DOI : 10.5958/0974-0112.2017.00104.9

Indian J. Hort. 74(4), December 2017: 541-545

Effect of integrated nutrient management on growth and yield of tomato in Begusarai district of Bihar

Sanjay Kumar*, R.N. Singh, V.P. Choudhary and Neeraj
Krishi Vigyan Kendra, Khodawandpur, Begusarai 848202, Bihar

ABSTRACT

A field experiment consisting of nine treatments including control was conducted to find out the most appropriate integrated nutrient management system for sustainable tomato production during 2013-15. It was found that the application of 50% RDF + vermicompost @ 2 tonnes/ha + soil and seedling treatment with *Azotobacter* and PSB appeared as the most suited combination for providing maximum plant height and number of primary branches/ plant, earliest days to flowering and picking of first fruit, maximum number of fruits/ plant, most superior fruit weight, highest yield / plant and highest TSS. The maximum yield/ ha (784 q/ ha), net return (Rs. 850,300) and B:C ratio (9.39) were also recorded with application of 50% RDF + vermicompost @ 2 tonnes/ ha + soil and seedling treatment with *Azotobacter* and PSB. The application of 50% RDF + vermicompost @ 2 tonne/ ha proved as the next better treatment followed by 100% RDF.

Key words: Integrated nutrient management, growth, yield, tomato.

INTRODUCTION

Tomato *Lycopersicon esculentum* Mill.) is the most popular and nutritious vegetable crop, widely grown around the world and second ranked after potato. It is the most important 'protective foods' of Bihar grown in area of 47,690 ha with a production of 106,177 MT annually (Anon, 1). Tomato requires large quantity of both organic and inorganic fertilizers. It has been realized worldwide that chemical fertilizers, while increasing crop yield may have adverse effect on soil health and its fertility in case of imbalanced use (Kumar *et al.*, 4). Hence, an alternate technology, i.e. use of organic manures and biofertilizers in conjunction with inorganic fertilizers, which still sustain high yield over years and environmental safety. The beneficial use of *Azotobacter* and phosphorus solubilizing bacteria as a supplementary source of plant nutrition on agricultural crop is well documented (Shukla *et al.*, 12). These non-conventional sources of fertilizers are not only cost effective but simultaneously boost the productivity of soil and crop. No attempt has been reported on the effect of organic manure, biofertilizers and inorganic fertilizers on tomato, especially in Begusarai (Bihar) conditions. Therefore, the present study was undertaken to assess the effect of application of biofertilizer, organic and inorganic sources of nutrition on growth and yield of tomato at farmer's field.

MATERIALS AND METHODS

A field experiment at four locations was carried out at farmer's field of Barauni, Begusarai, Gadhpura and Bakhri blocks of Begusarai district during 2013-15 under irrigated conditions. The soil is sandy loam at all the locations and laid out in randomized block design with three replications. The soil samples of all the locations before the transplanting in main field were analyzed for essential nutrients, organic carbon, EC and pH (Jackson, 3). The details of soil value is given in Table 1, which shows the soils to be low in available nitrogen at Barauni, Bakhri and Gardhpura though available phosphorus was low at all the locations. Available potash was low in Bakhri and Gadhpura, while organic carbon was medium at all the locations and available nitrogen was medium in Begusarai, whereas available potash was also medium in Begusarai and Barauni. Half dose of nitrogen and full dose of phosphorus with potassium were applied as basal dose. The rest amount of nitrogen was applied in two split doses after transplantation in the main field. The experiment was conducted with nine treatments and each treatment in three replications. The details of experiment are given in Table 2. The seed of tomato hybrid VL-642 (Seminis Co.) was sown in nursery beds containing mixture of vermicompost and soil in 1:1 ratio. One-month-old seedlings were transplanted at 90 × 75 cm. The plot size was 4 × 2.5 m and 12 plants were accommodated in each plot. Cultural activities with irrigation were done whenever required. Picking was done as per maturity of fruits from each plant and yield data was recorded at all the locations, whereas yield attributes were recorded only from the fields of Begusarai block. Total soluble solids (TSS) was determined with the help of Erma hand refracto-meter

*Corresponding author's E-mail: sanjay4b1967@gmail.com

Table 1. Nutrient content (%) of vermicompost and chemical properties of the soils of experimental field at different locations.

