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Effect of Integrated Nutrient Management on the Growth, Yield and Soil Nutrient Status in Tomato

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Abstract

A field experiment was conducted at the Integrated Research Farm of Himalayan College of Agricultural Sciences and Technology (HICAST) at Bandegaon, Lalitpur, Nepal during 2009 to scrutinize the effect of Integrated Nutrient Management (INM) on the growth, yield and soil nutrient status to tomato (*Lycopersicon lycopersicum* (L.) Karsten). Following a randomized complete block design, 9 treatments with 3 replications were maintained. The study revealed that the integration of organic manures in combination with inorganic fertilizers was found significant in improving the overall plant growth, yield and soil macro nutrient status than the sole application of either of these nutrients. Maximum plant height and number of leaves per plant were observed with treatment 16.66 mt/ha FYM + 8.33 mt/ha Vermicompost + NPK. The earlier of days to 50% flowering was observed in treatment 20 mt/ha FYM. Highest number of fruit clusters, maximum fruit weight and fruit yield (25.74 mt/ha) were recorded in treatment 16.66 mt/ha FYM + 8.33 mt/ha Vermicompost + NPK. The pH value was found near to neutral in treatment 10 mt/ha vermicompost. Similarly, the maximum organic matter percentage was also recorded in treatment 10 mt/ha vermicompost. The highest available nitrogen, phosphorus and potassium were found in treatment ½ NPK + 15 mt/ha vermicompost.

Key words: NPK, vermicompost, FYM, soil nutrients, tomato

Introduction

Tomato (*Lycopersicon lycopersicum* (L.) Karsten) is one of the major income generating vegetable crops of Nepal in terms of production and cultivated area. It occupies an area of 15,572 ha of land and its annual production is 2,19,194 mt (VDD 2009). Tomato has acquired the status of world's most popular vegetable crop due to its wider adaptability to various agroclimatic conditions. At present, tomatoes rank third, next to potato and sweet potato in terms of global vegetable production (FAO 2002). However, the average yield in Nepal is quite low compared to the average yield of Asia (2,430 mt/ha) and world (26.74 mt/ha) (FAO 2003).

Fertilizers no doubt have played a key role in agriculture production and have changed Asia from a region of food scarcity to food sufficiency. But the fertilizer production is largely dependent on the non-renewable energy sources. Consequently, the use of organic manures to supplement fertilizers has declined substantially. To achieve compliance with an increasing amount of agricultural, environmental, legislative and economical constraints, a well defined fertilizer strategy needs to be developed which would lead to optimization of nutrient use, crop production and quality. Thus, the integrated nutrient use of organic and inorganic fertilizers has assumed great significance in recent years.

Organic manures in proper blend with chemical fertilizers will predictably support crop growth (Kumar *et al.* 2009). Kumar and Sharma (2004) reported that application of organic manures with NPK were found best in obtaining higher values for yield and available macronutrients (NPK) in both tomato and carrot. As little information is available on the combined effect of NPK and organic manures on tomato, this study was made to find out the effect of INM on the soil nutrient status of tomato.

Methodology

The study was conducted during 2009 at the Integrated Research Farm of HICAST at Bandegaon, Lalitpur. Yash variety of tomato was selected. Each experimental plot was 2.5x2 m^2. One month old tomato seedlings were transplanted at a distance of 60x45 cm. The experiment was laid out in a randomized complete block design with 3 replications. There were 9 treatments: T_1 = 20 mt/ha, T_2 = Half of the recommended NPK + 30 mt/ha FYM, T_3 = Three fourths of the recommended NPK + 25 mt/ha, T_4 = 10 mt/ha Vermicompost, T_5 = Half of the recommended NPK + 15 mt/ha Vermicompost, T_6 = Three fourths of the recommended NPK +12.5 mt/ha Vermicompost, T_7 = 16.66 mt/ha FYM + 8.33 mt/ha Vermicompost + NPK, T_8 = Recommended NPK (100: 80: 60 kg/ha), T_9 = Control (no organic manures and inorganic fertilizers). The treatments were tested at 5% level of significance.

The required amounts of fertilizers and manures were weighed by a weighing balance separately. Organic manures were applied in the field an hour before transplantation by mixing properly with soil. Incase of chemical fertilizers, half of the total amount was basally applied and the remaining half was in circular furrows.

The observations in respect to increment in plant height, number of leaves per plant, days to 50% flowering, number of fruit clusters per plant, fruit weight, and yield per plant were recorded in the field while the estimations and analysis of available nitrogen, available phosphorus, and available potash were done in the soil laboratory of HICAST.

