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Studies on the Effect of Putrescine, Yeast and Vitamin C on Growth, Yield and Physiological Responses of Eggplant (*Solanum melongena* L.) 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 objective of the experiments was to investigate the physiological responses, growth and yield of eggplant to the foliar application of putrescine, yeast and vitamin C under such sandy soil conditions. Vegetative growth measurements, yield, hormonal changes in leaves (Cytokinins) and N, P and K contents of leaves were recorded to study the effects of these treatments. Foliar application of putrescine, yeast and vitamin C resulted in a significant increment of vegetative growth (including plant height, number of leaves, number of branches and fresh weight of plants) and yield of eggplant compared to control plants. Yeast treatments had the best results concerning plant growth and yield. All treatments increased cytokinins content especially at the high level of yeast. The treatments resulted in a significant increase of N, P and K contents of leaves. The possible roles of the treatments on growth , yield and physiological responses of eggplant are discussed.

Key words: Eggplant, Putrescine, Yeast, Vitamin C, Cytokinins

INTRODUCTION

Producing vegetable crops under sandy soil conditions in the new-reclaimed lands faces a lot of challenges as the desert areas are characterized with poor soil nutrients and unfavorable environmental conditions. This means that most of the vegetable crops such as eggplant (*Solanum melongena* L.) grown under such conditions need different applications as they may suffer from various environmental stresses in the field. Enhancing growth and productivity under these conditions will be of a great importance to maximize the yield. Putrescine is known to improve plant growth and development due to its effects on cell division and differentiation. Such findings were confirmed in bean plants (Altman *et al*., 1982). Moreover, putrescine (as one of the polyamine group) has a regulatory role in promoting productivity of many plants such as sweet pepper (Talaat, 2003), tomato (Cohen *et al.*, 1982) and pea plants (Gharib and Hanafy, 2005). On the other hand, Yeast is considered as a natural source of cytokinins and has stimulatory effects on bean plants (Amer, 2004). Yeast - as a natural source of cytokinins - 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). Hewedy *et al.* (1996) found that spraying eggplant with the solution of soft bread yeast gave higher yield and marketable fruits than control plants. The application of ascorbic acid may have a stimulatory effects on plants, for example, the application of ascorbic acid during cold season caused significant increases on growth parameters and total yield of tomato plants (Abdel-Halim, 1995). Other investigators found similar results on the stimulatory effects of vitamin C on other plants such as on potato (El-Banna *et al*., 2006), pepper (Shehata *et al*., 2002) and on pea plants (Helal *et al*., 2005).

The aim of the study was to examine the effects of purescine, yeast and vitamin C on eggplant grown under sandy soil conditions.

MATERIALS AND METHODS

The experiments were carried out under sandy soil conditions at the experimental station of the National Research Center in Nubaria region (physical and chemical properties of the soil are presented in Table 1)

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Table 1: Physical and chemical properties of the experimental soil.

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

during two successive seasons of 2006 and 2007. Eggplant seeds 'Black Beauty cv.' were sown in the first week of February. The seedlings were transplanted on the 7th of April. Transplanting was done on ridges of 70 cm width with a spacing of 30 cm in the row. Plants were sprayed twice with following substances at 15 days interval beginning after 30 days from transplanting:

- Putrescine : 25 ppm
- Putrescine: 50 ppm
- Yeast : 5 g/l
- Yeast : 10 g/l
- Vitamin C: 100 ppm
- Vitamin C: 200 ppm
- Control: (sprayed with only water).

***Preparation of the Yeast*:**

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

The following measurements were recorded:

- Plant growth and yield measurements: (plant height, number of leaves, number of branches and plant fresh weight) were recorded 75 days after transplanting. Total number of fruits and weight and total yield per feddan (4200 m^2) were also recorded.
- Chemical measurements: Nitrogen and potassium contents of leaves (according to FAO, 1980), phosphorus content of leaves (according to Troug and Meyer, 1939).
- Endogenous phytohormones (cytokinins): Samples for determination of cytokinins in fresh shoots were taken after 15 days from the second spray. 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 design of the experiments was 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 Putrescine, Yeast and Vitamin C on Vegetative Growth and Yield:

The results obtained in this study showed that spraying plants by putrescine, yeast and vitamin C significantly increased all growth parameters including plant height, number of leaves, number of branches and fresh weight of plants. The treatments also significantly enhanced eggplant productivity as number of fruits and total yield were significantly increased in response to the application of the treatments in both seasons (Table 2). The effects of the treatments on eggplant growth and yield were more obvious at the higher concentrations of each of the used substances. Putrescine is known to improve plant growth and development due to its effects on cell division and differentiation. Such findings were confirmed in bean plants (Altman *et al*., 1982). Abd El-Wahed *et al.* (2005) found that putrescine in absence or presence atonik significantly enhanced plant height, number of branches, shoot fresh and dry weights/plant during vegetative and flowering stages of chamomile plants. Moreover, putrescine has a regulatory role in promoting productivity of many plants such as sweet pepper (Talaat, 2003), tomato (Cohen *et al.*, 1982) and pea plants (Gharib and Hanafy, 2005).

Table 2: Effects of putrescine, yeast and vitamin C on growth and yield of eggplant.