Parameter	Vermi-compost		Location							
			Barauni		Begusarai		Gadhpura		Bakhari	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
pH (1:2)	7.2	7.3	7.8	7.8	7.9	7.8	7.9	7.9	8.1	8.00
EC (1.2) dS m^{-1}	-	-	0.62	0.59	0.54	0.53	0.69	0.68	0.72	0.72
Organic C (%)	-	-	0.67	0.69	0.72	0.74	0.59	0.59	0.51	0.50
N (kg/ ha)	1.53	1.41	194	201	282	287	206	213	201	200.00
P_2O_5 (kg/ ha)	1.62	1.39	40	43	32	29	31	27	30	30.00
K_2O (kg/ ha)	0.87	0.93	167	161	172	172	92	102	89	86.00

Table 2. Details of the treatments.

Treatment	Code	Details
Control	T1	No fertilizer / Vermicompost
100% recommended dose of fertilizer (RDF)	T2	N : P : K : : 120 : 80 : 80
50% RDF	T3	N : P : K : : 60 : 40 : 40
Vermicompost (2 tonnes/ ha)	T4	2 kg Vermicompost per plot
Azotobacter (3 kg/ ha) + PSB (3 kg/ ha)	T5	3 kg each of *Azotobacter* and PSB per plot were thoroughly mixed in soil before transplanting and seedling inoculation was done one hour before transplanting with culture of *Azotobacter* and PSB
50% RDF + vermicompost (2 tonnes/ ha)	T6	T3 + T4
50% RDF + *Azotobacter* (3 kg/ha) + PSB (3 kg/ ha)	T7	T3 + T5
Vermicompost (2 tonnes/ha) + *Azotobacter* (3 kg/ ha) + PSB (3 kg/ ha)	T8	T4 + T5
50% RDF + Vermicompost (2 tonnes/ ha) + *Azotobacter* (3 kg/ ha) + PSB (3 kg/ ha)	T9	T3 + T4 + T5

and expressed as percent TSS. Data obtained from tomato crops for two consecutive years were pooled and statistically analyzed as procedure given by Panse and Sukhatme (8).

RESULTS AND DISCUSSION

The experimental data (Table 3) clearly revealed that the maximum plant height (126 cm) was recorded with T_9 (50% RDF + vermicompost + soil and seedling treatment with *Azotobacter* and PSB) and found at par with treatment T_6 (123.2 cm), where integrated application of 50% RDF with vermicompost @ 2 tonnes/ha was applied. The next better treatment was T_2 (122.6 cm) at recommended dose of chemical fertilizer application and found statistically similar with the treatments T_7 and T_3 but significantly superior over the treatments T_4, T_5 and T_8. The shortest plant height (90.4 cm) was recorded with control. Similarly, maximum number of primary branches/ plant (8.50/ plant) were also recorded with T_9 (50% RDF + vermicompost @ 2 tonnes/ ha + soil and seedling treatment with *Azotobacter* and PSB) and found statistically identical with T_6 (50% RDF + vermicompost @ 2 tonnes/ ha) and T_2 (100% RDF). The least number of branches were recorded with control (6.42/ plant). The increase in height and number of branches/ plant due to application of organic and inorganic fertilizers might be due to better inorganic nitrogen utilization in the presence of biofertilizer, enhanced biological fixation and better development of root system with possible higher synthesis of plant growth hormones (Kumaraswami and Madalageri, 6; Pandey and Kumar, 7). The results also revealed that the initiation of flowering in tomato was influenced by the nutrient and biofertilizer application. The earliest flowering (37 days) was attained by the integrated application of 50% recommended dose of fertilizer and vermicompost @ 2 tonnes/ ha alongwith soil and

Table 3. Tomato growth, yield attributing characters and yield as influenced by inorganic and organic fertilizers in Begusarai Block.

Treatment	Plant ht. (cm)	No. of main br.	Days to first flowering	Days to first picking	No. of fruits per plant	Av. fruits per plant	Yield per plant (g)	TSS (%)
T1	90.40	6.42	42.00	77.00	47.00	76.00	3576.00	4.69
T6	122.60	8.00	39.00	71.20	60.00	87.00	5542.00	5.42
T3	117.30	7.50	40.30	72.00	56.00	83.00	4651.00	5.59
T4	112.00	7.08	41.20	74.60	51.00	82.00	4194.00	5.22
T5	109.40	6.92	41.60	75.00	48.00	78.00	3747.00	5.07
T6	123.20	8.17	38.00	71.00	61.00	101.00	6167.00	5.72
T7	120.60	7.83	40.00	71.60	57.00	92.00	5246.00	5.60
T8	114.80	7.17	41.00	71.80	54.00	89.00	4856.00	5.86
T9	126.00	8.50	37.00	70.00	62.00	105.00	6535.00	6.09
CD (p = 0.05)	9.8	0.58	4.4	6.96	8.22	22.06	724.14	0.41

