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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH, YIELD AND QUALITY OF TOMATO IN TRANS HIMALAYAN

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ABSTRACT

A field experiment was conducted during kharif season of 2008 and 2009 at Defence Institute of High Altitude Research, Det. Partapur, Leh and Ladakh, to determine the influence of biofertilizer, fertility levels and cow manure on growth, yield and quality of tomato var. Sultan in Trans-Himalayas. Results revealed that the treatments of 100% NPK or 10 t FYM ha^{-1} either in combination to each other or with Azotobacter had significant effect on plant growth and yield attributes over control. However, application of 50% NPK + FYM + Azotobacter gave values of plant^{-1} height (79 cm), branches (7.5), clusters of fruit (11), fruits cluster^{-1} (4.8), fruit size (6.3 cm), weight of fruit^{-1} (113.3 g), fruit yield: plant^{-1} (1.48 kg) and (12.3 q ha^{-1}) which were at par to the values obtained due to 100% NPK+ FYM + Azotobacter and significantly higher over other treatments.
Keywords: Interageted nutrient management, growth, yield, quality, tomato

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is the most popular vegetable crop of the world due to its wider adaptability and multifarious uses. It's cultivation is also done as an important vegetable crop in Leh - Ladakh area of Trans Himalaya. Tomato, being a heavy feeder and exhaustive crop, requires large quantities of inorganic and organic nutrient inputs. The excessive or indiscriminate use of nitrogenous fertilizer is not judicial for soil health and crop production. Hence, application of organic manure and biofertilizer in judicious combination to chemical fertilizers facilitates profitable and sustainable crop production along with maintenance soil fertility (Singh and Sinsinwar, 2006). The use of organic manures improves the level of soil organic carbon. Most of the soils of Leh and Ladakh region have either lacking or very poor microbial because of cryic conditions. However, application of psychrophilic beneficial microbes like *Azotobacter,* as diazotroph, in that area may not only help to improve plant growth of tomato by asymbiotic N_2 – fixation but it may also be helpful as producer of plant growth hormones and nutrients cycler during the cropping season when temperature goes optimal to 20 ^{0}C. Since, this type of work in trans-Himalayas is very scare, therefore, the present research work was undertaken to assess the response of tomato to integrated nutrient management.

MATERIALS AND METHODS

Field experiments were conducted at Defence Institute of High Altitude Research, Field Station, Partapur in Leh- Ladakh, J&K, during kharif 2009 and 2010 under irrigated conditions. The experimental soil belongs to the taxonomic order of Typic Cryorthents (Yadav and Prasad, 2005) with properties of sandy in texture, moderately alkaline (pH 8.4), EC 0.17 dSm^{-1}, O.C. 0.3 g kg^{-1}, available N 60 kg ha^{-1}, P_2O_5 5 kg ha^{-1} and K_2O 385 kg ha-1. Eleven treatments (T_1 control, T_2 50 % NPK of recommended doses, T_3 100 % NPK, T_4 *Azotobacter* (DIHAR 1), T_5 50 % NPK + *Azotobacter* , T_6 100 % NPK + *Azotobacter*, T_7 FYM @ 10 t ha^{-1}, T_8 50 % NPK + FYM, T_9 100 % NPK + FYM T_{10} 50 % NPK + FYM + *Azotobacter* and T_{11} 100 % NPK + FYM + *Azotobacter)* were imposed thrice in randomized block design. Seedling of tomato var. *Sultan* was transplanted in rows at distance of 40 x 40 cm. The recommended dose of fertilizer (RDF) was considered as 120-60-40 kg N, P_2O_5 and K_2O ha^{-1}. Two-third of NPK and whole amount of FYM was applied irrespective of treatments during field preparation. Seedlings inoculation was done one hour before transplanting with mass culture of *Azotobacter* using 15 % sticky solution prepared by molasses and gum acacia. The FYM contained 0.32 % N, 0.20% P and 0.40% K. The remaining part of RDF was applied as per treatment after first irrigation. Cultural activities and irrigations were done when ever required. Picking was done as per maturity of fruits from each plant and data was recorded. The vitamin C (ascorbic acid) content was determined by Dye method as described by Ranganna (1997). Total soluble solids (TSS) were determined with the help of hand refractrometer and expressed in ^{0}Brix (Ranganna, 1997). Total titrable acidity of the tomato juice was determined by