Determination of growth and yield of tomato

Plant height was measured from the ground level to the growing point and the observation was recorded at the end of the growing period for each treatment and was expressed in centimeters. Similarly, effective leaves were counted and the mean was calculated. The number of days to 50% flowering was counted for all treatments. The average was then calculated and recorded. The total number of fruit clusters was counted for each treatment and then the mean was calculated and recorded. The observations on fruit weight for each treatment were recorded at the time of harvest. After each harvest, the individual fruits were weighed and the data on fruit weight was summed up and expressed in gram. The observations on yield were recorded at the time of harvesting. After harvesting, the tomato fruits were weighed from each treatment plots.

Determination of soil macronutrient status

Soil samples representing 30 cm deep soil was collected from the experimental plot during the month of September. Three samples from each plot were taken and mixed to form one composite sample and then dried in shade and sieved through 2 mm bronze sieve and stored in cloth bags for further analysis. Available N was determined by Kjeldahl method (Jackson 1975), available P was determined by Modified Olsen's method (Olsen *et al.* 1954) and available K was determined by Ammonium acetate method (Hanway & Heidal 1952).

Results and Discussion

Growth

Plant height

Maximum increment in plant height (116.16 cm) was observed with T_7 16.66 mt/ha FYM + 8.33 mt/ha Vermicompost +NPK (Table 1). The better efficiency of organic manures in combination with inorganic fertilizers might be due to the fact that the organic manures would have provided the micronutrients in an optimum range to the plant. Application of organic manures would have helped in enhancing the metabolic activity through the supply of such important micronutrients in the early growth phase which in turn must have encouraged the overall growth. Several other workers have also reported the highest plant growth due to the combined application of organic manures and chemical fertilizers in tomato (Alam 2006, Azad 2000).

Number of leaves per plant

Maximum number of leaves per plant was recorded in treatment 16.66 mt/ha FYM + 8.33 mt/ha vermicompost + NPK (Table 1). Data of the present study clearly indicated that vegetative growth was higher in plots that received integrated (organic and inorganic) nutrient supply. This might be due to the fact that the application of NPK, FYM and vermicompost provided adequate N which is associated with high photosynthetic activity and vigorous vegetative growth. Combination of organic and inorganic fertilizers significantly increased the number of leaves in cabbage (Kabir 1998, Azad 2000)

Table 1. Effect of integrated nutrient management on the growth of tomato

Treatments	Plant height (cm)	Number of leaves per plant
T_1 (20 mt/ha)	103.03	102.75
T_2 (Half of the recommended NPK + 30 mt/ha FYM)	114.43	107.33
T_3 (Three fourths of the recommended NPK + 25 mt/ha	108.70	111.33
T_4 (10 mt/ha Vermicompost)	104.30	104.50
T_5 (Half of the recommended NPK + 15 mt/ha Vermicompost	114.60	111.33
T_6 (Three fourths of the recommended NPK +12.5 mt/ha Vermicompost	110.70	109.33
T_7 (16.66 mt/ha FYM + 8.33 mt/ha Vermicompost +NPK	116.16	114.50
T_8 (Recommended NPK (100: 80: 60 kg/ha)	103.85	105.50
T_9 (Control)	93.90	94.75
CD (0.05)	1.44	3.76

Days to 50% flowering

It is evident from the dada given in Table 2 that the earliness in days to 50% flowering (26.33) was recorded in treatment 20 mt/ha FYM. The earliness in flowering could be attributed to the faster enhancement of vegetative growth and storing sufficient reserved food materials for differentiation of buds into flower buds whereas the delayed flowering by the inorganic fertilizer treatment could be due to extended vegetative phase of the plant by the availability of inorganic nitrogen. These results are in close conformity of the findings of Renuka and Ravi Shankar (1998).

Number of fruit clusters per plant

Maximum number of fruit clusters (6.90) was recorded with T_7 16.66 mt/ha FYM + 8.33 mt/ha Vermicompost + NPK (Table 2). This confirms the significance of conjunctive use of chemical and organic fertilizers than the individual one which might be due to the solubilization effect of plant nutrients by the addition of FYM and Vermicompost leading to increased uptake of NPK. Bahadur *et al.* (2004) also showed that application of organic manures combined with recommended dose of inorganic fertilizers showed superior performance in tomato.

Fruit weight

The maximum fruit weight (52.8 g) was recorded in T_7 16.66 mt/ha FYM + 8.33 mt/ha Vermicompost +NPK (Table 2). This might be due to solubilization effect of plant nutrients by the addition of FYM and Vermicompost leading to increased uptake of NPK as was reported by Subbiah *et al*. (1982).

