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Behavior of Tomato Plants as Affected by Spraying with Chitosan and Aminofort as Natural Stimulator Substances under Application of Soil Organic Amendments

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Abstract: This study was carried out during the summer seasons of 2007 and 2008 at the Experimental Farm of Environmental Agric. Sci. Fac., El-Arish, North Sinai, Egypt to study the effect of organic manures such as farmyard manure (FYM), and goat manure and spraying with some amendment substances; viz, chitosan and aminofort on growth, yield and some traits of fruit quality of tomato plants (pH and TSS%) under sandy soil conditions. The data revealed that tomato plants fertilized by goat manure and FYM, respectively as well as spraying of chitosan and aminofort significantly increased all vegetative parameters (plant height and number of both branches and leaves/plant), fresh and dry weight of different plant organs(roots, branches, leaves, and total of both fresh and dry weight of plant), photosynthetic pigments, yield /plant and marketable yield / feddan, but diseased yield (expressed in fruits infected by blossom end rot) was increased as a result of application of organic manures compared to control treatments. Meanwhile, application of chitosan decreased the diseased yield. On the other hand, pH and TSS (%) were not significantly affected.

Key words: Tomato, goat manure, FYM, chitosan, aminofort, fresh weight, dry weight, chlorophyll, yield, pH, TSS

INTRODUCTION

Tomato (*Lycopersicum esculentum* Mill.) is one of the major and important vegetable crop in Egypt which consumed in fresh or process forms. Tomato fruits contain some important nutritional compounds for human health such as vitamins and lycopen which helps counteract the harmful effects of radical effects which are thought to contribute to age-related process and a number of types of cancer (Khan *et al*., 2006). For increasing the productivity of tomato to meet the increment in human population, it could be achieved through increasing the cultivated area or improving the land productivity, especially in sandy soils.

Sandy soils had unfavorable physical, and biological properties. Addition of organic manures to sandy soil is very important to improve these unfavorable characters. It has a positive effect on soil acidity, soil exchange capacity and buffering the soil infiltration (Hsieh and Hsu, 1993). The foundation of organic manure application is enriching the microbial activity which increase the microbial activity, microbial-biomass, biomass C, N flush and consequently increasing the enzymes activities (Nur *et al*., 2006; Dinesh *et al*., 2000; Appireddy *et al*., 2008), increase the availability of macro and micronutrients in soils; viz., N, P, K, Ca , Mg, Fe, Zn, Mn, and Cu as a result of organic manure mineralization, reduction of fixation and complexing properties of these manures with macro and micronutrients (Rasoli and Forghani, 2006; Agbede *et al*., 2008). Organic manures increase the tolerance to insect disease, help control weeds, increase the health of plant and finally ensure produce quality (Ghorbani *et al*., 2008). Under organic farming, application of manure compounds for enhancing plant growth and increase the ability to disease and pests is necessary.

Among the promising approaches for inducing plant disease resistance and reducing damage from fungal pathogens and stimulate the immunity of plant is chitosan (Hadwiger *et al*., 2002). Chitosan is a natural polysaccharides, which consists of a copolymer of N-acetyl-D-glucosamine and D-glucosamine residues, linked by β- 1,4 glycosidic bonds (Khin *et al*., 2006). Chitosan is derived from chitin, a polysaccharide found in the exoskeleton of shellfish such as shrimp, lobster, and or crabs and cell walls of fungi (Wojdyla, 2001). Very few efforts were done to study the effect of chitosan on plant growth and its productivity which applied mainly as antimicrobial to protect plants from soil pathogenics or to increase the storability of fruits such as strawberry (Vargas *et al*., 2006). The results of application of chitosan revealed that chitosan can increase the immunity of plant (Patkowska *et al*., 2006), antimicrobial effect of chitosan on pathogenics and microparasitic fungi

(Abou Sereih *et al*., 2007; Palma-Guerrero *et al*., 2008) which promotion of root system (Gornik *et al*., 2008), increase the plant health, the photosynthetic pigments and consequently the plant production (Chibu and Shibayama, 1999; Khan *et al*., 2002; Gornik *et al*., 2008).

Every plant like any organism needs certain compounds for growth over, the compounds of living cells as proteins, with building block material, and amino acids. Proteins are fundamental ingredients in the process of protein synthesis. Application of amino acids enhanced plant growth expressed in vegetative growth, fresh and dry weight of plant, helps to increase the chlorophyll concentration, achieved the set percentage and it required to increase the yield of tomato crop (Ting *et al*., 1998; Neeraja *et al*., 2005; Tantawy *et al*., 2009). Amino acids help to alleviate the negative effect of abnormal soil conditions such as salinity of water irrigation used (Abdel-Latif, 1995; Hafez, 2001).

So, that, the main objective of this study was to improve the sandy soil properties by using organic manures as soil amendments and application of some natural or biological stimulators as chitosan and amino acids to improve tomato plants growth and its productivity.

