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Effect of Integrated Nutrient Management on Growth and Yield of Tomato Hybrid COTH 3 *(Solanum lycopersicum* L.*)* under Shade net Condition

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An investigation was carried out to assess the growth and yield of hybrid tomato *(Solanum lycopersicum* **L.*)* under shade net using farm yard manure (FYM) and graded doses of N,P,K along with different biofertilizers** *viz.,* **Azophos, Methylobacterium and Azophosmet. The experiment was conducted at the Department of Horticulture, Agricultural College and Research Institute, Madurai. The experimental results revealed that the growth attributes** *viz.,* **plant height, number of branches, number of leaves, crop growth rate, relative growth rate, dry matter production and leaf chlorophyll content were enhanced with the application of 50 per cent recommended dose of N, P and 100 per cent recommended dose of K + 2 kg Azophosmet ha^{-1} in both the season. Further, the yield parameters namely, number of inflorescence per plant, number of fruits per plant, individual fruit weight, fruit yield per plant, fruit yield per plot and fruit yield per hectare were also found to be highest with the application of 50 per cent recommended dose of N, P and 100 per cent recommended dose of K + 2 kg Azophosmet ha^{-1} in both the seasons.**

Key words: Hybrid tomato, Azophos, Methylobacterium, Azophosmet.

Tomato *(Solanum lycopersicum* L.*)* is one of the important vegetables grown in the world. It is cultivated worldwide in a variety climatic conditions including sub tropics and tropics. It is universally treated as a "protective food" and it is also an excellent vegetable for processing. The fruits are eaten raw as salad as well as cooked and eaten. Among the vegetables tomato occupies fourth position in area and second position in production in India. Besides varietal influence, inputs like organic and inorganic sources of nutrients have played a vital role in maximizing the yield potential of any crop plant. In order to find out the effect of certain organic, inorganic and bio fertilizers on tomato, an experiment involving hybrid tomato COTH 3 was undertaken at The College Orchard in the Department of Horticulture, Agricultural College and Research Institute, Madurai under shade net condition.

Materials and Methods

The investigation was conducted to study the effect of the organic manure, farm yard manure (FYM 25 t/ha) and graded doses of N, P, K along with bio-fertilizers *viz.,* Azophos, Methylobacterium and Azophosmet on growth and development of tomato hybrid (COTH 3) under shade net condition at the College Orchard, Department of Horticulture, Agricultural College and Research Institute, Madurai, during July to December 2012 (1st season) December 2012 to April 2013 (2nd season). The experiment was laid out in a Randomized Block Design with three replications.

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Treatment details

T_1 : 200 kg N + 300 kg P_2O_5 + 200 kg K_2O (RDF)

T_2 : 200 kg N + 300 kg P_2O_5 + 200 kg K_2O + Azophos

T_3 : 200 kg N + 300 kg P_2O_5 + 200 kg K_2O + Methylobacterium

T_4 : 200 kg N + 300 kg P_2O_5 + 200 kg K_2O + Azophosmet

T_5 : 150 kg N + 225 kg P_2O_5 + 200 kg K_2O + Azophos

T_6 : 150 kg N + 225 kg P_2O_5 + 200 kg K_2O + Methylobacterium

T_7 : 150 kg N + 225 kg P_2O_5 + 200 kg K_2O + Azophosmet

T_8 : 100 kg N + 150 kg P_2O_5 + 200 kg K_2O + Azophos

T_9 : 100 kg N + 150 kg P_2O_5 + 200 kg K_2O + Methylobacterium

T_{10} : 100 kg N + 150 kg P_2O_5 + 200 kg K_2O + Azophosmet

A constant level of 200 kg of K_2O was applied in the form of muriate of potash for all the treatments. Twenty five per cent of N as urea, K as muriate of potash and entire dose of P as single super phosphate was applied at the time of planting and the remaining dose of N and K was applied as top dressing on 30th, 45th and 60th days after transplanting. About 100 g of hybrid tomato seeds were used to produce seedlings for one ha. Biofertilizers were applied in three modes namely, through seed treatment, seedling root dip and soil application at transplanting. Biofertilizers *viz.,* Azophos, Methylobacterium and Azophosmet at the rate 4 g each of inoculant per 40 g of seeds were mixed using rice gruel and shade dried for 30 minutes. The treated seeds were sown in protrays filled with well decomposed coir pith. Seeds were sown in separate protrays without biofertilizers