Fruit Yield

Tomato fruit yield was affected significantly by different treatments. Maximum yield (25.74 mt/ha) was observed in T_7 16.66 mt/ha FYM + 8.33 mt/ha Vermicompost + NPK (Table 2). The reasons for increased fruit yield by the application of NPK with FYM and Vermicompost leading to increased uptake of NPK. The results are in agreement with the findings of Kumaran *et al*. (1995) who recorded an increase in fruit yield by the application of NPK with FYM and Vermicompost.

Table 2. Effect of integrated nutrient management on the yield of tomato

Treatments	Days to 50% flowering	Number of clusters per plant	Individual fruit weight (g)	Yield (mt/ha)
T_1 (20 mt/ha)	26.33	5.98	37.45	21.70
T_2 (1/2 NPK + 30 mt/ha FYM)	27.00	6.54	43.89	24.18
T_3 (3/4 NPK + 25 mt/ha	28.00	6.36	49.10	25.11
T_4 (10 mt/ha Vermicompost)	26.66	6.18	40.82	22.07
T_5 (1/2 NPK + 15 mt/ha Vermicompost	27.33	6.58	49.41	25.29
T_6 (3/4 NPK + 12.5 mt/ha Vermicompost	28.66	6.69	45.87	24.22
T_7 (16.66 mt/ha FYM + 8.33 mt/ha Vermicompost +NPK	27.33	6.90	52.80	25.74
T_8 (Recommended NPK (100: 80: 60 kg/ha)	29.60	6.04	39.33	21.70
T_9 (Control)	31.66	5.06	33.82	19.07
CD (0.05)	1.67	0.14	7.82	2.25

Available macronutrients

The different treatments had significant influence on the available phosphorus in the soil. Maximum available Nitrogen (382.80 kg/ha) was observed in treatment half of the recommended NPK + 15 mt/ha (T^5) (Table 3). Inspite of using chemical fertilizers the available N was found low in NPK treated soil which might be due to leaching and volatilization losses, whereas in organic manure applied soil the applied manure holds the nutrients and retains losses. Mixing of N fertilizer and organic manures might have reduced the nitrogen losses, improved the fertilizer use efficiency thus increasing the availability of N. Bahadur *et al.* (2004) also reported that nitrogen uptake by okra increased significantly in treatments which received integrated nutrition. The maximum available phosphorus (100.40 kg/ha) was recorded in treatment half of the recommended NPK + 15 mt/ha (T^5) (Table 3). This may be attributed to the fact that vermicompost in combination with FYM and full dose of NPK might have helped in the solubilization of fixed P to soluble form making it easily available to the plant. The results are in conformity with the findings of Prasad and Rokima (1992) who reported the increase in available P content with the integrated use of organic, inorganic and biofertilizers. Different treatments had significant influence on available potassium in the soil. Maximum available P content (230.80 kg/ha) was recorded in treatment half of the recommended NPK + 15 mt/ha(T^5) (Table 3). Increment in potassium uptake was observed in almost all the integrated nutritional treatments over the sole chemical fertilization. Similar results were reported by Bahadur and Singh *et al.* (2004). This might be due to enhancement in K availability by shifting the equilibrium among the forms of K from relatively exchangeable K to soluble K forms in the soil.

Table 3. Effect of integrated nutrient management on the macro nutrient status of tomato

Treatments	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
T_1 (20 mt/ha)	323.30	71.00	174.90
T_2 (1/2 NPK + 30 mt/ha FYM)	350.80	88.70	193.60
T_3 (3/4 NPK + 25 mt/ha	363.60	90.50	203.60
T_4 (10 MT/ha Vermicompost)	331.70	73.40	179.90
T_5 (1/2 NPK + 15 mt/ha Vermicompost	382.80	100.40	230.80
T_6 (3/4 NPK +12.5 mt/ha Vermicompost	352.80	96.40	216.30
T_7 (16.66 mt/ha FYM + 8.33 mt/ha Vermicompost +NPK)	366.10	93.30	212.70
T_8 (Recommended NPK (100: 80: 60 kg/ha)	340.00	89.30	184.10
T_9 (Control)	269.40	65.90	147.20
CD (0.05)	26.12	5.96	25.17

The integration of organic manures in combination with inorganic fertilizers was found significant in improving the overall plant growth, yield and soil macro nutrient status than the sole application of either of these nutrients. The combined use of organic and inorganic nutrients result in solubilization of plant nutrients which lead to increased up take of NPK. Mixing of organic and inorganic nutrients reduce the nutrient losses, improving the fertilizer use efficiency thus increasing the soil nutrient availability.

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