MATERIALS AND METHODS

A field experiment was carried out during the summer seasons of 2007 and 2008. The main object of this research was to study the effect of two of organic soil amendments; i.e., Farmyard manure, goat manure plus the check treatments (without manure) and spraying of tomato plants (cv. GS-12) with chitosan and amino acids.

Tomato plants were transplanted in a sandy soil (sand 95.70%, silt 2.46% and clay 1.33%; organic matter 0.05%; pH 7.93 and EC of 0.701 dS m^{-1}) recovered from 0-15 cm layer at The Experimental Farm of The Faculty of Environmental Agricultural Sciences, El-Arish, Suez Canal University, North Sinai Governorate, Egypt. EC and pH of irrigation water were7.72 dS m^{-1} and 7.81, respectively. Total N, P and K were 2.01, 0.83, 1.21 and 0.49, 0.25, 0.52 for goat manure and FYM, respectively.

This experiment include nine treatments which are the combination between three sources of organic manures; viz., goat manure, farmyard manure and check treatment and spraying with two natural stimulator substances; viz., chitosan, aminofort and control treatment. Chitosan was applied as chito-care form. The chemical composition of chito-care and aminofort were shown in Table 1.

Organic manures were applied at a rate of 25 m^3/fed. for goat manure and 40 m^3 for FYM.

Treatments were randomly arranged in a split plot design with three replications. The organic manures were randomly arranged in the main plots, and spraying treatments (chitosan and aminofort) were randomly arranged in the sub plots. Plot area was 24 m^2 (24 m in length and 1m in width), and it was divided into 18 m^2 for yield and 6 m^2 for vegetative parameters. Plants were transplanted on May 5th and 9th in the 1st and 2nd seasons, respectively.

Table 1: The chemical composition of chito-care and aminofort

Aminofort	Chito-care
Amino acids (7%)	Chitosan oligomers
Fe (3%)	N (1000 ppm)
Zn (0.2%)	P_2O_5 (500 ppm)
B 0.(5%)	K_2O (500 ppm)
GA (12%)	Fe (100 ppm)
Citric acid (4.5%)	Zn (100 ppm)
Amino acids (7%)	Cu (50 ppm)
Mn 50 (ppm)	
B 50 (ppm)	

Organic manures were added in the mid of row, then covered and mixed with soil. Plants were sprayed four times at 10 days intervals beginning 20 days after transplanting. All plants received the recommended dose of NPK (124 kg N, 86 kg P_2O_5 and 144 kg k_2O/fed.). The other conventional practices were applied.

Data recorded

Vegetative growth: Samples of nine plants were randomly taken from each sub plot at 60 days from transplanting to estimate plant height, number of branches and leaves/ plant, fresh weight of roots, branches, leaves and total fresh weight. All plant parts were dried at 70°C till constant weight, and then dry weight of root, branches, leaves, and total dry weight of plant were calculated.

Photosynthetic pigments: Chlorophyll A, Chlorophyll B, total chlorophyll A+B, and carotenoids were recorded for the fourth leaf from the plant tip according to Wettstein (1957).

Yield and its components: Yield/plant, marketable yield/feddan, and disorder yield/feddan which estimated as the fruits that infected by blossom-end rot were measured.

Fruit quality: Random samples of six fruits were taken from each sub plot at the 2nd harvest, and pH and TSS% were estimated in the 2nd season only by pH meter and Carl Zeis refractometer, respectively.

Statistical analysis: Statistical analysis of the obtained data was carried out according to statistical analysis of variance according to Snedecor and Cochran (1980). Duncan's multiple range tests was used for comparison among means (Duncan, 1958).

RESULTS

Vegetative growth

Effect of organic manures: Data in Table 2 shows that fertilization of tomato plants with goat manure increased plant height, number of branches/plant and number of leaves/plant in the first season as well as plant height in the second season without significant differences with application of FYM, while the control treatments recorded the lowest values of vegetative growth. The same data illustrate that there were no significant differences among the treatments on number of both branches and leaves/plant in the second season.

Effect of chitosan and aminofort: It is illustrate from the data shown in Table 2 that spaying tomato plants with chitosan increased all vegetative growth parameters expressed in plant height, number of branches, and number of leaves per plant in the first season and plant height in the second season without significant differences with spraying with Aminofort. Control treatment recorded the last rank belong to the previous parameters. The same data show that there were no significant differences among the treatments on number of both branches and leaves/plant in the second season.

Effect of interaction between organic manures and spraying with chitosan and aminofort: The increase in plant height was fluctuated between spraying tomato plants with aminofort with fertilization of FYM or spraying plants with chitosan with fertilization of goat manure in the first and second seasons, respectively (Table 3). Number of branches and leaves/plant significantly increased by fertilizing tomato plants with goat manure with spraying of chitosan.

Fresh and dry weight

Effect of organic manures: Data in Table 4 show that the fresh and dry weight of different plant organs; viz., roots, branches, leaves and both total fresh and dry weight of tomato plant were significantly affected by application of different organic manures. Goat manure treatment recorded the first rank which recorded the highest values of the abovementioned traits followed by application of FYM, while control treatment was the last.

