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Physiological Responses, Growth, Yield and Quality of Snap Beans in Response to Foliar Application of Yeast, Vitamin E and Zinc under Sandy Soil Conditions

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Abstract: The experiments were conducted under sandy soil conditions in the experimental farm of the National Research Center in Nubaria region. The aim of the experiments was to investigate the effects of foliar application of yeast, vitamin E and Zn on vegetative growth , yield and physiological responses of snap bean plants. Several measurements were recorded to study the effects of these treatments including vegetative growth measurements, yield, pod quality, hormonal changes in leaves (Cytokinins, IAA and GA3), protein, carbohydrates, fibers in pods and total chlorophyll, Nitrogen, phosphorus and potassium contents in leaves. The results showed that foliar application of vitamin E, yeast and Zn treatments significantly improved vegetative growth and yield of bean plants compared to control plants especially at the higher concentrations. Concerning hormonal changes in response to the treatments, there were significantly higher contents of cytokinins, IAA and GA3. The yeast treatments obtained the highest levels of those hormones in leaves. The treatments resulted in a higher total chlorophyll content compared to control plants. Also treatments significantly improved the carbohydrates content in pods and reduced fibers. The effects of vitamin E, Yeast and Zn on chemical compositions of leaves and on pod quality are discussed.

Key words: Snap bean, Vitamin E, Zinc, Yeast, Sandy soil

INTRODUCTION

Snap bean plants (*Phaseolus vulgaris L.*) is considered one of important vegetable crops cultivated in Egypt for local market and it has a great importance for exportation. However, bean plants are relatively sensitive to environmental stresses that may occur in the field (especially under sandy soil conditions) compared to most vegetable crops which negatively affects its growth, yield and even the quality of pods. Many investigations indicated that bean plants is very sensitive to different environmental stresses such as chilling (El-Tohamy *et al*., 2001; Singer *et al*., 1996), drought (Millar and Gardner, 1972; Halterlein, 1983; El-Tohamy *et al*, 1999) and heat stress (Dale, 1964). Freyer (1992) reported that the high incidence of UV-B radiation and temperature extremes caused by high concentration of ozone and the other pollutants subjected plants to oxidative stress which in turn negatively affects plant growth, productivity and quality. Improving tolerance of bean plants to the possible environmental stresses by using different treatments is important to enhance its growth and maximize the yield. Vitamin E is considered as highly antioxidant at the membrane site (Hess, 1983). Yeast is a natural source of cytokinins and has stimulatory effects on bean plants (Amer, 2004). Foliar application with Zn could be of great importance to plants grown under sandy soil conditions as most sandy soils suffer from nutrient deficiency including microelements such as zinc. Sandy soils in many semiarid regions are known to limit mobility and availability of soil-Zn to plant roots (Marschner, 1993). Foliar application with zinc levels had a significant effect on groundnut growth, yield and its components as well as seed quality under sandy soil conditions (Gobarah, *et al*., 2006). Moreover, Karaman *et al*. (1999) showed that dry matter production increased with increasing Zn concentrations applied to bean plants. Also, Abd-El-Lateef *et al.* (1998) found that foliar application of either Fe and Zn alone or urea in combination with Zn or Cu on mungbean gave the tallest plants and the application of urea or Zn increased the number of branches per plant. The aim of the present study was to evaluate the efficiency of foliar application of vitamin E, Yeast and Zn on improving bean growth and productivity under sandy soil conditions.

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MATERIALS AND METHODS

The experiments were carried out in sandy soil conditions at the experimental station of the National Research Center in Nubaria region during two successive seasons 2006 and 2007. Seeds of snap bean (*Phaseolus vulgaris* L.) cv. Bronco were sown in the second week of February. Seeds were sown in hills 5-7 cm apart on two side ridges. Bean plants (20 days old) were sprayed with following treatments:

- Yeast : 5 g/l
- Yeast : 10 g/l
- Vitamin E: 0.1 ml/l
- Vitamin E: 0.3 ml/l
- Zn (chelated form 13%): 0.3 g/l
- Zn (chelated form 13%): 0.5 g/l
- Control: (sprayed with only water).