seedling treatment with *Azotobacter* & PSB, which was statistically identical with all the treatment except control where days to first flowering was more (42 days) than all the eight treatments. Similarly, days to first picking of fruit was also recorded least (70 days) in T_9 and statistically at par with all the treatments except control in which this value was maximum (77 days). All treatments showed earliness in flowering over control for days to first harvesting. Earliness of flowering and fruiting is an important trait in tomato crop and in these cases; it could be attributed to the faster enhancement of vegetative growth and storing sufficient reserve food material for differentiation of buds into flower buds. The results thus indicate that balanced application of all the essential elements is essential to get early flowering in tomato. Earlier, Renuka and Shankar (10) also reported earliness in flowering and fruiting in tomato when FYM was used with biogas slurry.

The results (Table 3) indicated that the treatment T_9 (50% RDF + vermicompost @ 2 tonnes/ ha + soil and seedling treatment with *Azotobacter* and PSB) produced maximum number of fruits per plant (62). The next best treatment in this regard was T_6 (50% RDF + vermicompost @ 2 tonnes/ ha) with 61 fruits/ plant and followed by T_2 (100% RDF) with 60 fruits/ plant. All the treatments were found statistically at par to each other except T_4, T_5 and control in respect of bearing the number of fruits/ plant. The treatment T_9 (50% RDF + vermicompost @ 2 tonnes/ha + soil and seedling treatment with *Azotobacter* and PSB) produced fruits with superior fruit weight (105 g/ fruit) but statistically at par with all the treatment except T_4, T_5 and control. The results of present studies are in accordance with Kumaran *et al.* (5) who reported an integrated application of organic and inorganic sources of nutrients gave more mean fruit number and fruit weight in tomato.

The treatment T_9 (50% RDF + vermicompost @ 2 tonnes/ ha + soil and seedling treatment with *Azotobacter* and PSB) emerged as most superior in production of more yield per plant (6535 g/ plant) and recorded similarly identical with production of tomato fruit 6167 g/plant in T_6 (50% RDF + vermicompost @ 2 tonnes/ ha). The next better treatment in this regard were T_2 (100% RDF), T_7 (50% RDF + soil and seedling treatment with *Azotobacter* and PSB), T_8 (vermicompost @ 2 tonnes/ ha + soil and seedling treatment with *Azotobacter* and PSB), T_3 (50% RDF), T_4 (vermicompost @ 2 tonnes/ ha) and T_5 (soil and seedling treatment with *Azotobacter* & PSB) in decreasing order. The lowest yield/ plant was obtained from treatment T_1 (control). It is a well known fact that nitrogen and phosphorus are essential constituents of protein and chlorophyll alongwith their movement in many other compounds of physiological importance in plant metabolism. Hence, increase in yield due to application of organic manure, fertilizer and biofertilizer together might be responsible for synthesis of plant growth hormones, development of good root system, therefore better nutrient utilization by better the crop plants. The results of the study are also in agreement with the findings of Sepat *et al.* (11). The total soluble solids (TSS) in fruit was significantly affected by the treatments. The highest TSS (6.09%) was recorded with an integrated application of 50% RDF + vermicompost @ 2 tonnes/ ha + soil and seedling treatment with *Azotabacte*r and PSB but found at par with the application of vermicompost @ 2 tonnes/ ha + soil and seedling treatment with *Azotobacter* and PSB (5.86%) and integrated application of 50% RDF + vermicompost

@ 2 tonnes/ ha (5.72%). Yadav *et al.* (13) reported that TSS increased when plants were supplied either with organic sources alone or in combination with inorganic components. Shukla *et al.* (12) also reported the fertilizer from different sources in combination resulted in higher yield of quality fruits.

It is revealed (Table 4) that the combined application of 50% RDF+ vermicompost @ 2 tonnes/ ha + soil and seedling treatment with *Azotobacte*r and PSB resulted in the highest yield at all the four locations but found statistically identical with the integrated application of 50% RDF + vermicompost @ 2 tonnes/ha and 100% RDF. The lowest yield was recorded with control treatment. It is clear that the integrated application of organic and inorganic sources of nutrition with biofertilizer and combined application of organic and inorganic sources of nutrition proved superiority over the recommended dose of fertilizers. These results are is close agreement with the findings of Gajbhiye *et al.* (2) and Patil *et al.* (9). This might be due to the availability of plant nutrients by improving soil physical conditions and solubilizing the nutrients in soil by applying organic sources of nutrition with biofertilizers.