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titrating the samples against 0.1 N NaOH using phenolphthalein as an indicator and expressed as percentage of citric acid (Ranganna, 1997). Data obtained from tomato crops for two consecutive years were pooled and statistically analyzed using the F-test as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

All the growth attributes like plant height, leaf area and number of leaf per branch were significantly influenced by the fertility levels, FYM and *Azotobacter* (Table1). Plant height increased significantly with corresponding increase in fertility levels up to 100 % NPK (73.3 cm). Number of branches (6.7), leaf area (181.8 cm^2) and number of leaf per branches (16.5) were significantly higher due to 100 % NPK over control, but these values were remained at par to the treatment of 50 % NPK. Alone treatment of *Azotobacter* did not improve growth attributes significantly. Combined application of 100 % NPK and 10 t FYM ha^{-1} resulted an increase in plant height (76.0 cm), leaf area (187.3 cm^2) and number of branches (6.8) significantly over an individual application of either 50 % NPK or 10 t FYM ha^{-1}. The highest values of all growth attributes were observed due to an integrated application of 100 % NPK and FYM + *Azotobacter* followed by 50% NPK + FYM + *Azotobacter* and 100% NPK + FYM. These three treatments were found to be comparable with non-significant differences because of high and continuous nutrient availability from combined nutrient sources which ultimately resulted an improved growth attributes and photosynthetic activities of the plants (Padloe *et al*., 1998).

Table 1: Effect of various treatments on the growth attribute of tomato (averaged over 2 years)

Treatments	Plant height (cm)	Leaf area (cm^2)	Branches $plant^{-1}$	Leaf $branch^{-1}$
T_1: control	57.3	148.3	4.5	10
T_2 : 50 % NPK	61.7	155.5	5.2	15
T_3 : 100 % NPK	73.3	181.8	6.7	16.5
T_4: *Azotobacter* (Az)	66	153.3	5.5	13.7
T_5 :*Az* + 50 % NPK	68.3	168.3	6	15.2
T_6 : *Az.* + 100 % NPK	68.7	173.3	6	15.2
T_7: FYM	64.7	163.8	5.2	15
T_8 : 50 % NPK +FYM	66.3	154	5.3	14
T_9 : 100 % NPK +FYM	76	187.3	6.8	16.7
T_{10}: 50 % NPK +FYM + *Az*	79	194.8	7.5	17.3
T_{11}: 100 % NPK +FYM + *Az*	79	218.3	7.8	18.7
LSd (p= 0.05)	10.6	22.7	1.5	2.5

The 100% NPK was considered as 120-60-40 kg N, P_2O_5 and K_2O ha^{-1}, respectively

The yield attributes of tomato (Table 2) were highly influenced by the application of fertility levels and their combinations with FYM and biofertilizer. Successive doses of fertility levels increased considerably the number of cluster per plant, number of fruits per cluster, size of fruit, weight of fruit and yield of fruits per plant. It is well known fact that nitrogen and phosphorous both are essential constituents of proteins and chlorophyll along with their involvement in many other compounds of physiological importance in plant metabolism. Hence, increase in yield due to the application of organic manure, fertilizer and biofertilizer together was might be responsible for synthesis of plant growth hormone, development of root system and therefore high nutrients utilization by the crop plants (Pandey and Kumar, 1989; Kumarswamy and Madalageri, 1990).