Plants were sprayed twice with these solutions with 2 weeks interval.

***Preparation of the Yeast*:**

Active dry yeast were dissolved in water followed by adding sugar at ratio 1:1 and kept overnight to activate and reproduction of yeast.

The following measurements were recorded:

- Plant growth and yield measurements: (plant height, number of leaves, and plant fresh weight) were recorded 60 days after sowing. Total yield (total number and weight of pods) was recorded as well as pod length and diameter.
- Chemical measurements: including total chlorophyll content (by chlorophyll meter spade-501 according to Yakava, 1986), nitrogen and potassium contents of leaves (according to FAO, 1980), phosphorus content of leaves (according to Troug and Meyer, 1939), carbohydrate content of pods (according to Shaffer and Hartman, 1921) , protein content (according to Piper, 1947) and fibers (according to A.O.A.C., 1984).
- Endogenous phytohormones (cytokinins, IAA and GA3): Samples for determination of endogenous hormones including indole acetic acid (IAA), gibberlleins (GA3) and cytokinins in fresh shoots were taken after 15 days from the second spray. Identification and determination of acidic hormones (IAA and GA3) were carried out by gas liquid chromatography (GLC). Samples were extracted according to the method adopted by Badr *et al*. (1971). Cytokinins fractions were extracted as previously mentioned for the acidic hormones and were detected by HPLC.

Statistical Analysis:

The experiments were established as complete randomized block design with 4 replicates and analysis of variance was calculated according to Snedecor and Cochran (1967). Least significant difference (L.S.D.) at 5% was used to compare between means.

RESULTS AND DISCUSSIONS

Effects of the Treatments on Vegetative Growth and Yield:

The effects of yeast, vitamin E and Zn on growth and yield of snap beans are shown in Table (1). The results showed that all treatments significantly increased vegetative growth and yield as indicated by plant height, number of leaves, plant fresh weight, number of pods and fresh weight of pods and pod length (while only pod diameter was not significantly affected). These effects were more obvious especially at higher concentrations of these treatments. Amer (2004) indicated that the application of yeast increased common bean growth, green pods yield and its component. Yeast is considered as a natural source of cytokinins that stimulates cell division and enlargement as well as the synthesis of protein, nucleic acid and chlorophyll (Kraig and Haber, 1980; Spencer et al 1983; Castelfranco and Beale, 1983 and Fathy and Farid, 1996). It also contains sugar, proteins, amino acids and vitamins (Shady, 1978). The improvement of snap bean growth in response to the foliar application of active dry yeast may be attributed to its contents of different nutrients, higher percentage of proteins, higher values of vitamins, especially B which may play an important role in improving growth and controlling the incidence of fungi diseases as mentioned by Meyer and Phaff (1969)

Table 1: Effects of yeast, vitamin E and Zn on growth and yield of snap bean plants.

Treatment	Plant height (cm)	Number of leaves	Plant fresh weight (g)	Number of pods/plant	Pods fresh weight/plant	Pod length (cm)	Pod diameter (cm)
		1st season					
Yeast (5g/l)	21.93	13.95	103.65	23.92	70.48	10.47	0.8
Yeast (10g/l)	23.92	13.95	127.97	29.9	80.72	10.96	0.9
Zn (0.3g/l)	23.92	13.95	100.86	19.93	83.31	11.46	1
Zn (0.5g/l)	25.91	15.95	146.31	33.89	89.27	12.96	1
Vit. E (0.1g/l)	22.92	11.96	88.4	25.91	57.01	11.96	0.8
Vit. E (0.3g/l)	23.92	15.95	135.25	31.89	80.33	11.46	1
Control	16.94	9.97	71.76	19.93	30.8	9.13	0.7
L.S.D. at 5%	2.97	2.02	11.67	3.37	7.67	1.74	N.S.
		2nd season					
Yeast (5g/l)	23	13.33	96.47	21.33	67.73	10.67	0.83
Yeast (10g/l)	26.33	14.67	135.6	26.67	75.75	11	0.97
Zn (0.3g/l)	23.83	14	97.8	24	85.45	11.83	0.9
Zn (0.5g/l)	24.67	16.67	137.3	33	89.74	12.5	0.93
Vit. E (0.1g/l)	22.67	12.67	91.97	24	58.63	10.83	0.83
Vit. E (0.3g/l)	24	14	128.97	30.33	82.2	11.5	0.97
Control	17.5	10.67	72.8	18.67	30.8	9	0.73
L.S.D. at 5%	3.29	2.61	15.66	5.34	5.6	1.86	N.S.

