paulista and Xera were obtained from Suez Canal Company for Commercial and Agricultural Development, Giza, Egypt.

The physical and chemical properties of the soil experimental site presented in Table (a).

TABLE (a). The physical and chemical properties of the experimental soil in 2012-2014.

Soil properties	2012	2014
Physical properties		
Clay %	1.8	2.8
Silt %	1.7	1.6
Sand %	95.6	96.5
Texture	Sandy	Sandy
Chemical properties		
E.C.(mmhos/cm)*	2.11	2.16
PH **	8.32	8.14
Organic matter (%)	0.07	0.08
Available N (ppm)	3.53	3.42
Available P (ppm)	3.52	3.82
Available K (ppm)	11.28	11.45

Samples of the soil were obtained from 25cm soil surface
*E.C: Electric conductivity, ** pH (1:2.5 suspension).

This experiment included 30 treatments, which were the combinations among two cultivars (Paulista and Xera), three nitrogen source ,*i.e.*, ammonium sulphate, 20.5 %N (AS), botanical compost (BC) and chicken manure (ChM) and five biocontrol treatments (control, *Trichoderma harzianum* (T1), *Trichoderma viride* (T2),mixture of *Trichoderma harzianum* + *Trichoderma viride* (T1+T2) and *Bacillus subtilis* (BS). The amounts of added AS, BC and ChM equivalent 80 kg N/ fed./each were about 390.2 kg /fed., 6.667 ton/fed. and 2.787 ton/fed., respectively.

The chemical properties of the botanical compost and chicken manure as average two seasons are presented in Table (b).

TABLE (b). The chemical properties of the botanical compost and chicken manure as average two seasons.

Elements	Botanical compost	Chicken manure
Macro elements %		
N	1.2	2.78
P	0.81	0.96
K	0.24	1.28
Micro elements (ppm)		
Fe	250	1104
Mn	146	210
Zn	105	209
Cu	50	413
Organic matter (%)	37	35.90

Prepration of bioagents

Bacillus subtilis (BS), *Trichoderma harzianum* (T1), *Trichoderma viride* (T2) and mixture of both (T1+T2) were obtained from Central Lab. of Organic Agriculture, ARC, Giza. *Trichoderma harzianum* and *Trichoderma viride* isolate was grown in liquid gliotixin fermentation medium (GFM) developed by (Brain and Hemming 1945) for 11 days under completer darkness conditions, at 25° C *Bacillus subtilis* isolate was grown on liquid nutrient glucose medium (NGM) developed by (Dowson, 1957) for 2 days, at 25° C. Different bioagents were prepared as suspension at concentration of 30×10^6/ml. Mixture of *Trichoderma harzianum* and *Trichoderma viride* was prepared by mixing the two antagonists at the rate of (1:1) to increase their activity on disease control.

The treatments were arranged in a split split plot in a complete randomized block design with three replicates. Snap bean cultivars were randomly distributed in the main plot, nitrogen fertilizers sources were randomly arranged in the sub plot and biocontrol agents treatment were randomly arranged in the sub sub plot. The experimental unit area was 12.6 m^2 it contained two dripper lines (9 m length and 70 cm wide).

Seeds of Paulista and Xera cultivars were sown in 27^{th} Sept. and 3^{rd} Oct. in both autumn experimental seasons. Seeds were sown in hills on both sides of dripper line, plants thinned after 20 days from sowing as one plant/hill. The distance between each two hills was 15 cm.

Biocontrol agents treatment (BS, T1, T2 and T1+ T2) were sprayed two times before flowering period (at 30 and 40 days from sowing). Each plot received 2 L spraying suspension while, the control treatments was sprayed with water only.

Data Recorded

Plant growth characters

A sample of five plants from each experimental unit was randomly taken at 50 days after sowing to evaluate, plant height, number of leaves and number of branches/plant. Samples were oven dried at 70°C till constant weight to determine dry weight of plant parts, *i.e*., shoots (branches and leaves) and pods.

Assessment of rust diseases

A random sample of ten plants from each experimental unit were randomly taken at 50 days after sowing in both study seasons for measuring reduction of disease incidence(DI) and disease severity .

DI % = (number of leaves infected/ total number of leaves examined x 100)

Disease severity was determined according to the scale reported by (Hanounik 1986), as following 1= No pustules or very small non sporulating flecks. 3= Few scattered pustules covering less than 1 % of leaf area and few or no pustules on stem. 5= Pustules common on leaves covering 1-4 % of leaf area, little defoliation and some pustules on stem. 7= extensive pustules on leaves

petioles and stems covering 8-10 % of leaf area, many dead leaves and severe defoliation.

DS % = (Sum (n X v) / 9 N X 100
Where: n = number of plants in every grade .V = numerical grade.
N= total number of leaves examined. 9 = maximum disease grade.

Yield and its components

Green pods of each experimental unit were harvested at proper maturity stage,(counted and weighed in all harvests till the end of experiment for calculating: yield/plot and total yield/feddan. Pod length and pod diameter were also determined in samples of pod taken from the 2nd harvest.

Statistical analysis

Data were subjected to proper statistical analysis of variance according to Snedecor and Cochran (1980) and means separation was done according to LSD at 5 % level of significance.

Results and Discussion

Plant growth

Morphological characters

The main effect

Presented data in Table 1 shows that Paulista cv. gave higher number of leaves/ plant in both seasons, whereas Xera cv. recorded the higher plants in the 1st season only. There were no significant differences between Paulista and Xera in number of branches /plant in both seasons and plant height in the 2nd one.

Fertilizing of snap bean plants with (ChM) at 2.787 ton/fed. (fed equal 0.42 ha) significantly increased number of leaves and branches/ plant and plant height followed by (AS) at 390.2 kg / fed. at both seasons.

The beneficial effect of organic manure on growth may be due to that organic manure improves the soil structure conditions improving its aeration which encouraged the plant roots to be well developed and increase plant growth (Cook, 1972). Chicken manure contains higher levels of nutrient elements (Amanullah *et al*., 2007).

These elements are essentially required for plant growth and contributed to increase the meristematic activity of the plant tissues and in building protein molecules (Marschner, 1995). There for, encourage the growth of snap bean plants through promoting the plants to generate leaves and increasing the translocation of photosynthesis.

Concerning the effect of some biocontrol agents, the obtained results in Table 1 show that foliar application of snap bean plants with mixture of (T1 +T2) increased number of both branches, leaves/ plant and plant height at both tested seasons, except number of leaves at the 2nd one. These results agree with those

reported by Abd El-Hamed (2014). He found that *Trichoderma harzianum* increased number of branches / plant of snap bean. Isolates of several other *Trichoderma* spp. can reduce the severity of foliar diseases, presumably by inducing systemic resistance in plants (De Ceusterand and Hoitink 1999).

