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TREATMENT OF SNAP BEAN PLANTS GROWN UNDER SANDY SOIL CONDITIONS WITH SOME NATURAL MATERIALS AND ITS RELATION TO GROWTH, YIELD AND POD QUALITY

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ABSTRACT

Two field experiments were carried out during the fall seasons of 2012 and 2013 at the Agriculture Research Farm, El-Kassasien Hort. Res. Station, Ismalia Governorate, Egypt, and storage Lab., Hort. Dept., Fac. of Agric., Zagazig University, to study the effect of seed and soil inoculation (arbuscular mycorrhizal fungi, soil yeast) as well as foliar application with some natural materials (pigeon manure tea, compost tea, humic acid and effective microorganisms) on growth, photosynthetic pigments, yield and its components as well as chemical constituents of snap bean pods (*Phaseolus vulgaris* L.) cv. Paulista. It aimed also to study the effect of the abovementioned treatments on snap bean pods storability during cold storage at 7 ^{o}C and 90-95% RH in different periods, i.e., 7, 14,21 and 28 days. Results show that there were significant increases in vegetative growth characters, photosynthetic pigments, yield and it's components as well as some chemical constituents of pods as a_result of snap bean seeds inoculation with AMF plus application with soil yeast around root zone by using hand sprayer as compared to other treatments.

Spraying snap bean plants with pigeon manure tea at 10g/L recorded maximum values of vegetative growth characters, photosynthetic pigments, yield and it's components as well as chemical constituents of pods followed by humic acid at 3cm^3/L as compared to the control.

The interaction treatment between dual inoculation with AMF and soil yeast and foliar spray with pigeon manure tea gave the highest values of vegetative growth characters, photosynthetic pigments, yield and it's components as well as chemical constituents of pods followed by the interaction treatment between dual inoculation with AMF and soil yeast and foliar spray with humic acid.

Generally, quality parameters of snap bean pods during cold storage at 7 ^{o}C and 90-95 RH indicate that weight loss was increased, while dry matter, total carbohydrates and crude protein percentage in snap bean pods were decreased as the storage period prolonged up to 28 days from the beginning of storage period. Green pods obtained from plants treating by dual inoculation with AMF and soil yeast and sprayed with pigeon manure tea or humic acid and stored at 7 ^{o}C and 90-95 RH for 21 days was the best interaction treatment recorded the lowest values of weight loss and the best values of dry matter, total carbohydrates and crude protein percentage.

Keywords: AMF, soil yeast, pigeon manure tea, compost tea, humic acid, effective microorganisms, snap bean, growth, yield, chemical constituents, storage period.

INTRODUCTION

Snap bean (*Phaseolus vulgaris* L.) is one of the most important vegetable crops grown in Egypt for both local consumption and exportation. Such importance comes from the fact that legumes are cheap and very rich in protein content, minerals and vitamins which is essential for human nutrition rather than the role of such crops in improving soil fertility (Kerlous, 1997 and Abdel-Hakim *et al*., 2012).

Uses of mineral fertilizers (NPK) without rationalization may cause environmental pollution as well contaminate the underground water. For these reasons, there was a great attention to use biofertilizers in production of snap bean in order to reduce plant and soil contamination with different elements and decline the usage of mineral fertilizers as well as produce clean crop and also to improve the soil properties. Biofertilizers (microbial inoculation), which contain efficient strains of nitrogen fixing, could be used partially instead of chemical nitrogen fertilizers. Moreover, these bacterial cells increase the availability of nutrients in the form that can be easily absorbed by plants (Subba Rao, 1993).

Arbuscular Mycorrhizal (AM) fungi are found in many soils around the world, and they form association with 80% of all terrestrial plant roots (Harley and Harley, 1987). AM fungi helps in water regulation of plants by extending their hyphae towards the available moisture zone for continuous water absorption and translocating it to plants. AM association can affect the host plants in terms of stomatal movement and photosynthesis of leaves and has been shown to increase the rate of transpiration, photosynthesis and chlorophyll content (Panwar, 1991). The beneficial effects of AM fungi symbiotic association on the growth of plants are well known (Rajasekaran and Nagarajan, 2004).

Treatment snap bean plants with AM fungi significantly increased vegetative growth, chlorophyll content, chemical composition of pods and yield and its components as compared to the control (El-Shimi, 2004). Massoud *et al*. (2009) found that inoculation snap bean plants with the mixture of AM- fungi, symbiotic and a symbiotic N_2 -fixers and *Bacillus circulans* + rock phosphate + feldspar) was superior in plant height, number of branches, and fresh yield (ton/fed) when compared with the control. Inoculation *Vigna unguiculata* L. with arbuscular mycorrhizal fungi gave a significant increase in root length, shoot height, dry weight of root and shoot, percentage of mycorrhizal infection, chlorophylls *a, b* and total chlorophyll (Arumugam *et al*., 2010). Interaction between Mycorrhiza and *Rhizobium* showed the highest seed yield and biological yield of snap bean plants (Safapour *et al*., 2011).