Table 2: Effect of various treatments on the yield attributes and yields of tomato (Av. over 2 years)

Treatments	Cluster $plant^{-1}$	Fruits $Cluste^{-1}$	Fruit Size (cm)	Fruit Wt. (g)	Fruits yield $plant^{-1}$ (kg)	Yield q ha^{-1}
T_1: control	4.3	3.5	5.2	87.3	0.54	7.7
T_2 : 50 % NPK	7	3.8	5.4	91.7	0.69	9.6
T_3 : 100 % NPK	9.3	4.3	6.0	103.3	1.07	10.9
T_4: *Azotobacter* (Az)	4.8	3.7	5.6	96.3	0.61	8.0
T_5 :*Az* + 50 % NPK	8.3	4.2	5.8	100.0	0.94	10.1
T_6 : *Az.* + 100 % NPK	8.5	3.8	5.8	100.0	0.88	10.9
T_7: FYM	5.8	3.8	5.7	95.0	0.84	9.6
T_8 : 50 % NPK +FYM	5.3	3.7	5.8	96.7	0.63	9.0
T_9 : 100 % NPK +FYM	11	4.8	6.1	103.3	1.17	11.3
T_{10}: 50 % NPK +FYM + *Az*	11	4.8	6.3	113.3	1.48	12.3
T_1: control	12.3	4.8	6.3	116.7	1.62	12.7
LSd (p= 0.05)	3.8	0.6	0.8	31.2	0.50	1.3

Application of *Azotobacter* as alone treatment could not improve yield of tomato significantly. Yield values recorded with 10 t FYM ha^{-1} were found to be intermediate between 50 and 100 % NPK. Application of 50 % NPK along with Azotobacter produced yield comparable to 100 % NPK. The highest yield values were recorded with an integrated application of 100 % NPK + FYM + Azotobacter followed 50 % NPK + FYM + Azotobacter and 100 % NPK + FYM. Barakart *et al*. (1998) have reported that the outcome in the form of various growth and yield parameters is the expression of integrated influence of various growth factors. Hence, with the increment in supply of essential nutrients to tomato, their availability, acquisition, mobilization and influx into the plant tissues increased and thus improved growth and yield components could be achieved (Shukla *et al*., 2009).

Table 3: Effect of different treatments on the quality of tomato (averaged over 2 years)

Treatments	TSS (^{0}Brix)	Ascorbic acid (mg/100g)	Acidity (%)
T_1: control	4.74	18.7	0.82
T_2 : 50 % NPK	4.96	20.76	1.02
T_3 : 100 % NPK	5.37	24.19	0.95
T_4: *Azotobacter* (Az)	4.41	21.37	1.00
T_5 :*Az* + 50 % NPK	4.68	21.93	1.07
T_6 : *Az.* + 100 % NPK	5.04	21.90	1.08
T_7: FYM	4.92	20.68	0.98
T_8 : 50 % NPK +FYM	4.92	20.22	1.05
T_9 : 100 % NPK +FYM	5.08	26.40	1.08
T_{10}: 50 % NPK +FYM + *Az*	5.20	25.73	1.09
T_1: control	5.40	26.97	1.10
LSd (*p*= 0.05)	0.51	3.51	0.32

The total soluble solids (TSS) and ascorbic acid in fruit significantly affected by treatments. Highest TSS and ascorbic acid was observed with an integrated use of 100 % NPK and 10 t FYM ha^{-1} along with *Azotobacter* followed by the same combination that involved *Azotobacter* at 50 % NPK. The difference in per cent acidity as citric acid was at par in different treatments, but it was higher in integrated use of 100 % NPK and 10 t FYM ha^{-1} along with *Azotobacter*. Similar observation has also been reported by Ahlawat et al. (2009). Application of biofertilizer with NPK and FYM might have exhibited regulatory role on absorption and translocation of various metabolites, in which most important carbohydrates affect the quality of fruits. During ripening of fruits the carbohydrate reserves of the root and stem are drawn upon heavily and hydrolyzed into sugars. Terry *et al*. (2000) have reported that translocation of assimilates from leaves to the developing fruit increased during ripening stage. Biofertilizers are also known to favor the synthesis of different growth regulators like IAA, GA and cytokinins (Awasthi *et al*., 1998) and accumulation of dry matter (Wange, 1996).

Thus, it was inferred that application of 50% NPK + FYM @ 10 t ha^{-1} + *Azotobacter* should be adopted by the tomato growers to achieve rational yield in Trans - Himalayas of Leh and Ladakh in J&K.

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