Treatment	Plant height (cm)	Number of leaves	Number of branches	Plant fresh weight (g)	Number of Fruits/plant	Yield (ton/feddan)
1st season						
Putrescine (25 ppm)	45.00	49.00	4.33	138.50	15.67	14.52
Putrescine (50 ppm)	49.33	50.67	5.67	147.05	18.00	16.52
Yeast (5g/l)	50.33	51.67	5.00	165.90	15.67	15.60
Yeast (10g/l)	51.67	55.33	6.00	244.94	18.00	18.21
Vit. C (100 ppm)	45.67	47.33	5.00	133.91	16.33	13.97
Vit. C (200 ppm)	51.00	53.33	5.00	157.25	18.67	16.55
Control	40.00	35.33	3.00	119.50	14.00	10.70
L.S.D. at 5%	4.868	7.631	1.340	12.314	2.360	2.110
2nd season						
Putrescine (25 ppm)	43.24	46.42	3.79	128.73	15.15	13.25
Putrescine (50 ppm)	46.08	48.62	5.04	136.82	17.68	15.46
Yeast (5g/l)	48.32	46.88	4.09	149.29	13.86	13.84
Yeast (10g/l)	46.65	49.42	5.68	231.24	16.74	18.05
Vit. C (100 ppm)	41.88	43.85	4.73	124.41	15.79	13.44
Vit. C (200 ppm)	49.26	53.12	5.07	150.61	17.99	15.49
Control	38.06	31.13	2.84	112.33	12.95	9.76
L.S.D. at 5%	6.84	8.74	1.28	18.837	2.75	2.430

Table 3: Effects of putrescine, yeast and vitamin C on chemical contents of leaves.

Treatment	N%	P%	K%
1st season			
Putrescine (25 ppm)	2.72	0.62	2.73
Putrescine (50 ppm)	4.25	0.75	2.85
Yeast (5g/l)	3.06	0.85	3.04
Yeast (10g/l)	4.49	0.93	3.63
Vit. C (100 ppm)	2.55	0.65	2.65
Vit. C (200 ppm)	2.71	0.54	2.66
Control	2.03	0.40	2.05
L.S.D. at 5%	0.610	0.300	0.55
2nd season			
Putrescine (25 ppm)	2.59	0.52	2.57
Putrescine (50 ppm)	4.02	0.72	2.69
Yeast (5g/l)	2.91	0.81	2.90
Yeast (10g/l)	4.25	0.89	3.39
Vit. C (100 ppm)	2.43	0.62	2.50
Vit. C (200 ppm)	2.59	0.59	2.52
Control	1.90	0.39	1.95
L.S.D. at 5%	0.64	0.29	0.51

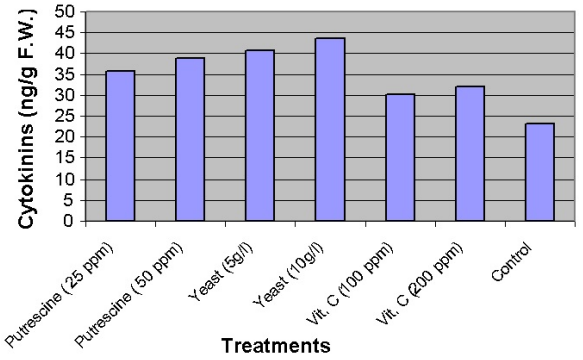

Fig. 1: Effects of putrescine, yeast and vitamin C on cytokinins content

The results also indicated that the highest growth and yield were obtained by the application of the high concentration of yeast. These findings are in agreement with the results of Amer (2004) who indicated that the application of yeast increased common bean growth, green pods yield and its component. It is known that 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 plants 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) and Subba Rao (1984). On the other hand, foliar application of vitamin C resulted in higher growth and yield of eggplant. Similar results on the stimulatory effects of vitamin C on other plants were indicated such as on potato (El-Banna *et al*., 2006), pepper (Shehata *et al*., 2002) and on pea plants (Helal *et al*., 2005). Also, Abdel-Halim (1995) found that the application of vitamin C on tomato plants caused significant increase on growth parameters (stem length, number of branches, leaves, flowers and fruit set and dry weight of shoots per plant) as well as total weight, number of fruits and total yield.

Effects of Putrescine, Yeast and Vitamin C on Chemical Composition of Leaves and Hormonal Changes:

Table (3) shows that putrescine, yeast and vitamin C significantly increased N, P and K contents of leaves especially at the higher concentrations. The highest N, P and K contents were obtained by higher concentration of yeast followed by the highest levels of putrescine and vitamin C respectively. These results are in harmony with the findings of Gharib and Hanafy (2005) who found that foliar application of putrescine affected the chemical composition of pea as it resulted in a significant increase of N concentration. Moreover, 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 effect of vitamin C on chemical composition of potato leaves was evident (El-Banna *et al*., 2006). They found that N, P and K contents in leaves were significantly increased by the application of ascorbic acid.

Concerning hormonal changes of plants, a higher content of cytokinins was observed in response to foliar applications of putrescine, yeast and vitamin C than control plants (Fig. 1). These effects were clear at the high levels of these substances.

Putrescine as a bioregulator may promoted eggplant growth and productivity through the increase of cytokinins (Fig. 1) as one of its mode of actions, there is evidence that putrescine can improve plant growth and development due to its effects on cell division and differentiation and such findings were confirmed in bean plants (Altman *et al*., 1982). Other investigations indicated that it could have an effect on endogenous hormones such as auxins (Pedreno *et al*., 1990). Talaat *et al.* (2005) reported that the application of putrescine on periwinkle transplants resulted in an increase in the quantitative amounts of cytokinins. Moreover, El-Bassiony (2004) found that exogenous application of putrescine on pea plants increased the amounts of endogenous cytokinins.

Yeast treatments showed the highest values of cytokinins of leaves compared to other treatments. 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. Also the application of vitamin C resulted in an increase of endogenous promoting hormones in plants, for example, foliar application of vitamin C caused an increase in growth and yield and endogenous promoters of tomato plants (Abdel-Halim, 1995).

The study suggests the possibility of using putrescine, yeast and vitamin C for improving growth and yield of eggplant under sandy soil conditions.

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