inoculation to serve as control. Biofertilizers *viz.,* Azosphos, Methylobacterium and Azophosmet at the rate 200g each were mixed with rice gruel and made into slurry. Then seedling roots were dipped in the slurry for 30 minutes and transplanted. Azophos, Methylobacterium and Azophosmet at the rate of 4 kg ha^{-1}, 2 kg ha^{-1} and 2 kg ha^{-1}, respectively were thoroughly mixed with sieved 50 kg of FYM and then applied on the sides of the ridges at the time of transplanting.

Table 1.Effect of integrated nutrient management on growth parameters of tomato hybrid (COTH 3) grown in two seasons under shade net condition

Treatments	Plant height (cm)									Number of branches								
	30 DAT			60 DAT			90 DAT			30 DAT			60 DAT			90 DAT		
	1st season	2nd season	Pooled mean	1st season	2nd season	Pooled mean	1st season	2nd season	Pooled mean	1st season	2nd season	Pooled mean	1st season	2nd season	Pooled mean	1st season	2nd season	Pooled mean
T_1	51.42	50.22	50.82	94.89	93.82	94.35	125.60	126.03	125.81	3.45	3.27	3.36	7.00	6.92	6.96	15.40	16.80	16.10
T_2	58.65	57.19	57.92	107.44	109.19	108.31	144.22	146.73	145.47	5.80	5.42	5.61	9.80	8.89	9.34	17.86	19.59	18.72
T_3	54.89	53.49	54.19	106.00	108.33	107.16	130.69	132.00	131.34	4.82	4.78	4.80	7.28	6.55	6.91	16.60	16.45	16.52
T_4	60.22	60.78	60.50	111.63	98.72	105.17	151.42	154.47	152.94	6.40	6.17	6.28	10.65	9.76	10.20	20.62	19.27	19.94
T_5	59.00	59.98	59.49	110.00	105.46	107.73	129.40	128.39	128.89	5.28	4.96	5.12	8.82	7.88	8.35	18.40	16.92	17.66
T_6	53.61	52.76	53.18	103.62	104.00	103.81	132.45	134.28	133.36	4.21	5.00	4.60	9.00	8.96	8.98	16.26	16.84	16.55
T_7	63.67	60.81	62.24	112.67	107.93	110.30	147.86	147.09	147.47	4.44	4.20	4.32	10.40	9.20	9.80	17.22	17.56	17.39
T_8	65.65	65.52	65.58	113.42	100.07	106.74	152.22	151.14	151.68	6.80	6.28	6.54	11.00	10.58	10.79	24.41	24.07	24.24
T_9	55.19	53.90	54.54	111.25	103.52	107.38	137.21	140.19	138.70	5.00	5.10	5.05	9.20	8.80	9.00	19.60	18.00	18.80
T_{10}	67.43	66.92	67.17	118.82	117.22	118.02	158.47	161.11	159.79	7.47	6.96	7.21	11.46	11.20	11.33	27.82	27.52	27.67
SEd	0.0872	0.0913	0.0888	0.1064	0.1059	0.0956	0.1856	0.1929	0.1888	0.0204	0.0174	0.0187	0.0245	0.0240	0.0240	0.0643	0.0599	0.0614
CD(0.05)	**0.1832**	**0.1918**	**0.1866**	**0.2235**	**0.2225**	**0.2008**	**0.3899**	**0.4052**	**0.3966**	**0.0429**	**0.0366**	**0.0393**	**0.0515**	**0.0504**	**0.0505**	**0.1350**	**0.1259**	**0.1290**