Regarding the economics of tomato cultivation (Table 5) clearly indicate that though the cost of cultivation was higher with application of 50% RDF + vermicompost treatment alongwith soil and seedling treatment with *Azotobacter* and PSB (T_9) but it gave higher yield and net profit (Rs. 8,50,300/ ha) over control (Rs. 4,40,800/ ha). This treatment also gave highest B:C ratio (9.39) compared to control. Other two treatments (T_2 and T_6) gave almost equal B:C ratio. Sole use of organic and biofertilizer (T_4 and T_5) brought lower B:C ratio (6.06), while least in control (5.95). Application of organic, biofertilizer and inorganic sources of nutrition together showed superiority over inorganic (50% RDF) alone. Thus, it was inferred that application of 50% RDF + vermicompost (2 tonnes/ ha) + soil and seedling treatment with biofertilizer could be the best option for getting sustainable yields of tomato in Begusarai district of Bihar.

Table 4. Effect of vermi-compost, biofertilizer and chemical fertilizer on fruit yield at different locations of tomato.

Treatment	Yield (q/ha)			
	Barauni	Begusarai	Gadhpura	Bakhari
T_1	362	429	359	292
T_2	601	665	564	464
T_3	524	558	502	432
T_4	494	503	498	426
T_5	421	450	402	394
T_6	626	740	584	479
T_7	578	629	542	459
T_8	560	583	521	443
T_9	652	784	603	512
CD (p = 0.05)	66.4	124.5	56.4	50.2

Table 5. Effect of benefit:cost ratio on tomato cultivation in Begusari Block.

Treatment	Yield (q/ha)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
T_1	429	74000	514800	440800	5.95
T_2	665	80500	798000	717500	8.91
T_3	558	79500	669600	590100	7.42
T_4	503	85500	603600	518100	6.06
T_5	450	76500	540000	463500	6.06
T_6	740	89500	888000	798500	8.92
T_7	629	83500	754800	671300	8.03
T_8	583	86500	699600	613100	7.09
T_9	784	90500	940800	850300	9.39

Tomato price = Rs. 12/kg

REFERENCES

1. Anonymous. 2015. *Economic Survery* 2014-15, Finance Department, Govt. of Bihar.
2. Gajbhiye, R.P., Sharma, R.R. and Tewari, R.N. 2003. Effect of biofertilizers on growth and yield of tomato. *Indian J. Hort*. **60**: 368-71.
3. Jackson, M.L. 1967. *Soil Chemical Analysis*, Prentice Hall, of India, Pvt. Ltd. New Delhi.
4. Kumar, R., Batra, V.K. and Singh, R.K. 2012. Effect of organic and inorganic nutrition on growth, yield nutrient uptake and fruit quality of tomato. *Haryana J. Hort. Sci.* **41**: 164-67.
5. Kumaran, S., Natarajan, S. and Thamuraj, S. 1998. Effect of organic and inorganic fertilizers on growth, yield and quality of tomato. *South Indian Hort*. **46**: 203-05.
6. Kumarswamy, D. and Madalageri, B.B. 1990. Effect of *Azotobacter* on tomato. *South Indian Hort.* **38**: 345-46
7. Pandey, A. and Kumar, S. 1989. Potential of *Azotobacter* and *Azospirillum* as bio-fertilizers for upland agriculture - A review. *J. Sci. Indust. Res*. **48**: 134-44.

8. Panse, V.G. and Sukhatme, P.V. 1978. *Statistical methods for Agricultural Workers*, ICAR, New Delhi.

9. Patil, M.B., Mohammed, R.G. and Ghadge, P.M. 2004. Effect of organic and inorganic fertilizers on growth, yield and quality of tomato. *J. Maharashtra Agric. Univ.* **29**: 124-27.

10. Renuka, B. and Shankar, R.C. 2001. Effect of organic fertilizers on growth and yield of tomato. *South Indian Hort.* **49**: 216-17

11. Sepat, N.K., Kumar, A., Yadav, J. and Srivastava, R.B. 2012. Effect of integrated nutrient management on growth, yield and quality of tomato in trans Himalayan. *Ann. Pl. Soil Res*. **14**: 120-23.

12. Shukla, Y.R., Thakur, A.K. and Joshi, A. 2009. Effect of inorganic and bio-fertilizers on yield and horticultural traits in tomato. *Indian J. Hort.* **66**: 285-87.

13. Yadav, B.D., Singh, B. and Sharma, Y.K. 2004. Production of tomato under organic condition. *Haryana J. Hort. Sci.* **33**: 306-07.

Received : April, 2016; Revised : September, 2017;
Accepted : October, 2017