Effect of spraying with chitosan and aminofort: It is clear from the data in Table 4 that spraying tomato plants with chitosan or aminofort increased the fresh and dry weight of roots, branches, leaves and both total fresh and dry weight of plant.

Table 2: Effect of organic manures and spraying with chitosan and aminofort on vegetative growth of tomato plants

	First season (2007)			Second season (2008)		
Treatments	Plant height (cm)	No. of branches/plant	No. of leaves/plant	Plant height (cm)	No. of branches/plant	No. of leaves/plant
Organic manures						
without	56.77b	7.55b	36.77b	38.66b	11.88a	40.00a
Goat manure	68.33a	10.22a	47.66a	42.00ab	10.33a	48.11a
FYM	59.44ab	8.33ab	37.11b	46.16a	8.44a	43.88a
Chitosan and aminofort						
control	58.33b	8.55a	35.00b	37.50b	9.77a	40.11a
Chitosan	63.33a	9.44a	45.77a	45.50a	11.55a	48.88a
Aminofort	62.88ab	8.11a	40.77ab	43.83a	9.33a	43.00a

Values having the same letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test

Table 3: Effect of interaction between organic manures and spraying with chitosan and aminofort on vegetative growth of tomato plants

	Organic× Chitosan Manures	First season (2007)			Second season (2008)		
Treatments	aminofort	Plant height (cm)	No. of branches/plant	No. of leaves/plant	Plant height (cm)	No. of branches/plant	No. of leaves/plant
Without	Control	55.00e	7.66b	25.66b	32.00d	12.66ab	34.33c
	Chitosan	58.00de	7.33b	42.00ab	42.50bc	13.33a	45.00a-c
	Aminofort	57.33de	7.66b	42.66ab	41.50bc	9.66a-c	40.66bc
Goat manure	Control	65.66a-c	9.66ab	45.33a	38.00c	8.33c	44.33a-c
	Chitosan	68.66ab	11.33a	53.00a	43.00bc	13.00a	55.00a
	Aminofort	70.66a	9.66ab	44.66ab	45.00b	9.66a-c	45.00a-c
FYM	Control	54.33e	8.33ab	34.00ab	42.50bc	8.33c	41.66bc
	Chitosan	63.33b-d	9.66ab	42.33ab	51.00a	8.33c	46.66ab
	Aminofort	60.66c-e	7.00b	35.00ab	45.00b	8.66bc	43.33a-c

Values having the same letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test

Table 4: Effect of organic manures and spraying with chitosan and aminofort on fresh and dry weight of tomato plants

	Fresh weight (g)				Dry weight (g)			
Treatments	Roots	Branches	Leaves	Total fresh weight	Roots	Branches	Leaves	Total dry weight
First season (2007) Organic manures								
Without	27.72b	52.06b	174.58c	254.37c	10.09b	12.33b	43.55b	65.15b
Goat manure	39.51a	85.41a	280.18a	405.16a	13.22a	21.77a	64.11a	99.11a
FYM	32.73ab	73.33a	214.36b	320.42b	10.53b	16.88ab	45.55b	72.97b
Chitosan and aminofort								
Control	26.67b	65.07b	181.50b	273.24b	10.21a	15.44b	40.77b	66.44b
Chitosan	36.57a	74.01a	238.95a	349.53a	11.73a	18.11a	54.44ab	84.28a
Aminofort	36.72a	71.73ab	248.69a	357.14a	11.90a	17.44ab	58.00a	86.51a
Second season (2008) Organic manures								
Without	37.16b	80.00b	189.16c	306.33b	17.66b	19.66b	36.00b	73.33b
Goat manure	53.66a	95.83a	275.00a	424.50a	25.00a	23.16a	49.66a	97.83a
FYM	51.11ab	93.33ab	246.66b	391.10a	22.00ab	21.50ab	45.16a	88.66ab
Chitosan and aminofort								
Control	42.83b	75.00b	166.66b	284.5b	19.16b	19.33b	37.00b	75.50b
Chitosan	50.27a	91.66a	274.44a	416.38a	22.50ab	22.66a	47.66a	92.83a
Aminofort	48.83ab	102.50a	269.72a	421.05a	23.00a	22.33a	46.16a	91.50ab

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test

Table 5: Effect of interaction between organic manures and spraying with chitosan and aminofort on fresh and dry weight of tomato plants