Yeast is considered as a natural source of Bs vitamins and most of the essential elements (Nagodawithana, 1991). Yeasts in root zone may influence plant growth indirectly by encouraging the growth of other plant growth promoting rhizomicroorganisms, combined inoculation of AM fungus and *Saccharomyces cerevisiae* resulted in highest vegetative growth, chlorophyll content, nitrogen and phosphorus uptake as well as pod yield of cowpea plants (Body *et al*., 2007).

Foliar spray with yeast had a simulative effect on vegetative growth, chlorophyll content and yield and its components (Nour and Eisa, 2009 and Abdel-Hakim *et al*., 2012 on snap bean; Mohamed, 2014 on pea and Marzauk *et al*., 2014 on broad bean) .

Compost and pigeon manure tea, in modern terminology are a compost and pigeon manure extract, plant extracts, liquid manure and compost teas can by further understood in the context of their influences on the rhizosphere and phyllosphere. Also, manure and compost tea production is a brewing process that extracts microorganisms from compost or manure followed by microbial growth and multiplication including beneficial bacteria, fungi and protozoa (Ingham, 2005). Foliar spray with manure tea had simulative effect on vegetative growth, chlorophyll content and yield and its components, Moyin-Jesu (2003) for goat dung, turkey and duck manure tea fertilizers on locust bean, El-Nakma (2008) for compost tea on pea, Ahmed and Elzaawely (2010) and Kurtar (2013) for pigeon manure on cowpea and cabbage.

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, productivity and quality (El-Bassiony *et al*., 2010; Hanafy *et al*., 2010; Shehata and El-Helaly, 2010) and Shafeek *et al*. (2013) on broad bean.

Many researchers reported that spraying plants with effective microorganisms (EM) encouraged plant growth, productivity and quality (Javaid and Mahmood, 2010 on soybean and Dawa *et al*., 2013 on pea).

Thus, this work aimed to study the effect of soil and foliar spray with some natural materials (arbuscular mycorrhizal fungi, soil yeasts, humic acid, compost tea, pigeon manure tea and effective microorganisms) on improving growth, photosynthetic pigments, yield and its components and pods quality as well as increasing storability of green snap bean pods grown under sandy soil conditions.

MATERIALS AND METHODS

Field experiment:

The present investigation was carried out during the fall seasons of 2012 and 2013 at the Agriculture Research Farm, El-Kassasien Hort. Res. Station, Ismalia Governorate, Egypt. It aimed to study the effect of soil and seed treatment as well as foliar spray with some natural materials (arbuscular mycorrhizal fungi, soil yeast, pigeon manure tea, compost tea, humic acid and effective microorganisms) on growth, photosynthetic pigments, yield and its components as well as some chemical constituents of snap bean pods (*Phaseolus vulgaris* L.) cv. Paulista. The physical and chemical analysis of the experimental soil is presented in Table 1 according to Chapman and Pratt (1982).

Table 1: The physical and chemical properties of the experimental soil (average of two seasons).

Physical properties		Chemical properties	
Coarse sand (%)	5.9	Organic matter (%)	0.29
Fine sand (%)	78.8	Available K (ppm)	119.3
Silt (%)	8.6	Available P (ppm)	4.85
Clay (%)	6.7	Available N (ppm)	21.7
Field capacity	6.8	Calcium carbonate (%)	3.97
Wilting point	2.5	pH	7.8
Available water	4.5	EC $dS.m^{-1}$(1:5)	0.59
Water holding capacity	14.5	S.P%	23.5

Seeds of snap bean cv. Paulista were obtained from Hort. Res. Inst., Agric. Res. Center, Egypt, and sown on September 15^{th} and 18^{th} in 2012 and 2013, respectively on one side of drippers lines (two seeds /hill) at 10 cm apart. At 15 days from sowing, plants were thinned leaving one plant / hill. The experimental unit area was $10.5m^2$, it contained 3 dripper lines with 5m length each with 70 cm wide with 150 plant per plot. One dripper line was left between each two experimental units without spraying as a guard row to avoid the overlapping of spraying solution.