TABLE 1. Effect of cultivars, nitrogen fertilizer sources and some biocontrol agents on morphological characters of snap bean plant grown under sandy soil conditions during 2012 - 2014.

Characters / Treatments	Branches number / plant		Leaves number / plant		Plant height (cm)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
	Effect of cultivars					
Paulista	4.96	5.14	19.08	19.51	47.06	49.56
Xera	4.98	4.76	16.56	16.10	50.86	50.73
L.S.D at 5%	N.S	N.S	0.96	2.84	2.53	N.S
	Effect of nitrogen sources					
AS	5.08	4.78	16.01	16.68	48.91	49.80
BC	4.41	4.58	14.68	14.70	46.95	49.38
ChM	5.43	5.50	22.78	22.03	51.03	51.26
L.S.D at 5%	0.19	0.16	0.92	1.10	1.58	0.59
	Effect of biocontrol agents					
Control	4.69	5.00	15.00	18.19	42.44	52.52
T1	5.08	4.83	17.66	17.41	49.02	47.58
T2	5.00	4.86	18.80	18.61	49.58	50.25
T1+T2	5.50	5.33	20.02	18.00	57.44	53.66
BS	4.61	4.75	17.63	18.80	46.33	46.72
L.S.D at 5%	0.28	0.37	1.63	N.S	2.22	2.83

AS: ammonium sulphate, BC: botanical compost and ChM : chicken manure NS: not significant at 0.05 T_1: *Trichoderma harzianum* , T_2 : *Trichoderma viride* and BS : *Bacillus subtilis*

The dual interaction effect

Respecting the interaction between cultivars and nitrogen fertilizer sources, the obtained results in Table 2 show that, fertilizing of Xera cv. with ChM gave the highest value of number of branches/ plant in both seasons and recorded the highest plants at the 2nd season, whereas fertilizing of Paulista cv with ChM gave the highest number of branches /plant at the 2nd season.

As for the interaction between cultivars and biocontrol agents, results show that, foliar application of Paulista cv. with T1 + T2 as biocontrol agents recorded the maximum values of number of both branches and leaves/ plant at both seasons testes, whereas foliar application of Xera cv. with T1 +T2 recorded the higher plants in the 1st season only.

Concerning the effect of interaction between nitrogen fertilizer sources and biocontrol agents (Table 2), fertilizing of snap bean plants with ChM and foliar application with T1+T2 as biocontrol agent gave the highest number of branches/ plant in both seasons and number of leaves/ plant in the 1st season and recorded the maximum values of plant height at both seasons with few exceptions. Some

investigators explain this protection effect as antibiosis action occurred in court of infection (Matei and Matei, 2008) some other investigators reported changes in plant physiology and chemical components in plants treated with these bioagents (Hafez *et al*., 2012).

TABLE 2. Effect of dual interaction between cultivars and nitrogen fertilizer sources, cultivars and biocontrol agents, nitrogen fertilizers sources and biocontrol agents on morphological characters of snap bean plant grown under sandy soil conditions during 2012 - 2014.

Characters / Treatments		Branches number/ plant		Leaves number/ plant		Plant height (cm)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of interaction between cultivars and nitrogen sources							
Paulista	AS	4.93	5.00	17.03	19.00	46.83	50.47
	BC	4.60	5.00	16.10	16.83	45.90	49.80
	ChM	5.37	5.43	24.13	22.70	48.47	48.43
Xera	AS	5.23	4.57	15.00	14.37	51.00	49.13
	BC	4.23	4.17	13.27	12.57	48.00	48.97
	ChM	5.50	5.57	21.43	21.37	53.60	54.10
L.S.D at 5%		0.02	0.02	NS	0.10	NS	0.06
Effect of interaction between cultivars and biocontrol agents							
Paulista	Control	4.83	4.94	13.72	18.50	37.22	52.78
	T1	4.39	4.89	19.28	19.22	46.83	46.61
	T2	5.00	4.94	19.61	19.72	48.28	49.94
	T1+T2	5.06	5.78	23.06	20.22	57.00	51.72
	BS	5.56	5.17	19.78	19.89	46.00	46.78
Xera	Control	5.00	5.06	16.28	17.89	47.67	52.28
	T1	5.17	4.78	16.06	15.61	51.22	48.56
	T2	4.94	4.78	18.00	17.50	50.89	50.56
	T1+T2	5.44	4.89	17.00	15.78	57.89	55.61
	BS	4.39	4.33	15.50	13.72	46.67	46.67
L.S.D at 5%		0.05	0.06	0.26	0.27	0.35	NS
Effect of interaction between nitrogen source and biocontrol agents							
A.S	Control	5.17	5.58	13.83	18.42	44.17	56.83
	T1	5.42	4.75	15.83	16.67	46.42	46.00
	T2	5.00	4.25	17.83	17.42	50.58	47.83
	T1+T2	5.50	5.20	18.00	16.17	56.25	51.50
	B.S	4.33	4.08	14.58	14.75	47.17	46.83
B.C	Control	3.58	3.75	12.00	14.08	37.83	51.33
	T1	4.33	4.58	13.50	14.58	48.83	46.50
	T2	4.58	4.83	15.58	15.92	46.75	50.17
	T1+T2	5.25	5.33	15.00	14.33	58.17	53.33
	BS	4.33	4.42	17.33	14.58	43.17	45.58
ChM	Control	5.33	5.67	19.17	22.08	45.33	49.42
	T1	5.50	5.17	23.67	21.00	51.83	50.25
	T2	5.42	5.50	23.00	22.50	51.42	52.75
	T1+T2	5.75	5.42	27.08	23.50	57.92	56.17
	BS	5.17	5.75	21.00	21.08	48.67	47.75
L.S.D at 5%		0.08	0.11	0.47	NS	0.64	0.82

AS: ammonium sulphate , BC: botanical compost and ChM : chicken manure NS: not significant at 0.05 T_1: *Trichoderma harzianum* , T_2 : *Trichoderma viride* , BS : *Bacillus subtilis*

The triple interaction effect

The obtained results in Table 3 indicated that, in general, the triple interaction among cvs Paulista or Xera, ChM and T1 or T2 as well as mixture of T1 + T2 gave the highest number of branches /plant, whereas the interaction among cv. Paulista, ChM and foliar application with T1+ T2 as biocontrol agent recorded the maximum value of leaves's number/ plant at both seasons and plant height at the 1st one.