		Dry weight (g)				Fresh weight (g)			
Treatments	Organic×chitosan and manures aminofort	Roots	Branches	Leaves	Total fresh weight	Roots	Branches	Leaves	Total dry weight
First season (2007)									
Without	Control	22.17e	48.33e	118.76d	189.26e	9.22c	11.66c	34.66c	55.55c
	Chitosan	32.33bcd	54.17de	207.83bc	294.33cd	11.03bc	13.00c	49.33bc	73.36bc
	Aminofort	28.67cd	53.69de	197.16c	279.52d	10.03bc	12.33c	46.66bc	66.55bc
Goat manure	Control	34.16abc	77.76abc	239.55b	351.47b	11.66bc	19.33b	48.66bc	79.66b
	Chitosan	39.22ab	91.16a	289.33a	419.71a	12.66ab	23.33ab	67.00a	103.00a
	Aminofort	45.17a	87.33ab	311.67a	444.17a	15.33a	22.66a	76.66a	114.66a
FYM	Control	23.69de	69.12cd	186.18c	278.99d	9.76bc	15.33bc	39.00bc	64.10bc
	Chitosan	38.17ab	76.69abc	219.69bc	334.55bc	11.50bc	18.00b	47.00bc	76.50b
	Aminofort	36.33abc	74.18bc	237.23b	347.74b	10.33bc	17.33b	50.66b	78.33b
Second season (2008)									
Without	Control	30.00c	60.00d	115.00e	205.00f	16.50cd	17.00e	26.00d	59.50e
	Chitosan	47.50ab	82.50bc	245.00c	375.00cd	21.50b-d	20.00de	46.00b	87.50cd
	Aminofort	34.00bc	97.50b	207.50d	339.00de	15.00d	22.00bd	36.00c	73.00d
Goat manure	Control	51.00a	77.50c	200.00d	328.50de	22.50bc	20.00de	40.50bc	83.00cd
	Chitosan	52.50a	95.00b	295.00b	442.50b	22.50bc	25.50a	52.50a	100.50ab
	Aminofort	57.50a	115.00a	330.00a	502.50a	30.00a	24.00ab	56.00a	110.00a
FYM	Control	47.50ab	87.50bc	185.00d	320.00e	18.50b-d	21.00cd	44.50b	84.00cd
	Chitosan	50.83a	97.50b	283.33b	431.66b	23.50b	22.50bc	44.50b	90.50bcd
	Aminofort	55.00a	95.00b	271.66bc	421.66bc	24.00ab	21.00cd	46.50b	91.50bcd

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test

Effect of interaction between organic manures and spraying with chitosan and aminofort: All interaction treatments among application of goat manure or FYM with or without spraying with chitosan and aminofort increased the fresh weight of roots in the second season significantly. The same trend was found in the first season, except fertilization with FYM only (Table 5). It is also clear from the same data that the interaction between fertilization of goat manure with spraying with aminofort and chitosan, respectively were the superior treatments wherein increased fresh weight of branches, leaves, total fresh weight of plant, and the dry weight of the same parameters.

Photosynthetic pigments

Effect of organic manures: It is obvious from the data in Table 6 that fertilization of tomato plants with goat manure increased all the photosynthetic pigments; i.e., chlorophyll a, chlorophyll b, total chlorophyll (a + b) and carotenoids significantly. These results are true in both seasons.

Effect of spraying with chitosan and aminofort: Spraying tomato plants with chitosan or aminofort had a significant effect on components of photosynthetic pigments expressed in chlorophyll a, chlorophyll b, total chlorophyll (a + b) and carotenoids compared to control treatment (Table 6).

Effect of interaction between organic manures and spraying with chitosan and aminofort: Data in Table 7 show the effect of interaction between organic manures and spraying with chitosan and aminofort on photosynthetic pigments in tomato leaves. The data

Table 6: Effect of organic manures and spraying with chitosan and aminofort on photosynthetic pigments of tomato plants

	Photosynthetic pigments (mg g^{-1} Fresh weight)							
	First season (2007)				Second season (2008)			
Treatments	Chl. A	Chl. B	Chl. A+B	Carotenoids	Chl. A	Chl. B	Chl. A+B	Carotenoids
Organic manures								
Without	1.80b	0.50b	1.30b	1.74ab	1.08b	0.43b	1.51c	1.68b
Goat manure	2.16a	0.67a	1.49a	1.95a	1.50a	0.62a	2.13a	1.91a
FYM	1.57c	0.43b	1.13c	1.56b	1.27b	0.46b	1.73b	1.70b
Chitosan and aminofort								
Control	1.66b	0.46b	1.20b	1.58b	1.17b	0.48a	1.66b	1.68b
Chitosan	1.99a	0.57a	1.41a	1.86a	1.35a	0.50a	1.85a	1.81a
Aminofort	1.89a	0.57a	1.32ab	1.82a	1.34a	0.52a	1.86a	1.80a

Values having the same letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test

Table 7: Effect of interaction between organic manures and spraying with chitosan and aminofort on photosynthetic pigments of tomato plants