This experiment included twenty treatments which were the combination between four seed and soli inoculation treatments and five foliar application. Treatments were arranged in a split plot design with three replicates seed and soil inoculation treatments were assigned at random in the main plots, while sub-plots were devoted to foliar application treatments. The treatments carried out in this study were as follows:

Main plots (seed and soil inoculation):

1-Control (without) 2- Arbuscular mycorrhizal fungi (AMF) at 1kg/fed.
3- Soil yeast at 10 L/fed. 4- AMF + soil yeasts.

Sub-plots (foliar application):

1- Control (tab water) 2- pigeon manure tea at 10g/L 3- Compost tea at 10g/L 4- Humic acid at $3cm^3$/L 5- Effective microorganisms (EM) at $3cm^3$/L.

Snap bean plants were sprayed three times during the growth period after 20, 30 and 40 days from sowing. Each experimental unit received 2 L spraying solution using spreading agent (Super Film) in all treatments. The untreated plants (check) were sprayed with 2 L tap water with spreading agent.

Mature compost and pigeon manure were soaked by tied each dose (10g/L water) in a cotton tissue and left hanged for 48 hours in a plastic bucket, sized 20 L until the water turns into brown in color and the extract had no smell, then used for spraying.

The composition of compost and pigeon manure tea is listed in Table 2.

Table 2: Some chemical characteristics of the used organic tea .

parameters	Pigeon tea	Compost tea
pH (1:5)	6.15	6.72
EC $dS.m^{-1}$	5.07	5.65
Total N ppm	89.7	58.9
Total P ppm	16.9	13.4
Total K ppm	465	398
Total Fe ppm	33.8	26.3
Total Mg ppm	11.3	8.6
Total Zn ppm	9.7	6.9

Arbuscular mycorrhizal fungi (AMF) inoculum was prepared as described by Massoud *et al.* (2009). Mixed surface sterilized spores of AM – genera via, *Glomus, Gigaspora* and *Acaulospora* were prepared after propagation and mixed with sterilized vermiculite 20% as a carrier (500 spore / g vermiculite). Then adhesion using sticker such as Arabic gum and uniformly coated on the seeds and air dried for 1 hour before planting.

The yeast strain (*Saccharomyces cerevisiae*) was grown on glucose peptone yeast (GPY) liquid medium contains 2% glucose, 0.5% peptone 0.3% yeast extract (Difco, 1985). This medium was autoclaved at 121 ^oC for 20 min then the strain inoculated with loop full and incubated at 30 ^oC for 48 h on rotary shaker at 150 rpm. The inoculum of yeast strain ($1x10^7$ CFU/ml) were added two times around root zone by using hand sprayer at a rate of 10 L/fed in twice after 15 and 30 days from sowing. Arbuscular mycorrhizal fungi and yeast strain were obtained from the microbiology department, Soils, Water and Environment Res. Inst., Agric. Res. Center, Giza, Egypt.

All plots received equal amounts of compost at a rate of 20 m^3/feddan during soil preparation, and 50% of recommended nitrogen fertilizer rate (120 kg/fed.) ammonium nitrate (33.5% N) was added in three equal doses during soil preparation, at 20 and 40 days after sowing, the other recommended agricultural practices for commercial snap bean production; i.e., irrigation, phosphorus and potassium fertilization and weed control were followed according to Agriculture Ministry recommendation for snap bean.

Data recorded: The obtained data in this study were recorded as follows:

A. vegetative growth characters: Six plants from each plot were randomly taken at 50 days after sowing to evaluate Plant height, number of leaves and branches/plant and dray weight of foliage.

B. Photosynthetic pigments: Disk samples from the fourth upper leaf on the main stem were taken at 50 days after sowing to determine chlorophyll a, b and total chlorophyll (a+b) as well as carotenoids according to Wettestein (1957).

C. Yield and its components:

Green pods of each experimental unit were continuously harvested at suitable maturity stage counted and weighed in each harvest till the end of the experiment and the following data were recorded: Average number of pods/plant, average pod weight, green pods yield /plot and total green pods yield /fed. At the second harvest, ten pods from each experimental unit were randomly taken to measure average pod length .

D. Pod chemical constituents:

Sample of green pods from each experimental unit was oven dried at 70 ^{o}C. It finely ground separately and digested with sulfuric acid and percholoric acid (3:1). Nitrogen%, phosophorus% and potassium % were determined according to the method described by Bremner and Mulvaney (1982), Olsen and Sommers (1982) and Jackson (1970), respectively. crude protein was calculated by multiplying the total nitrogen by 6.25. Total carbohydrates were determined colorimetrically using the method described by Dubois *et al.* (1956).