TABLE 3. Effect of triple interaction among cultivars, nitrogen fertilizers sources and some biocontrol agents on morphological characters of snap bean plant grown under sandy soil conditions during 2012 - 2014.

Characters / Treatments			Branches number/ plant		Leaves number / plant		Plant height (cm)	
			1st season	2nd season	1st season	2nd season	1st season	2nd season
Paulista	AS	Control	5.16	5.83	13.33	21.50	36.33	58.16
		T1	5.16	4.83	16.00	18.66	41.50	45.00
		T2	5.00	4166	19.00	19.66	51.83	49.83
		T1+T2	5.16	5.66	19.50	17.50	56.50	52.16
		BS	4.16	4.50	17.33	17.66	48.00	47.16
	BC	Control	3.33	4.33	10.83	16.16	34.33	54.33
		T1	4.66	5.00	14.50	15.50	52.33	48.16
		T2	4.66	5.16	17.83	16.66	42.50	48.83
		T1+T2	5.50	5.83	17.33	17.66	57.66	42.16
		BS	4.83	4.66	20.00	18.16	42.66	48.50
	ChM	Control	4.66	4.66	17.00	17.83	41.00	45.83
		T1	5.16	4.83	27.33	23.50	46.66	46.66
		T2	5.50	5.50	22.00	22.83	50.50	51.16
		T1+T2	6.00	5.83	32.33	25.50	56.83	53.83
		BS	5.50	6.33	22.00	23.83	47.33	44.66
Xera	AS	Control	5.16	5.33	14.33	15.33	52.00	55.50
		T1	5.66	4.66	15.66	14.66	51.33	47.00
		T2	5.00	4.33	16.66	15.16	49.33	45.00
		T1+T2	5.83	4.83	16.50	14.83	56.00	50.00
		BS	4.50	3.66	11.83	11.83	46.33	46.50
	BC	Control	3.83	3.16	13.16	12.00	41.33	48.33
		T1	4.00	4.16	12.50	13.66	45.33	44.83
		T2	4.50	4.50	13.33	15.16	51.00	51.50
		T1+T2	5.00	4.83	12.66	11.00	58.66	57.50
		BS	3.83	4.16	14.66	11.00	43.66	42.66
	ChM	Control	6.00	6.66	21.33	26.33	49.66	53.50
		T1	5.83	5.50	20.00	18.50	57.00	53.83
		T2	5.33	5.50	24.00	22.16	52.33	54.33
		T1+T2	5.50	5.00	21.83	21.50	59.00	58.50
		BS	4.83	5.16	20.00	18.33	50.00	50.83
LSD at 0.05			0.70	0.91	4.00	4.24	5.45	N.S

AS: ammonium sulphate , BC: botanical compost and ChM : chicken manure T_1: *Trichoderma harzianum* , T_2 : *Trichoderma viride* and BS : *Bacillus subtilis*

Dry weight

The main effect

Data presented in Table 4 showed that there were significant differences between Paulista and Xera cvs. in dry weight of branches, leaves, shoots and pods/ plant.

Paulista cv. gave higher value of dry weight of branches and shoots, whereas Xera cv. gave higher value of dry weight of leaves and pods /plant in both seasons.

Concerning the effect of nitrogen fertilizer sources, data show that fertilization of snap bean plants with ChM significantly increased dry weight of branches, leaves, shoots and pods/ plant, followed by as in both seasons. Chicken manure contains several species of living organisms that release phytohormones as GA_3, IAA and CYT which stimulates plant growth (Reynders and Vlassak, 1982) and this in turn increases dry matter accumulation.

Foliar application data of snap bean plants with T_1+T_2 as biocontrol agent showed an increase in dry weight of branches, leaves, shoots and pods/ plant compared to control and other biocontrol agent treatments. All biocontrol agents increased fresh and dry weight during b oth seasons. This might be due to their effect on rust pathogen and have a profound effect on crop health (Kloepper *et al.,* 2004). Abdul Wahid *et al*. (2007) found that application of Trichoderma as foliar application increased shoot height, number of flowers and leaf area of bbflowering and leaf expansion mechanism. There are several mechanisms to promote plant growth, the production of external growth regulators (IAA), the induction of growth regulators in treated plant and the lowering ABA content in treated plants this hormone is known to inhibit and regulate plant growth.

TABLE 4. Effect of cultivars, nitrogen fertilizer sources and some biocontrol agents on dry weight of snap bean plant grown under sandy soil conditions during 2012 - 2014.

Character / Treatments	Dry weight of branches/ plant (g)		Dry weight of leaves/ plant (g)		Shoot dry weight / plant (g)		Dry weight of pods/ plant (g)	
	1st Season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of cultivars								
Paulista	7.39	7.42	7.91	7.86	15.30	15.28	3.96	3.98
Xera	6.84	7.04	7.66	8.03	14.50	15.07	4.05	4.01
L.S.D at 5%	0.22		0.06	0.06	0.04	0.06	0.64	0.28
Effect of nitrogen sources								
AS	7.01	7.02	7.91	7.72	14.92	14.74	4.29	4.22
BC	6.03	5.99	6.36	6.49	12.39	12.48	3.33	3.33
ChM	8.34	8.67	9.09	9.63	17.43	18.30	4.43	4.43
L.S.D at 5%	0.08	0.17	0.12	0.12	0.12	0.16	0.02	0.09
Effect of biocontrol agents								
Control	6.89	7.06	7.66	7.95	14.55	15.01	3.67	3.73
T1	6.84	7.03	7.61	7.59	14.45	14.62	3.82	3.79
T2	7.08	6.95	7.71	7.82	14.79	14.77	3.84	3.87
T1+T2	7.98	8.05	8.25	8.41	16.23	16.46	4.98	4.71
BS	6.80	7.48	7.72	7.97	14.52	15.45	3.72	3.86
L.S.D at 5%	0.22	0.28	0.14	0.21	0.32	0.29	0.14	0.17

AS: ammonium sulphate , BC: botanical compost and ChM : chicken manure T_1 T_1: *Trichoderma harzianum* , T_2 : *Trichoderma viride* and BS : *Bacillus subtilis*

The differences found between these cultivars might be attributed to the genetic architecture of these cultivars (Sallam, 2001).

Fertilizing snap bean plants with ChM significantly increased pod length, pod diameter, yield/ plot and total yield/fed., followed by AS treatment. The effect of compost or chicken manure fertilization might be due to the huge numbers of antagonistic microorganisms in the manure in addition to balanced nutrient substances which led to healthy plant (Hoitink, 1998).

The dual interaction effect

In general, fertilizing of Paulista cv. with ChM significantly increased dry weight of branches, leaves shoots and pods/plant, followed by fertilizing of Xera cv. with ChM Table 5.