		Photosynthetic pigments (mg g^{-1} Fresh weight)							
		First season (2007)				Second season (2008)			
Treatments	Organic×Chitosan and manures aminofort	Chl. A	Chl. B	Chl. A+B	Caroten-oids	Chl. A	Chl. B	Chl. A+B	Caroten-oids
Without	Control	1.68e	0.48d	1.20b	1.67c	1.31d	0.40d	0.91e	1.61d
	Chitosan	1.95cd	0.51cd	1.44a	1.76bc	1.58c	0.42d	1.16d	1.76b
	Aminofort	1.79de	0.51cd	1.28b	1.80bc	1.65bc	0.46cd	1.18d	1.67c
Goat manure	Control	2.09bc	0.60bc	1.49a	1.85b	2.06ab	0.61ab	1.44b	1.77b
	Chitosan	2.26a	0.72a	1.54a	2.03a	2.23a	0.66a	1.57a	1.99a
	Aminofort	2.14ab	0.69ab	1.45a	1.99a	2.10a	0.59b	1.51ab	1.99a
FYM	Control	1.21f	0.31e	0.90c	1.21d	1.60bc	0.44d	1.16d	1.66cd
	Chitosan	1.76e	0.49d	1.27b	1.81bc	1.76bc	0.44d	1.32c	1.69c
	Aminofort	1.74e	0.51cd	1.23b	1.66c	1.83b	0.50c	1.33c	1.76b

Values having the same alphabetical letter(s) did not significantly differ at 0.05 level of significance, according to Duncan's multiple range test

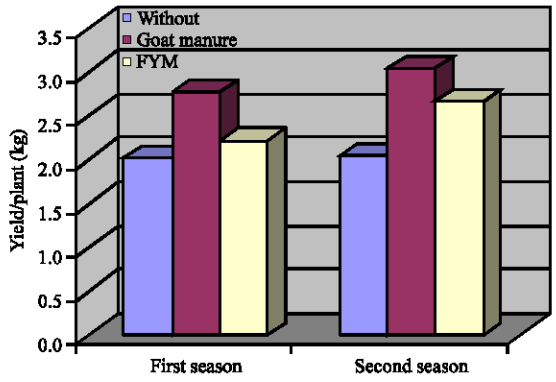

Fig. 1: Effect of organic manures on plant yield of tomato

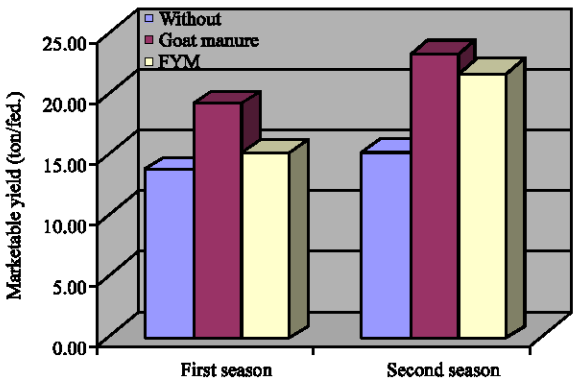

Fig. 2: Effect of organic manures on marketable yield of tomato plants

reveal that the highest concentration of photosynthetic pigments (chl.a, chl.b, and total chl.a+b as well as carotenoids) were achieved by the interaction between application of goat manure and spraying with chitosan followed by application of the same organic manure source and spraying with aminofort.

Yield

Effect of organic manures: It is clear from Fig. 1 that application of goat manure was the best treatment for increasing yield/plant without significant difference with fertilization of FYM, while control treatment recorded the lowest value of yield/plant.

Concerning the marketable yield/fed, Fig. 2 shows that fertilization with goat manure and FYM, respectively increased the marketable yield/fed by 40.39, 54.58 and 22.25, 44.03% over the control treatment in both seasons. On the other hand, the both sources of organic manures increased the disorded yield/fed. compared to the control treatment. This increment was high with application of goat manure (Fig. 3).

Effect of spraying with chitosan and aminofort: Figure 4 shows the effect of spraying tomato plants with chitosan and aminofort on yield/plant. It is clear that spaying with

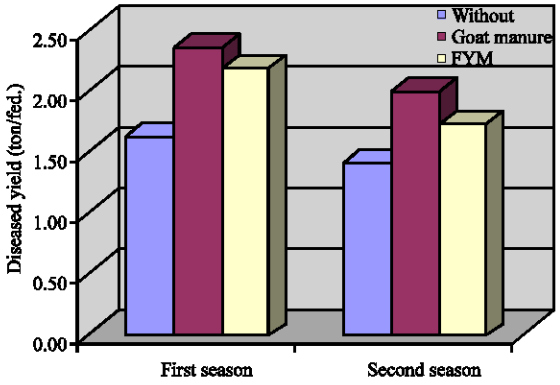

Fig. 3: Effect of organic manures on diseased yield (ton/fed.)

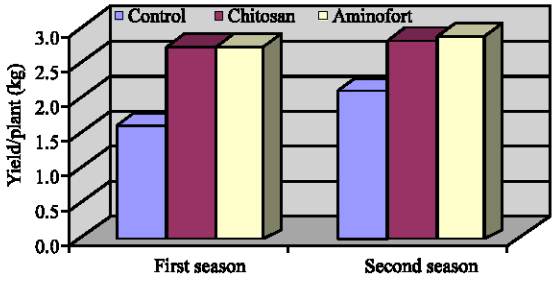

Fig. 4: Effect of spraying with chitosan and aminofort on plant yield of tomato

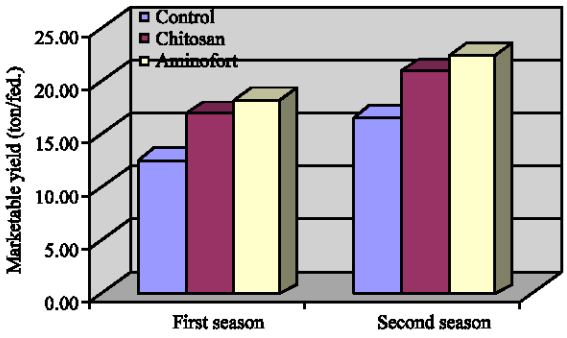

Fig. 5: Effect ofspraying with chitosan and aminofort on marketable yield of tomato