Table 2: Effects of yeast, vitamin E and Zn on chemical characters of pods and leaves of bean plants.

Treatment	N%	P%	K%	Total chlorophyll content	Proteins %	Carbohydrates %	Fibers %
				1st season			
Yeast (5g/l)	3.22	0.38	2.95	38.87	16.72	18.33	9.59
Yeast (10g/l)	3.79	0.49	3.27	39.87	18.06	22.01	10.61
Zn (0.3g/l)	2.69	0.28	2.19	37.87	17.58	14.67	12.57
Zn (0.5g/l)	2.71	0.28	2.22	33.89	18.12	14.67	13.33
Vit. E (0.1g/l)	2.62	0.22	2.24	31.89	16.86	11	14.69
Vit. E (0.3g/l)	2.66	0.24	2.22	33.89	17.03	14.67	13.1
Control	2.03	0.17	2.01	27.91	13.03	9.08	16.67
L.S.D. at 5%	0.73	0.19	0.74	4.231	2.3	2.076	2.331
				2nd season			
Yeast (5g/l)	3.56	0.34	3.11	36.33	17.03	17.46	9.92
Yeast (10g/l)	3.78	0.39	3.37	37.33	18.17	20.96	10.79
Zn (0.3g/l)	2.81	0.22	2.14	34	16.74	13.97	13.09
Zn (0.5g/l)	2.86	0.24	2.23	33.67	17.26	13.97	12.7
Vit. E (0.1g/l)	2.78	0.24	2.28	31.67	16.19	11.12	13.99
Vit. E (0.3g/l)	2.83	0.24	2.37	33	16.58	13.97	13.64
Control	2.11	0.19	2.11	29	13.8	10.07	15.87
L.S.D. at 5%	0.81	0.18	0.77	4.397	2.13	2.062	2.287

and Subba Rao (1984). On the other hand, the application of vitamin E promoted bean growth and productivity and these effects agreed with the findings of El Bassiouny *et al.* (2005) who found that foliar application of vitamin E significantly increased plant height, number of leaves and branches and number of pods and yield of faba bean. They attributed these effects to the fact that it is a low molecular weight lipophilic antioxidant which protect membrane from oxidative damage. Hess (1993) also indicated that vitamin E is highly effective antioxidant at the membrane site. On the other hand, foliar application with zinc levels had a significant effect on groundnut growth, yield and its components as well as seed quality under sandy soil conditions (Gobarah, *et al*., 2006). Karaman *et al*. (1999) showed that dry matter production increased with increasing Zn concentrations applied to bean plants. Similar results were obtained by Abd-El-Lateef *et al.* (1998) who found that foliar application of either Fe and Zn alone or urea in combination with Zn or Cu on mungbean gave the tallest plants and the application of urea or Zn increased the number of branches per plant. They concluded that beneficial effects were attained from the combination of urea with Zn on pod-number and with all trace elements on pod-weight per plant.

Effects of the Treatments on Chemical Characters of Pods and Leaves:

Table (2) shows the chemical characters measured including N, P, K and total chlorophyll contents of leaves and also protein, carbohydrate, and fiber contents of pods. Although all the treatments increased N, P and K content of leaves, these effects were not significant except for yeast treatments which significantly increased N, P and K content in both seasons.