Respecting the interaction between snap bean cultivars and foliar application with some biocontrol agents. Data revealed that no significant differences effect was found between dry weight of plant parts in both seasons, except dry weight of branches at the 1st season. Also, the interaction between nitrogen fertilizer sources and foliar application with biocontrol agents had no significant effect on dry weight of branches, leaves shoots and pods / plant at both seasons tested, except dry weight of pods in the 1st seasons.

The triple interaction effect

The interaction among Paulista cv. fertilized with ChM and foliar application of T1 + T2 as biocontrol agent gave the highest values of leaves dry weight of branches and pods/plant, followed by the interaction among Xera cv. with ChM and T1+T2 compared to the other triple interactions treatments (Table 6). These results may be due to that organic manures support the number of leave, fresh and dry weight % of plant through the stimulation effect on the meristematic activity of tissue where these organic manures are rich in (N.P.K) and other minerals which are compulsory for plant growth. It was also noticed that, the differences between all tested bioagents were significant in increasing the fresh and dry weight of shoots, leaves and branches when used to control rust pathogenic fungi. All biocontrol agents increased fresh and dry weight during both seasons. This might be due to their effect on rust pathogen and have a profound effect on crop health (Kloepper *et al.,* 2004).

TABLE 5. Effect of dual interaction between cultivars and nitrogen fertilizer sources, cultivars and biocontrol agents, nitrogen fertilizers sources and biocontrol agents on dry weight of snap bean plant grown under sandy soil conditions during 2012 - 2014.

Characters / Treatments		Dry weight of branches/ plant (g)		Dry weight of leaves/ plant (g)		Shoots dry weight / plant (g)		Dry weight of pods/ plant (g)/ 30	
		1st Season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of interaction between cultivars and nitrogen sources									
Paulista	AS	7.18	7.11	7.75	7.58	14.73	14.64	4.36	4.37
	BC	6.05	6.13	6.74	6.41	12.79	12.54	2.89	2.92
	ChM	8.94	9.02	9.25	9.60	18.19	18.62	6.45	4.68
Xera	AS	6.83	6.94	8.08	7.87	14.91	14.81	4.23	4.07
	BC	5.95	5.85	5.97	6.57	11.92	12.42	3.71	3.76
	ChM	7.75	8.33	8.92	9.67	16.67	18.00	4.22	4.20
L.S.D at 5%		0.13	0.19	0.16	0.14	0.17	NS	0.07	0.06
Effect of interaction between cultivars and biocontrol agents									
Paulista	Control	7.06	7.38	7.83	7.80	14.89	15.19	3.64	3.75
	T1	6.90	7.16	7.77	7.54	14.67	14.70	3.81	3.79
	T2	7.65	7.11	7.75	7.73	15.40	14.84	3.88	3.79
	T1+T2	8.38	8.08	8.41	8.41	15.73	15.98	4.85	4.73
	B.S	6.98	7.36	7.82	7.83	14.80	15.19	3.65	3.85
Xera	Control	6.72	6.73	7.49	8.09	14.21	14.82	3.72	3.73
	T1	6.78	6.91	7.44	7.64	14.23	14.55	3.85	3.81
	T2	6.50	6.79	7.67	7.92	14.17	14.71	3.80	3.93
	T1+T2	7.58	8.03	8.09	8.41	15.67	15.42	5.12	4.71
	BS	6.63	6.73	7.61	8.10	14.24	14.84	3.79	3.88
L.S.D at 5%		0.39	NS	NS	NS	NS	NS	NS	NS
Effect of interaction between nitrogen source and biocontrol agents									
AS	Control	6.73	6.81	7.74	7.63	14.47	14.45	3.98	3.97
	T1	6.86	6.74	7.74	7.57	14.60	14.31	4.09	3.99
	T2	7.02	6.52	7.88	7.60	14.90	14.13	4.07	4.15
	T1+T2	7.91	8.20	8.37	8.10	15.19	15.19	5.31	4.74
	BS	6.51	6.85	7.85	7.71	14.36	14.56	4.03	4.18
BC	Control	5.55	5.69	6.18	6.58	11.73	12.27	2.95	3.13
	T1	5.60	5.90	6.28	5.97	11.88	11.87	3.32	3.21
	T2	6.16	5.82	6.32	6.27	12.48	12.09	3.18	3.24
	T1+T2	8.28	8.13	8.22	8.60	12.86	12.94	5.42	5.19
	BS	5.92	5.79	6.20	6.58	12.11	12.37	2.94	3.24
ChM	Control	8.39	8.67	9.05	9.63	17.44	18.30	4.10	4.12
	T1	8.07	8.46	8.80	9.24	16.87	17.70	4.08	4.18
	T2	8.05	8.51	8.93	9.60	16.98	18.11	4.27	4.25
	T1+T2	9.24	9.22	9.55	10.08	18.13	18.97	5.52	5.47
	BS	7.97	8.50	9.11	9.61	17.08	18.11	4.20	4.18
L.S.D at 5%		NS	NS	NS	NS	NS	NS	0.04	NS

AS: ammonium sulphate , BC: botanical compost and ChM : chicken manure NS: not significant at 0.05 ,T_1: *Trichoderma harzianum* , T_2 : *Trichoderma viride* and BS : *Bacillus subtilis.*

TABLE 6. Effect of triple interaction among cultivars, nitrogen fertilizers sources and some biocontrol agents on dry weight of snap bean plant grown under sandy soil conditions during 2012 - 2014.