chitosan or aminofort increased the yield of plant significantly compared to control treatment. On the other side, spraying tomato plants with aminofort recorded the highest value of marketable yield/fed (44.32, 35.03% in the first and second seasons, respectively) without significant difference with spraying of chitosan wherein increased the marketable yield by 34.25 and 25.72% in both seasons over than the control treatment (Fig. 5).

Regarding the diseased yield, the data in Fig. 6 show that there were no significant differences among the treatments on diseased fruits yield/fed in the second

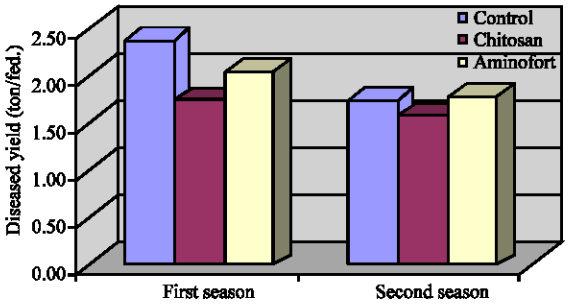

Fig. 6: Effect of spraying with chitosan and aminofort on diseased yield (ton/fed.)

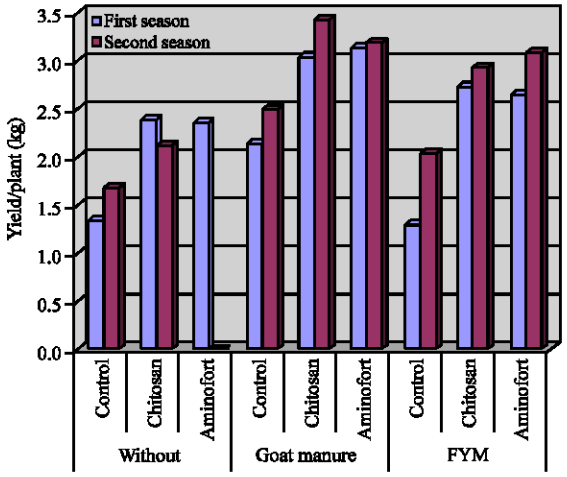

Fig. 7: Effect of interaction between organic manures and spraying with chitosan and aminofort on tomato yield/plant

season. While, in the first season the diseased fruits yield/fed. was significantly decreased with spraying of chitosan followed by spraying with aminofort. The highest fruit yield diseased was recorded by control treatment.

Effect of interaction between organic manures and spraying with chitosan and aminofort: It is clear from the data shown in Fig. 7 that the interaction between fertilization of tomato plants with goat manure with spraying chitosan and aminofort was the best interaction treatment for increasing yield/plant followed by spraying chitosan and aminofort with fertilization of FYM. The same trend was obtained with marketable yield/fed which is illustrated in Fig. 8. With regard to the diseased yield, data in Fig. 9 reveal that fertilization tomato plants with goat manure alone increased the impaired yield fruits/fed. without significant differences than spraying aminofort with fertilizing of the both organic manure sources in the first season. In the second season, fertilization of goat manure or FYM separately recorded the highest values of

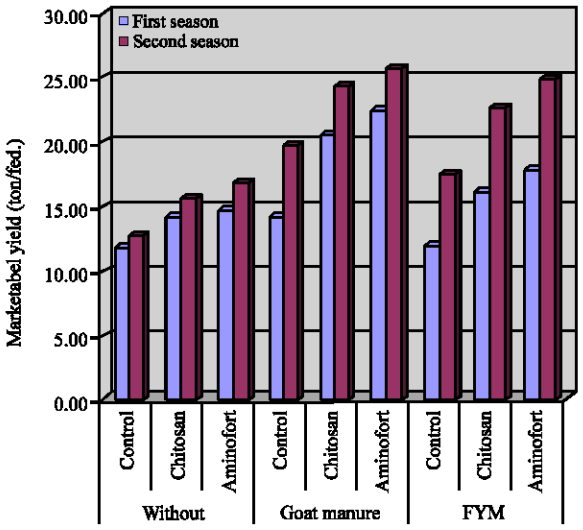

Fig. 8: Effect of interaction between organic manures and spraying with chitosan and aminofort on marketable yield of tomato