Storage experiment:

This experiment was conducted to study the effect field experiment on keeping quality of snap bean green pods during cold storage, mature green pods from the field experiment, were harvested at suitable maturity stage for marketing on 15th November and transported soon to the handling Lab., Hort. Dept., Fac. of Agric., Zagazig University, Egypt, and kept overnight at 7 ^{o}C and 90-95% relative humidity (RH). Marketable green snap bean pods (250g) packed in micro perforated polypropylene bags 12 × 15cm (with 30µ thickness) sealed hermetically. Twelve polypropylene bags were prepared for each treatment, placed in carton box (30 × 20 ×10cm), then stored at 7 ^{o}C and 90-95% RH for 28 days. Three polypropylene bags were randomly taken from each treatment every 7 days for determining the postharvest measurements. The experimental design was completely randomized with three replicates.

Pod physical and chemical properties were recorded as follow:

A. Weight loss (%): It was calculated according to the following equation:

$$\textbf{Weight loss (\%)} = \frac{\textbf{Initial weight of pods – Weight of pods at sampling dates}}{\textbf{Initial weight}} \times 100$$

B. Dry matter (%): It was determined after drying at 70 ^{o}C till constant weight.

C. Total carbohydrates and crude protein (%) were determined as aforementioned in the first experiment.

Statistical analysis: data of the field experiment and cold storage experiment were statistically analyzed using MSTAT statistical software and the treatments means were compared using LSD at 0.5 level of probability according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Growth characters and photosynthetic pigments :

Effect of seed and soil inoculation:

It is obvious from the data presented in Table 3 that treating snap bean seeds with AMF or /and soil yeast significantly increased vegetative growth characters expressed as plant height, number of leaves and branches per plant as well as total dry weight in addition to photosynthetic pigments, the most favorable treatment for enhancing growth characters and photosynthetic pigments was the dual inoculation with AMF and soil yeast than the individual treatment with AMF or soil yeast. on the other hand the lowest values in this respect were recorded generally in case of the control.

The beneficial effect of yeast application on growth parameters of snap bean plants may be due to that yeast (*Saccharomyces Cerevisiae*) as a natural source for cytokinins had stimulatory effects on cell division, cell enlargement, protein and nucleic acid synthesis as well as chlorophyll formation (Spencer *et al.,* 1983). Also yeast was found to contain carbohydrate, amino acids and lipids as well as several vitamins and most nutritional elements, i.e., Na, Ca, Fe, Mg, K, P, S, Zn and Si (Nagodawithana, 1991).

Such stimulative effect of AMF on the chlorophyll content may be due to the increase in stomatal conductance, photosynthesis, transpiration and enhanced plant growth (Rajasekaran *et al*., 2006) or due to the presence of large and more numerous bundle sheath chloroplasts in the inoculated leaves (Krishna and Bagyaraj, 1984). Obtained results are agreeable with those reported by Nour and Eisa (2009), Abdel-Hakim *et al*. (2012) on snap bean, Mohamed (2014) on pea and Marzauk *et al*. (2014) on broad bean for yeast. Similar findings with AMF were obtained by El-Shimi (2004), Massoud *et al.,* (2009) on snap bean and Arumugam *et al*. (2010) on cow pea.

Effect of foliar application:

Presented data in Table 3 indicate that spraying snap bean plants with all tested treatments, i.e., pigeon manure tea, compost tea, humic acid and EM had significant increase on vegetative growth characters and photosynthetic pigments as compared to untreated plants, the superior treatments in this respect were pigeon manure tea followed by humic acid. These results are true in both growing seasons. The increase in vegetative growth characters and photosynthetic pigments of snap bean plants by using pigeon manure tea solution could be due to its high N, P, K, Fe, Mg and Zn contents (Table 2). Whereas the beneficial effects of humic acid on plant growth could be referred to its acting as source of plant growth hormones (Nardi *et al.,* 1999).

Similar findings with manure tea foliar application were obtained by Moyin-Jesu (2003) for goat dung, turkey and duck manure tea fertilizers on locust bean, El-Nakma (2008) for compost tea on pea, Ahmed and Elzaawely (2010) and Kurtar (2013) for pigeon manure on cowpea and cabbage. In addition, the obtained results with humic acid foliar nutrition agree with those of El-Bassiony *et al*. (2010), Hanafy *et al*. (2010), Shehata and El-Helaly (2010) on snap bean and Shafeek *et al*. (2013) on broad bean.

Effect of the interaction:

It is evident from the results in Table 4 that such interaction treatments generally had a promotive effect on vegetative growth and photosynthetic pigments of snap bean plants, the interaction between dual inoculation with AMF and soil yeast beside foliar application with pigeon manure tea resulted in the maximum values of abovementioned characters followed by the interaction between dual inoculation with AMF and soil yeast in addition to foliar application with humic acid at 3cm^3 /L as compared to other treatments in both growing seasons.