Characters / Treatments			Dry weight of branches/ plant (g)		Dry weight of leaves/ plant (g)		Shoot dry weight/ plant (g)		Dry weight of pods/ plant (g)	
			1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Paulista	AS	Control	6.87	7.14	7.59	7.45	14.46	14.54	3.95	4.01
		T1	6.76	6.74	7.53	7.47	14.24	14.21	4.29	4.08
		T2	7.57	6.79	7.59	7.38	15.16	14.17	4.20	4.2
		T1+T2	8.19	7.52	8.30	8.10	16.44	15.67	5.35	5.39
		BS	6.54	7.23	7.74	7.49	14.28	14.72	3.99	4.16
	BC	Control	5.59	5.92	6.70	6.36	12.24	12.28	2.69	2.84
		T1	5.29	5.87	6.73	6.07	12.02	11.94	2.92	2.92
		T2	6.37	5.94	6.65	6.14	13.02	12.08	2.91	2.83
		T1+T2	6.99	6.96	7.06	6.99	14.05	13.45	3.31	3.06
		BS	6.02	5.96	6.58	6.48	12.60	12.44	2.61	2.91
	ChM	Control	8.72	9.10	9.19	9.59	17.41	18.64	4.26	4.38
		T1	8.65	8.74	9.06	9.09	17.71	17.83	4.20	4.34
		T2	9.00	8.61	9.00	9.67	18.00	18.28	4.51	4.43
		T1+T2	9.97	9.75	9.86	10.13	19.83	19.88	5.89	5.73
		BS	8.38	8.90	9.15	9.51	17.53	18.41	4.35	4.48
Xera	AS	Control	6.59	6.49	7.90	7.81	14.49	14.30	4.01	3.91
		T1	6.96	6.61	7.96	7.66	14.92	14.27	3.88	3.90
		T2	6.46	6.26	8.17	7.82	14.63	14.08	3.94	4.10
		T1+T2	7.63	8.88	8.43	8.11	16.06	16.99	5.57	4.26
		BS	6.49	6.46	7.95	7.94	14.44	14.40	4.06	4.19
	BC	Control	5.57	5.46	5.67	6.80	11.23	12.26	3.21	3.41
		T1	5.90	5.92	5.82	5.88	11.72	11.80	3.71	3.50
		T2	5.95	5.71	5.98	6.24	11.93	11.95	3.44	3.64
		T1+T2	6.59	6.51	6.58	7.09	13.17	13.60	4.93	4.65
		BS	5.83	5.63	5.81	6.68	11.64	12.30	3.26	3.57
	ChM	Control	8.07	8.24	8.91	9.67	16.98	17.91	3.94	3.84
		T1	7.48	8.19	8.55	9.39	16.03	17.57	3.94	4.01
		T2	7.10	8.41	8.86	9.53	15.96	17.94	4.02	4.05
		T1+T2	8.52	8.68	9.24	10.04	17.76	18.72	5.15	5.21
		BS	7.56	8.11	9.06	9.70	16.62	17.81	4.05	3.87
LSD at 0.05			0.23	0.15	0.18	0.21	N.S	N.S	0.38	0.42

AS: ammonium sulphate , BC: botanical compost and ChM : chicken manure NS: not significant at 0.05 ,T_1: *Trichoderma harzianum*, T_2 : *Trichoderma viride* and BS : *Bacillus subtilis.*

TABLE 7. Effect of cultivars, nitrogen fertilizer sources and some biocontrol agents on yield its components of snap been plant grown under sandy soil conditions during 2012 - 2014.

Characters / Treatments	Pod length (cm)		Pod diameter (cm)		Yield /plot (kg)		Yield /fed.(ton)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of cultivars								
Paulista	12.58	12.37	0.71	0.70	12.28	12.20	4.09	4.06
Xera	11.68	11.74	0.70	0.69	10.87	10.51	3.62	3.50
L.S.D at 5%	0.18	0.51	N.S	N.S	0.27	1.26	0.09	0.42
Effect of nitrogen sources								
AS	12.10	11.73	0.68	0.67	11.66	11.81	3.88	3.93
BC	11.12	11.29	0.70	0.67	9.84	9.86	3.28	3.28
ChM	13.18	13.15	0.74	0.76	13.23	12.40	4.41	4.13
L.S.D at 5%	0.179	0.39	0.02	0.01	0.42	0.45	0.14	0.15
Effect of biocontrol agents								
Control	12.36	12.27	0.71	0.70	10.54	11.20	3.51	3.73
T1	11.76	11.62	0.68	0.67	10.92	10.55	3.64	3.51
T2	12.03	11.88	0.71	0.76	10.81	10.45	3.60	3.48
T1+T2	12.58	12.30	0.70	0.69	14.30	13.91	4.76	4.63
BS	11.93	12.20	0.73	0.73	11.32	10.68	3.77	3.56
L.S.D at 5%	0.48	N.S	N.S	0.03	0.56	0.80	0.18	0.26

AS: ammonium sulphate, BC: botanical compost and ChM : chicken manure , T_1: *Trichoderma harzianum* , T_2 : *Trichoderma viride* and BS : *Bacillus subtilis* , fed =0.42 ha.

Yield and its components

The main effect

Data in indicated that there were significant differences between Paulista and Xera cvs. in pod length, yield/ plot and total yield/fed. at both tested seasons. Paulista cv. gave higher pod length yield/ plot and total yield/fed. than Xera (Table 7).

In addition, foliar application of snap bean plants with T_1+T_2 as biocontrol agent increased pod length, yield/ plot and total yield/fed. These results agreed with those reported by Feleafel and Mirdad (2014) with respect to chicken manure. This improvement led to an increase in yield and dry matter. Bioagents do not only affect outside the treated plants but also affect metabolism inside plant and lead to changes in plant component (Hafez *et al*., 2012). In addition *B. subtilis* produce some growth regulators that increased all growth parameters compared with control treatment. (Ryder *et al*., 1999). On the other hand, *B. subtilis* grows on the treated surfaces and utilized available nutrient substances preventing pathogenic spores to establish germinate and invade healthy tissues.

The dual interaction effect

With respect to the effect of interaction between cultivars and nitrogen fertilizer sources, presented data in Table 8 show that fertilizing cv. Paulista with ChM recorded maximum values of pod length, yield/ plot and total yield/fed. at both seasons. Respecting the interaction between snap bean cultivars and foliar application with some biocontrol agents, the same data show that, foliar application of snap bean cv. Paulista with T1+T2 recorded maximum values of

yield/ plot and total yield/fed. in both seasons. The interaction between ChM and T1+T2 as biocontrol agents recorded maximum values of pod length, yield/ plot and yield/fed., whereas, the interaction between ChM and *Bacillus subtilis* (BS) as biocontrol agents recorded maximum values of pod diameter.

TABLE 8. Effect of dual interaction between cultivars and nitrogen fertilizer sources, cultivars and biocontrol agents, nitrogen fertilizers sources and biocontrol agents on yield and its components of snap bean plant grown under sandy soil conditions during 2012 - 2014.