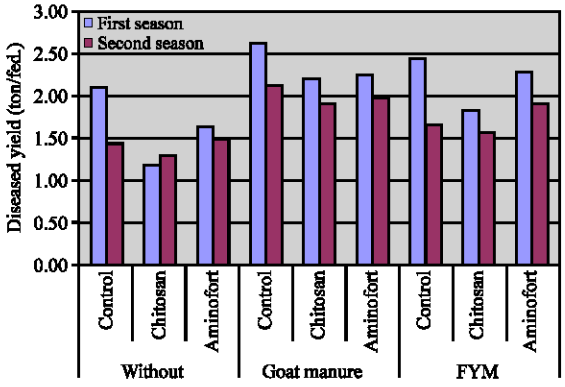

Fig. 9: Effect of interaction between organic manures and aminofort on diseased yield (ton/fed)

disorded fruit yield without significant differences with the other treatments, except spraying with chitosan alone which recorded the lowest value of disorded fruit yield/feddan.

Fruit quality

Effect of organic manures: Regarding fruit quality (pH and TSS), Fig. 10 shows that there were no significant differences among the organic manure sources on fruit quality. The treatments did not reflect any significant differences on fruit pH which recorded 4.11, 4.22 and 4.20 for control treatment, goat manure and FYM, respectively. Applications of FYM slightly increased TSS (7.02%) compared to goat manure (6.53%) and control treatments (5.96%).

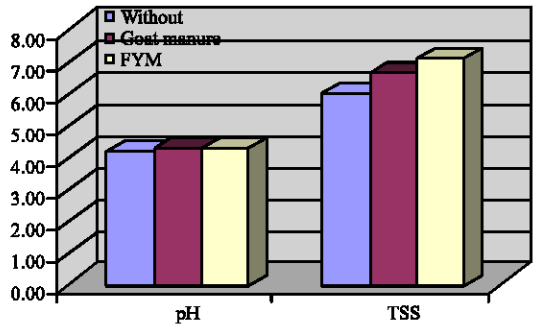

Fig. 10: Effect of organic manures on pH and TSS(%) of tomato fruits

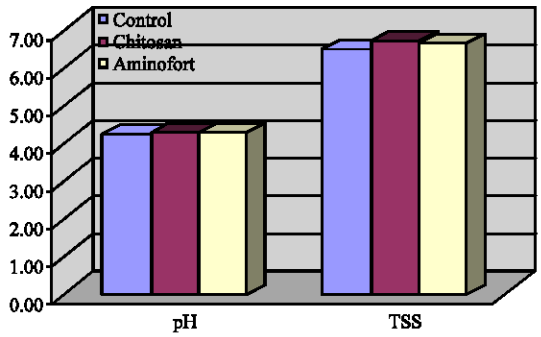

Fig. 11: Effect of spraying with chitosan and aminofort on pH and TSS (%) of tomato fruits

Effect of spraying with chitosan and aminofort: Figure 11 shows that spraying tomato plants with chitosan or aminofort did not reflect any significant effect on pH (4.19, 4.18) and TSS (6.61%, 6.54%) of tomato fruits compared to control treatment which recorded 4.16 and 6.36% for pH and TSS, respectively.

Effect of interaction between organic manures and spraying with chitosan and aminofort: It is clear from Fig. 12 that there were no significant differences among the interaction treatments on pH and TSS in tomato fruits.

DISCUSSION

Effect of organic manures: Fertilization of tomato plants with goat manure or FYM increased all different plant organs expressed in plant height, number of both branches and leaves/plant, the total fresh and dry weight of plant as well as the contents of chlorophylls (Table 2, 4 and 6). The positive effect of goat manure or FYM on vegetative growth may be attributed to the high content of nitrogen in both sources, respectively, and the other beneficial effects of organic manures on soil properties.

The increments in the above mentioned traits are higher with application of goat manure than FYM. This

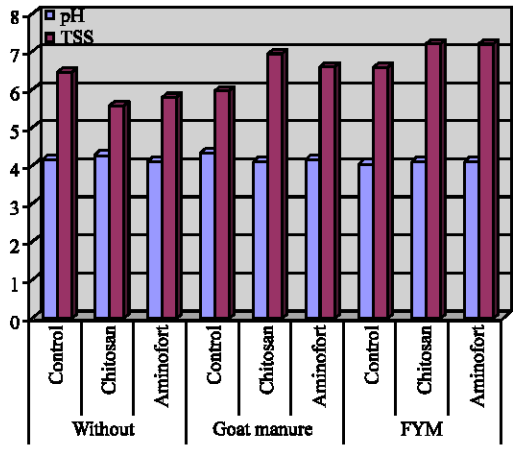

Fig. 12: Effect of interaction between organic manures and spraying with chitosan and aminofort on pH and TSS(%) of tomato fruits

may be owed to the higher contents of nutrients compared to FYM (Reddy and Reddi, 2002).The increment in plant growth and the content of photosynthetic pigments may be attributed to the positive effect on sandy soil properties. Application of organic manures change the organic matter input and it may affect on soil properties and crop depending on mineral nutrients supply and soil microbiological properties (Chirinda *et al*., 2008), increase in microbial activities, microbial-biomass, biomass C, N flush and consequently increasing the enzymes activities (Nur *et al*., 2006; Dinesh *et al*., 2000; Appireddy *et al*., 2008).The increment in plant growth due to application of organic manure ascribed to reducing in soil bulk density, increase porosity and moisture content as well as higher availability of macro and micronutrients in soils; viz, N, P, K, Ca , Mg, Fe, Zn, Mn, and Cu as a result of organic manure mineralization, reduction of fixation and complexing properties of these manures with macro and micronutrients (Rasoli and Forghani, 2006; Agbede *et al*., 2008).