Results and Discussion

Growth attributes

The plant height was recorded at three stages *viz.,* 30, 60 and 90 DAT in the first and second season of crop. The plant height at three stages was significantly influenced by the use of organic manures, inorganic fertilizers and biofertilizers during both seasons. In the first season crop, the treatmental effects were highly significant. The treatment T_{10} (50 % N + 50% P +100% K of RDF + 2 kg Azophosmet) recorded the highest mean plant height of 67.43, 118.82 and 158.47 cm at 30, 60, 90 DAT. In the second season crop, the treatment T_{10} (50% N + 50% P +100% K of RDF + 2 kg Azophosmet) exhibited the highest mean height of 66.92, 117.22 and 161.11 cm on the 30, 60, 90 DAT (Table 1). The plant height of tomato crop was found to increase significantly with the application of organic and inorganic fertilizers and biofertilizers. Similar findings were reported earlier in okra *i.e.,* plant height and number of leaves increased to a significant extent with the application of 50% of recommended dose of N and P +100% K + 2 kg Azophosmet (Mariappan *et al.,* 2012). The greater plant height achieved could be attributed to stimulation of cellular expansion and cell division under shade net house. The luxuriant growth of plant might be due to the lower level of due to lesser light photo oxidation and wind under shade net house condition. Similar findings were also obtained by Ramesh Kumar and Arumugam (2010) in tomato.

The treatment T_{10} also recorded more number of branches per plant (7.47, 11.46 and 27.82 and 6.96, 11.20 and 27.52) on 30, 60 and 90 days after planting in first and second crop, respectively (Table 1). This may be due to increased meristematic activity in apical tissue, expansion of cell and formation of new cell wall (Pal and Jana, 1992). Being a part of protein, N is an important constituent of protoplasm and enzymes, the biological catalytic agent, helping in speeding up the life processes. Hence, the number of branches was possibly enhanced by N application. The present result is in accordance with the findings of Nandekar and Sawarkar, (1990) and Subbiah *et al.,* (1983) in brinjal and Mallangouda *et al.,* (1995) in capsicum.

Yield parameters

Application of organic, inorganic nutrients and bio fertilizers had a significant effect on yield attributes of the crop. The number of inflorescence showed significant difference among the treatments and T_{10} (50 % N + 50 % P and 100 % K of RDF + 2 kg Azophosmet) recorded more number of inflorescences per plant 20.07 and 20.22 in first and second crops, respectively (Table 2). Among the two seasons, significant differences were observed among the treatments. The treatment T_{10} (50 % N + 50% P + 100% K of RDF + 2 kg Azophosmet) recorded the highest fruit weight (65.16 g and 65.20 g) in first and second crops respectively (Table 2). The size of the fruit depends

upon the vegetative growth and development of plant. It appears that nutrient treatments leading to increased shoot and leaf growth, ultimately were capable of manufacturing greater amount of food materials and the same when translocated into fruit, led to an increase in fruit size.

Table 2.Effect of integrated nutrient management on yield parameters of tomato hybrid (COTH 3) grown in two seasons under shade net condition