Characters / Treatments		Pod length (cm)		Pod diameter (cm)		Yield /plot (kg)		Yield /fed. (ton)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of interaction between cultivars and nitrogen sources									
Paulista	AS	12.53	11.93	0.69	0.70	12.15	12.45	4.050	4.150
	BC	11.80	11.99	0.71	0.68	10.90	10.86	3.633	3.620
	ChM	13.43	13.20	0.74	0.74	13.82	13.30	4.607	4.433
Xera	AS	11.67	11.53	0.68	0.65	11.19	11.19	3.730	3.730
	BC	10.45	10.60	0.69	0.66	8.79	8.87	2.930	2.957
	ChM	12.93	13.10	0.75	0.79	12.65	11.51	4.217	3.837
L.S.D at 5%		0.02	0.04	N.S	NS	0.08	0.07	0.04	0.023
Effect of interaction between cultivars and biocontrol agents									
Paulista	Control	12.94	12.89	0.71	0.69	10.48	12.42	3.493	4.140
	T1	11.91	11.56	0.69	0.68	11.90	11.14	3.967	3.713
	T2	12.30	11.72	0.72	0.70	11.07	10.56	3.690	3.520
	T1+T2	13.02	12.51	0.69	0.67	15.70	15.13	5.233	5.043
	BS	12.76	12.86	0.77	0.80	12.30	11.77	4.100	3.923
Xera	Control	11.78	11.67	0.72	0.71	10.56	9.98	3.519	3.327
	T1	11.61	11.69	0.69	0.67	9.49	9.98	3.313	3.327
	T2	11.78	11.72	0.71	0.71	10.55	10.36	3.516	3.453
	T1+T2	12.14	12.09	0.72	0.72	12.91	12.69	4.304	4.230
	BS	11.11	11.56	0.70	0.68	10.34	9.60	3.446	3.200
L.S.D at 5%		N.S	N.S	N.S	N.S	0.19	0.12	0.087	0.036
Effect of interaction between nitrogen source and biocontrol agents									
AS	Control	12.67	12.50	0.73	0.73	9.68	11.58	3.227	3.860
	T1	11.92	11.33	0.63	0.67	11.09	10.65	3.697	3.550
	T2	12.08	11.67	0.65	0.62	11.50	11.57	3.833	3.857
	T1+T2	12.33	11.83	0.67	0.63	14.58	14.39	4.860	4.797
	BS	11.50	11.33	0.75	0.72	11.49	10.90	3.830	3.633
BC	Control	11.83	11.50	0.75	0.67	8.78	9.98	2.927	3.327
	T1	10.33	10.70	0.65	0.62	8.52	8.57	2.840	2.857
	T2	10.50	10.67	0.73	0.73	9.33	8.98	3.110	2.993
	T1+T2	11.38	11.32	0.72	0.67	13.54	13.54	4.513	4.513
	BS	11.58	12.28	0.67	0.67	9.94	9.35	3.164	3.117
ChM	Control	12.58	12.83	0.67	0.70	13.18	12.04	4.393	4.013
	T1	13.03	12.83	0.78	0.73	13.15	12.45	4.383	4.150
	T2	13.53	13.33	0.77	0.77	11.61	10.82	3.870	3.607
	T1+T2	14.03	13.75	0.73	0.78	15.24	14.91	5.080	4.970
	BS	12.72	13.00	0.78	0.83	12.99	11.80	4.330	3.933
L.S.D at 5%		0.14	0.16	0.01	0.01	0.15	0.22	0.045	0.066

AS: ammonium sulphate , BC: botanical compost and ChM : chicken manure NS: not significant at 0.05 ,T_1: *Trichoderma harzianum* , T_2 : *Trichoderma viride* and BS : *Bacillus subtilis*, fed=.042ha.

The triple interaction effect

The triple interaction among cultivars, nitrogen fertilizer sources and foliar application with some biocontrol agents had significant effect on pod length, pod diameter, yield/ plot and total yield/ fed. in the 2nd season only (Table 9). The interaction among Paulista cv. ChM and T1 + T2 as biocontrol agent recorded maximum values of pod length, yield/ plot and total yield/fed. without significant differences compared with the interaction.

TABLE 9. Effect of triple interaction among cultivars, nitrogen fertilizers sources and some biocontrol agents on yield and its components of snap bean plant grown under sandy soil conditions during 2012 - 2014.

Characters / Treatments			Pod length (cm)		Pod diameter (cm)		Yield /plot (kg)		Yield /fed. (ton)	
			1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Paulista	AS	Control	13.33	13.00	0.70	0.76	9.36	13.96	3.12	4.65
		T1	12.00	11.33	0.66	0.73	11.84	10.93	3.94	3.64
		T2	12.66	12.00	0.66	0.63	11.93	11.13	3.97	3.71
		T1+T2	12.33	11.66	0.66	0.60	15.14	14.78	5.04	4.92
		BS	12.33	11.66	0.76	0.76	12.45	11.43	4.15	3.81
	BC	Control	13.00	12.00	0.76	0.70	8.53	10.46	2.84	3.48
		T1	10.33	10.66	0.63	0.63	9.82	9.44	3.27	3.14
		T2	10.50	10.83	0.73	0.73	9.84	9.36	3.28	3.12
		T1+T2	12.33	12.20	0.70	0.60	13.54	12.20	5.18	4.73
		B.S	12.83	14.23	0.73	0.73	10.77	10.83	3.95	3.61
	ChM	Control	12.50	13.66	0.66	0.60	13.53	12.83	4.51	4.27
		T1	13.40	12.66	0.76	0.66	14.03	13.03	4.67	4.34
		T2	13.73	13.33	0.76	0.73	11.43	11.16	3.81	3.72
		T1+T2	14.40	13.66	0.70	0.80	16.41	15.41	5.47	5.20
		BS	13.10	12.66	0.80	0.90	13.68	13.03	4.50	4.34
Xera	AS	Control	12.00	12.00	0.76	0.70	10.00	9.2	3.33	3.06
		T1	11.83	11.33	0.60	0.60	10.33	10.03	3.44	3.45
		T2	11.50	11.33	0.63	0.60	11.06	12.00	3.68	4.00
		T1+T2	12.33	12.00	0.66	0.66	15.00	14.66	5.00	4.88
		BS	10.66	11.00	0.73	0.66	10.55	10.26	3.51	3.45
	BC	Control	10.66	11.00	0.73	0.63	9.33	9. 50	3.01	3.16
		T1	10.33	10.73	0.66	0.60	7.22	7.70	2.40	2.56
		T2	10.50	10.50	0.73	0.73	8. 81	8.60	2.93	2.86
		T1+T2	10.43	10.43	0.73	0.73	11.66	10.06	3.55	3.35
		BS	10.33	10.33	0.60	0.60	8.21	7.87	2.73	2.62
	ChM	Control	12.66	12.00	0.66	0.80	12.83	11.24	4.27	3.74
		T1	12.66	13.00	0.80	0.80	12.26	11.86	4.08	3.95
		T2	13.33	13.33	0.76	0.80	11.79	10.46	3.93	3.48
		T1+T2	12.33	13.83	0.76	0.76	14.06	13.40	4.68	4.46
		BS	12.33	13.33	0.76	0.76	12.3	10.56	4.10	3.52
LSD at 0.05			N.S	1.34	N.S	0.08	N.S	2.08	NS	0.69

AS: ammonium sulphate , BC: botanical compost and ChM : chicken manure NS: not significant at 0.05 ,T_1: *Trichoderma harzianum* , T_2 : *Trichoderma viride* , BS : *Bacillus subtilis* , fed=0.42ha.