Yield/plant and marketable yield/fed. were increased with fertilization of goat manure and FYM compared to control treatment (Fig. 1, 2). These results may be converted to the enhancement of plant vegetative growth due to application of organic manures wherein showed an increase in tomato plant healthy (Ghorbani *et al*., 2008), increasing in photo assimilation as a result of increasing in leaf area and dry weight of tomato plants (Azarmi *et al*., 2008). In this connection, Ghorbani *et al*. (2006) found that fertilizing tomato plants with cattle manure had high marketable yield compared to sheep manure. On the other hand, the both sources of organic manures; i.e., goat manure and FYM increased the diseased yield (Fig. 3). The increment in diseased yield was higher than with application of goat manure. This may be owed to the highest vegetative growth which need to supplemental of a lot of water quantities for the high vegetative and fruits growth under sandy soils. In contrast with Azarmi *et al*. (2008) who found that the occurrence rate of physiological disorder of blossom-end rot of tomato fruits was reduced with increasing in sheep manure vermicomposted rate in soil. The data pointed out in Fig. 10 illustrate that there were no significant differences among the organic manure sources on pH and TSS in tomato fruits. These results are in harmony with those reported by Azarmi *et al*. (2008), who found that addition of sheep manure vermicomposted to the soil had not significant effect on TSS and pH of tomato fruits juice.

Effect of chitosan: Spraying tomato plants with chitosan increased significantly all the vegetative growth traits of plant as well as the contents of photosynthetic pigments (Table 2, 4, 6). These results may be owed to antimicrobial effect of chitosan on pathogenics and microparasitic fungi (Abou Sereih *et al*., 2007; Palma-Guerrero *et al*., 2008) which caused a promotion of root hair (Gornik *et al*., 2008) and seemed good plant due to increments soil actinomyces and decreased filamentous fungus (Hitomi *et al*., 2006). Spraying tomato plants with chitosan increased the vigor plants, and this phenomenon was probably connected with bigger resistance of tomato roots fungi pathogenesis which had healthier roots (Borkowski *et al*., 2007). Table 2 showed that application of chitosan increased the number of leaves that may be attributed to the increment in internodes (Gornik *et al*., 2008).

Concerning the effect of spraying of chitosan on tomato yield, Fig. 4, 5 and 6 show increment in yield/plant and marketable yield/fed., and decreased the disorder yield/feddan.The increase in yield may be owed to the increment in photosynthetic pigments which led to the increment in the vigor growth and hence increase in yield. Regarding the disorder yield, the data in Fig. 6 reveal in the first season that, the diseased fruits yield/fed. was decreased significantly with spraying of chitosan followed by spraying with aminofort. The highest fruit yield diseased was recorded by control treatment. The decreasing of disorder yield due to application of chitosan might be due to the increment in lignification (Wojdyla, 2001).

Generally, it could be said that spraying plants with chitosan increased plant product as a result of stimulation of the immunity of plants (Wanichpongpan *et al*., 2001; Hadwiger *et al*., 2002; New *et al*., 2004) to protect plants against microorganisms (Pospieszny *et al*., 1991) and to simulation of roots, shoots, leaves and chlorophyll content and photosynthetic rate (Chibu and Shibayama, 1999; Khan *et al*., 2002; Gornik *et al*., 2008).

Effect of aminofort: Application of aminofort increased both total fresh and dry weight of plant as shown in Table 4 as a result of increasing in plant vegetative growth; viz., plant height, number of both branches and leaves/plant as well as increased the photosynthetic pigment in tomato leaves (Table 2, 6). The simulative effect of aminofort may be owed to the contents of amino acids, GA and other mineral nutrients.

In this respect, the abovementioned results are in agreement with Tantawy *et al*. (2009), who found that application of amino acids increased tomato plant height, leaf area of plants, fresh and dry weight of aerial plants, as well as total chlorophyll which reduced the percentage of barely albino plants (Ting *et al*., 1998). Also, amino acids improved plant growth and production under saline water (Abdel-Latif, 1995; Hafez, 2001).

The increment in marketable yield (Fig. 5) may be attributed to the increase in leaves chlorophyll content leading to increment in carbohydrate synthesis and consequently increment in plant production (Fig. 4). Application of amino acids increased pollen germination and the length of pollinic tube, leading to increment in fruit set %, average fruit weight, and yield/plant (Neeraja *et al*., 2005), but TSS was not affected significantly (Tantawy *et al*., 2009).

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