All treatments significantly improved the total chlorophyll content of leaves especially at the higher levels of each of yeast, vitamin E and Zn treatments. The highest values of chlorophyll content were obtained with the yeast treatments. As shown in table (2), all treatments improved quality and nutritional values of pods as they improved protein and carbohydrates contents of pods while they resulted in a significant decrease in fiber content.

The improvement of growth of bean plants in response to foliar application of the treatments may result in improving quality of pods such as increased protein, carbohydrates and decreased fiber content. The treatments also increased chlorophyll content. These results agreed with results found by Amer (2004) who found that applying yeast to bean plants significantly increased chlorophyll content. Also, Fathy and Farid (2000) indicated that the application of yeast to tomato plants resulted in an increase in nitrogen, potassium and Ca contents of leaves. The tomato plants may have more pronounced effect compared to bean plants considering nutrient contents. Vitamin E had also a positive effects on chlorophyll content of bean plants as indicated by Schmitz and Noga (1998). Moreover, It is concluded that foliar sprays of urea combined with Fe or Zn increase seed yield and improve the quality of seeds of mungbeans (Abd-El-Lateef *et al.*, 1998).

Effects of the Treatments on Endogenous Phytohormones (Cytokinins, IAA and GA3):

All treatments significantly increased cytokinins, IAA and GA3 contents of leaves. The higher concentrations of these treatments had more pronounced effects on the above mentioned phytohormones (figure 1).

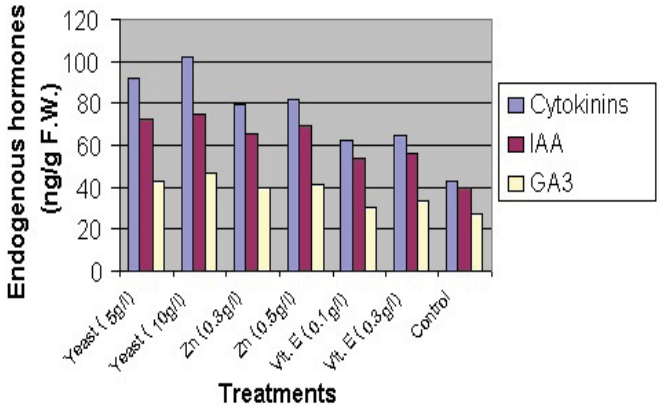

Fig. 1: Effects of yeast, vitamin E and Zn on endogenous hormones.

Yeast treatments showed the highest values of cytokinins, IAA and GA3 of leaves. Yeast is a natural source of cytokinins and has stimulatory effects on bean plants (Amer, 2004). Yeast has also higher contents of different nutrients, higher percentage of proteins, higher values of vitamins as reported by Meyer and Phaff (1969) and Subba Rao (1984). This may explain the increase of cytokinins and other promoting hormones in response to yeast application. The higher contents of cytokinins and auxins may be attributed to the promoting effects of vitamin E on growth and yield bean plants as El Bassiouny *et al.* (2005) attributed these promoting effects on growth and yield to the fact that it is a low molecular weight lipophilic antioxidant which protect membrane from oxidative damage. Also, Hess (1993) indicated that vitamin E is highly effective antioxidant at the membrane site. On the other hand, Abd-El-Lateef *et al.* (1998) indicated the positive effects of Zn application and found that foliar application of either Fe and Zn alone or urea in combination with Zn or Cu on mungbean gave the tallest plants and the application of urea or Zn increased the number of branches per plant. Similar results were obtained in this study when Zn was applied to bean plants. The higher promoting hormone contents in response to the application of Zn may be due to the fact that Zinc has an effect on building up the natural auxin (IAA) and consequently activating the cell division and enlargement. The present study indicates the effectiveness of using the foliar application of yeast, vitamin E and Zn on promoting the growth and yield of bean plants grown under sandy soil conditions.

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