Among Xera cv. ChM and T1 or T2 or T1+T2 (as biocontrol agent) with respect to pod length .On the other hand, the interaction among Paulista cv. with ChM and BS as biocontrol agent recorded maximum values of pod diameter. Increase of beans yield also due to two factors, healthy root system that can

absorb and supply adequate amount of raw nutrient substances and the syntheses of these raw nutrient material effectively in presence of high amount of chlorophyll and protein, resulted in more pod. (Sontos *et al*., 2001) reported that, increasing beans yield and its components as a result of chicken manure fertilization was due to the enhancing effect of chicken manure on vegetative growth.

Rust disease incidence and severity (%)
The main effect

Presented data in Table 10 shows that, there were no significant differences between incidence (DI %) and severity (DS %) of rust disease, except on Paulista and Xera cultivars DS in the 2nd season. Paulista cv. show higher rust severity (38.79 %) than Xera cv. (30.43 %) at the 2nd season. These results agreed with those reported by Abd El-Hamed (2014) who reported that the Paulista cv. showed highest percentage of infected plants, disease severity and the lowest one in survival plants also, Xera cv. was the lowest cv. in DS and highest one in survival plants.

TABLE 10. Effect of cultivars, nitrogen fertilizer sources and some biocontrole agents on rust disease in leaves of snap been grown under sandy soil conditions during 2012 -2014.

Characters / Treatments	Reduction of leaf rust disease (%)			
	Incidence		Severity	
	1st Season	2nd season	1st season	2nd season
Effect of cultivars				
Paulista	21.11	15.06	33.97	38.97
Xera	17.88	15.66	32.95	30.43
L.S.D at 5%	N.S	N.S	N.S	1.74
Effect of nitrogen sources				
AS	21.83	16.46	38.48	38.13
BC	18.00	14.96	29.12	30.41
ChM	18.66	14.66	32.79	35.57
L.S.D at 5%	2.75	1.12	1.342	2.41
Effect of biocontrol agents				
Control	28.33	24.72	48.45	45.11
T1	19.16	13.22	27.75	30.12
T2	19.44	14.00	32.98	35.50
T1+T2	15.27	12.33	30.45	30.74
BS	15.27	12.55	27.68	32.05
L.S.D at 5%	7.08	3.41	4.53	4.01

AS: ammonium sulphate , BC: botanical compost and ChM : chicken manure T_1: *Trichoderma harzianum* , T_2 : *Trichoderma viride* , BS : *Bacillus subtilis.*

TABLE 11. Effect of dual interaction between cultivars and nitrogen fertilizer sources, cultivars and biocontrol agents, nitrogen fertilizers sources and biocontrol agents on rust disease in leaves of snap bean grown under sandy soil conditions during 2012-2014.

Characters / Treatments		Reduction of leaf rust disease (%)			
		Incidence		Severity	
		1st Season	2nd season	1st season	2nd season
Effect of interaction between cultivars and nitrogen sources					
Paulista	AS	23.33	15.60	39.36	42.46
	BC	20.00	14.93	29.12	34.12
	ChM	20.00	14.67	33.45	40.36
Xera	AS	20.33	17.33	37.60	33.81
	BC	16.00	15.00	29.14	26.71
	ChM	17.33	14.67	32.13	30.79
L.S.D at 5%		N.S	N.S	N.S	N.S
Effect of interaction between cultivars and biocontrol agents					
paulista	Control	28.89	23.89	48.08	49.04
	T1	22.22	13.11	27.44	36.71
	T2	22.22	14.67	35.67	39.13
	T1+T2	16.67	11.33	28.06	34.05
	BS	15.56	12.33	30.63	35.96
Xera	Control	27.78	25.56	38.83	30.08
	T1	16.11	13.33	28.07	23.53
	T2	16.67	13.33	30.30	31.88
	T1+T2	13.89	13.33	32.85	27.44
	BS	15.00	12.78	24.75	28.15
L.S.D at 5%		N.S	N.S	N.S	N.S
Effect of interaction between nitrogen source and biocontrol agents					
AS	Control	31.67	28.33	53.73	50.75
	T1	19.17	12.83	32.92	35.00
	T2	23.33	15.00	40.83	35.60
	T1+T2	18.33	14.17	32.45	32.07
	BS	16.67	12.00	32.98	37.27
BC	Control	25.00	42.50	42.50	39.68
	T1	20.00	28.89	28.89	23.87
	T2	17.50	24.59	24.59	34.81
	T1+T2	12.50	25.25	25.20	28.53
	BS	15.00	24.47	24.47	25.18
ChM	Control	28.33	49.14	49.14	44.93
	T1	18.33	21.97	21.97	31.50
	T2	17.50	33.53	33.53	36.11
	T1+T2	15.00	33.71	33.71	31.63
	BS	14.17	25.62	25.62	33.70
L.S.D at 5%		N.S	N.S	N.S	N.S

Fertilizing snap bean plants with (AS) recorded maximum values of DI % (21.83 % and 16.46 %) and (38.48 % and 38.13 %) for DS% at the 1st and 2nd seasons, respectively. Whereas botanical compost (BC) recorded the lowest values of DI % (18 % and 14.96 %) and DS% (29.12 and 30.41%) at the 1st and 2nd seasons, respectively. This might be due to that farm manure has acidic pH. This acidic reaction makes microelements available for plant nutrition (Chaboussous, 1985).

As well as, foliar application of snap bean plants with biocontrol agents (T1 and T2, (T1+T2) and BS) were recorded minimum values of DI % and DS% compared to control.

The treatment of T1+T2 and BS gave the lowest values of DI %, while T1 gave the lowest values of DS%.

These results agreed with those reported by Abd-El-Hamed (2014). He found that foliar application of snap bean with different biocontrol agents gave the lowest values of DS% compared to control *T. harzianum* and *Bacillus subtilis* were the highest effective against the rust disease.

The dual interaction effect

The dual interactions between cultivars and nitrogen fertilizer sources, cultivars and biocontrol agents and nitrogen fertilizer source and biocontrol agents did not reflect any significant effect on leaves rust disease incidence and severity on snap bean plant at both seasons.