Treatments	Number of Inflorescences			Individual fruit weight (g)			Number of fruits per plant			Fruit yield per plant (kg)			Fruit yield per hectare		
	1st season	2nd season	Pooled mean	1st season	2nd season	Pooled mean	1st season	2nd season	Pooled mean	1st season	2nd season	Pooled mean	1st season	2nd season	Pooled mean
T_1	17.01	16.80	16.90	52.02	53.16	52.59	44.05	43.20	43.62	26.43	25.92	26.17	97.89	96.00	96.94
T_2	18.11	18.80	18.45	59.37	59.88	59.62	48.45	51.22	49.83	29.07	30.72	29.89	107.67	113.77	110.72
T_3	17.99	18.48	18.23	57.17	58.24	57.70	47.97	49.94	48.95	28.78	29.96	29.37	106.61	110.98	108.79
T_4	18.91	19.21	19.06	60.72	60.22	60.47	51.60	52.86	52.23	30.96	31.71	31.33	114.67	117.46	116.06
T_5	17.55	18.15	17.85	56.98	56.52	56.75	46.21	48.61	47.41	27.73	29.17	28.45	102.70	108.04	105.37
T_6	17.16	17.25	17.20	55.16	54.96	55.06	44.67	45.02	44.84	26.80	27.01	26.91	99.27	100.06	99.66
T_7	19.71	19.92	19.81	63.76	63.20	63.48	54.85	55.70	55.27	32.91	33.42	33.17	121.90	123.79	122.84
T_8	19.97	20.16	20.06	64.16	64.55	64.35	55.91	56.65	56.28	33.55	33.99	33.77	124.26	125.89	125.07
T_9	19.28	19.48	19.38	62.02	61.19	61.60	53.15	53.92	53.53	31.89	32.35	32.12	118.11	119.82	118.96
T_{10}	20.07	20.22	20.14	65.16	65.20	65.18	56.29	56.88	56.58	33.77	34.13	33.95	125.09	126.40	125.74
SEd	**0.0190**	**0.0194**	**0.0190**	**0.0702**	**0.0658**	**0.0678**	**0.0759**	**0.0775**	**0.0762**	**0.0455**	**0.0465**	**0.0457**	**0.1686**	**0.1721**	**0.1692**
CD(0.05)	**0.0398**	**0.0407**	**0.0400**	**0.1474**	**0.1382**	**0.1423**	**0.1594**	**0.1627**	**0.1600**	**0.0956**	**0.0976**	**0.0960**	**0.3542**	**0.3615**	**0.3556**

The treatment T_{10} (50 % N + 50 % P and 100 % K of RDF + 2 kg Azophosmet) recorded the highest number of fruits per plant 56.29 and 56.88 during first and second crops respectively (Table 2). The increase in the number of fruits over control may be due to the higher amount of food manufactured by foliage as well as increased sink points due to better hormonal balance in the plant system as documented by Verma *et al.* (1970). The treatments T_{10} (50 % N + 50 % P and 100 % K of RDF + 2 kg Azophosmet) recorded the highest yield per plant 33.77 and 34.13 kg in first and second crops, respectively (Table 2). Among the treatment T_{10} (50 % N + 50 % P and 100 % K of RDF + 2 kg Azophosmet) recorded the highest yield per hectare (125.09 t ha^{-1}) in first season. In the second crop T_{10} (50 % N + 50 % P and 100% K of RDF + 2 kg Azophosmet) registered the highest fruit yield (126.40 t ha^{-1}) (Table 2). Similar finding was reported earlier in okra. Application of 50% of recommended dose of N and P +100% K + 2 kg Azophosmet increase the number of fruits per plant, fruit length, fruit girth, fruit weight and yield per ha. (Mariappan *et al.,* 2012) Better performance of crop in response to combined inoculation of Azospirillum, Methylobacterium and Phosphobacteria in cotton was also documented earlier (Gomathy *et al*., 2008). There was also early flowering and boll development due to combined inoculation. In the present study, 50% N and P + 100% K along with 2 kg Azophosmet had resulted in early flowering in tomato.

The increase in yield may be attributed to the increased vegetative growth reflected in terms of foliage production, plant height, number of branches and number of leaves as observed from the data (Table 1 and 2). The growth characters *viz.,* plant height, number of branches, number of leaves and leaf area showed a strong positive correlation with yield. Increased vegetative growth might have possibly increased the synthesis of carbohydrates, which ultimately promoted greater yield. This leads to support the findings of Metha and Shekhawat (1967) and Barooah and Ahmed (1983) in tomato.

Conclusion

The treatment *viz.,* 100 kg N + 150 kg $P_2 O_5$ + 200 kg $K_2 O$ + 2 kg Azophosmet registered highest values for the growth attributes *viz.,* plant height and number of branches and the yield parameters including number of infloresences, individual fruit weight, number of fruits, fruit yield per plant and fruit yield per ha.

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