The triple interaction effect

The triple interaction among cultivars, nitrogen fertilizer sources and foliar application with some biocontrol agents had no significant effect on leaves rust disease incidence and severity on snap bean plant at both seasons (Table 12). The effect of mixture can be explain on the light of work carried out by (Abd El- Moity, 1985). He stated that, this synergistic effect might be due to complementary effect between different isolates included in the mixture. This means that, one isolate produced antifungal substance, whereas the second isolate has high potentialities in mycoparasitism**,** while the third one induce plant resistant (Bolar *et al*., 2000).The combination between these different effects results in high effect in controlling rust disease., whereas, the interaction between ChM and (BS) as biocontrol agents recorded maximum values of reduction disease incidence and disease severity (Table 12). This can be explained of the light of fact that *B. subtilis* grow very fast and occupied the court of infection and compete for spaces and nutrients preventing pathogens to invade plants (Wolk and Sorkar 1994). *B. subtilis* produce some growth regulators that increased all growth parameters compared with control treatment so prevent pathogens to invade plants (Ryder *et al*., 1999).

TABLE 12. Effect of triple interaction among cultivars, nitrogen fertilizers sources and some biocontrol agents on rust disease in leaves of snap bean grown under sandy soil conditions during 2012-2014.

Characters / Treatments			Reduction of leaf rust disease (%)			
			Incidence		Severity	
			1st season	2nd season	1st season	2nd season
Paulista	AS	Control	30.00	26.66	54.81	53.33
		T1	23.33	12.33	31.85	38.88
		T2	26.66	15.00	40.83	40.74
		T1+T2	20.00	13.33	60.06	37.40
		BS	16.66	10.66	39.25	41.94
	BC	Control	26.66	23.33	40.83	45.18
		T1	23.33	15.00	28.14	30.59
		T2	20.00	14.00	32.85	37.77
		T1+T2	13.33	11.00	19.29	30.37
		BS	16.66	12.33	24.47	26.66
	Ch M	Control	30.00	21.66	48.61	48.61
		T1	20.00	12.00	22.33	40.66
		T2	20.00	15.00	33.33	38.88
		T1+T2	16.66	10.66	34.81	34.37
		BS	13.33	14.00	28.15	39.25
Xera	AS	Control	33.33	30.00	52.65	48.17
		T1	15.00	13.33	32.99	31.11
		T2	20.00	15.00	40.83	30.46
		T1+T2	16.00	15.00	34.84	26.72
		BS	16.66	13.33	26.69	32.59
	BC	Control	23.33	21.66	44.16	34.16
		T1	16.66	11.66	29.62	17.15
		T2	15.00	13.66	16.33	31.85
		T1+T2	11.66	15.00	31.11	26.69
		BS	13.33	13.33	24.47	23.00
	Ch M	Control	26.66	25.00	49.66	41.24
		T1	16.66	15.00	21.59	22.33
		T2	15.00	11.66	33.73	33.33
		T1+T2	13.33	10.00	32.59	28.89
		BS	15.00	11.66	23.08	28.15
LSD at 0.05 %			N.S	N.S	N.S	N.S

AS: ammonium sulphate , BC: botanical compost and ChM : chicken manure NS: not significant at 0.05 ,T_1: *Trichoderma harzianum* , T_2 : *Trichoderma viride* , BS : *Bacillus subtilis*

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تأثير بعض مصادر السماد النيتروجينى و بعض عوامل المكافحة الحيوية على النمو ، المحصول و الإصابة بمرض الصدأ لبعض أصناف الفاصوليا المنزرعة تحت ظروف الأرض الرملية

منال مندور و هويدا متولى
المعمل المركزى للزراعة العضوية - مركز البحوث الزراعية - القاهرة – مصر.

أجرى هذا البحث خلال موسم الخريف لعامين متتاليين (٢٠١٢ – ٢٠١٤) فى مزرعة بمحطة بحوث البساتين بالقصاصين، محافظة الإسماعيلية ، مصر لدراسة تأثير ثلاثة مصادر من السماد النيتروجينى (سلفات أمونيوم ٢٠،٥٪ نيتروجين بمعدل، ٣٩٠،٢ كجم /فدان (فدان = ٠،٤٢ هكتار) و كمبوست نباتى بمعدل ٦،٧٦٦طن / فدان و سماد الدواجن بمعدل ٢،٧٨٧ طن / فدان). وخمس معاملات مكافحة حيوية (كنترول، ترايكوديرما هارزيانيم، ترايكودرما فيردى، خليط ترايكوديرما هارزيانيم + ترايكودرما فيردى، باسيلس سنتلس) ودراسة تأثير العوامل السابقة على النمو ، المحصول وكذلك الإصابة بمرض الصدأ لصنفى الفاصوليا بوليستا و اوجزيرا المنزرعة تحت ظروف الاراضي الرملية خلال موسم الخريف.

اظهرت النتائج ان الصنف بوليستا أعطى أكبر وزن جاف للمجموع الخضرى والمحصول الكلى للفدان بالمقارنة بالصنف اوجزيرا أدى التسميد بسماد الدواجن بمعدل٢،٧٨٧ طن / فدان إلى زيادة الوزن الجاف للمجموع الخضرى والمحصول الكلى للفدان وكذلك أدى الرش بخليط الترايكودرما هارزيانيم + ترايكودرما فيردى إلى زيادة عدد كل من الأفرع و الأوراق على النبات ، الوزن الجاف للمجموع الخضرى ، طول القرن ، المحصول الكلى للفدان ،وقد أدى تسميد صنف الفاصوليا صنف بوليستا بسماد الدواجن بمعدل٢،٧٨٧طن / فدان و الرش بالترايكوديرما هارزيانيم + ترايكودرما فيردى إلى زيادة عدد الأفرع و عدد الأوراق على النبات ، ارتفاع النبات ، الوزن الجاف للأوراق و الأفرع و المجموع الخضرى و طول القرن و المحصول الكلى للفدان .

أظهر الصنف أوجزيرا أقل شدة إصابة بمرض الصدأ بالمقارنة بالصنف باوليستا وقد ادي تسميد الفاصوليا بالكمبوست النباتى بمعدل٦،٧٦٦ طن / فدان أقل نسبة اصابة بمرض الصدأ يلية سماد الدواجن بمعدل٢،٧٨٧ طن / فدان .

في حين سجل التسميد بسلفات النشادر بمعدل٣٩٠،٢ كجم / فدان أعلى نسبة بهذا الخصوص وأدى الرش بعوامل المقاومة الحيوية الي النقص الإصابة بمرض الصدأ بالمقارنة بالكنترول (بالنباتات الغير معاملة) وأدى الرش بخليط الترايكودرما هارزيانيم + ترايكودرما فيردى، أو باسيلس سنتلس إلى خفض الإصابة بمرض الصدأ .