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Economics of Integrated Plant Nutrient System (IPNS) in Tomato (*Lycopersicon esculentum* L.) Under Dry Temperate Region of Himachal Pradesh

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ABSTRACT

Integrated Plant Nutrition System (IPNS) is a system of planning and management of plant nutrients through crop rotations for enhanced productivity, profitability and sustainability. A field experiment to evaluate the effect of five organic sources of plant nutrients along with three fertility levels on productivity and economics of tomato was conducted during *kharif* seasons of 2006 and 2007 at HAREC, Kukumseri (L&S). Application of FYM @ 2.5 t/ha in combination with PSB has produced significantly taller plants with higher values of yield contributing characters *viz*. number of branches per plant, number of fruits per plant, fruit weight, fruit weight per plant and fruit diameter, reflected in getting significantly highest tomato yield (700.9 q/ha), productivity (3.84 q/ha/day) and economic efficiency (₹ 1549.4/ha/day), which was followed by FYM 5 t/ha for all these characters. With increasing the dose of NPK by 50% over recommended i.e. 150% NPK, the yield contributing attributes were significantly improved, contributing in producing significantly highest tomato yield (767.4 q/ha) and productivity 4.21 q/ha/day with the best economic efficiency of ₹ 1721.5/ha/day. Increasing 50% NPK beyond recommended resulted in 5.33% higher yield of tomato crop.

Keywords: Tomato, FYM, PSB, *Azotobacter*, productivity, profitability

Alarmed with the decline in the soil health and chemicalization of the modern day farming, greater emphasis on the INM system is being given in the recent years. The INM approach is economically cheap, technically sound, practically feasible and sustain higher production. Vegetable crops because of their high productive ability put tremendous pressure on soil for nutrients. In vegetables, complementary use of chemical fertilizers, organic manures, biofertilizers and other organics is important to maintain and sustain a higher level of soil fertility and crop productivity. Tomato (*Lycopersicon esculentum* Miller nom. Cons.) is the most popular home garden and the third most consumed crop in the world. As a processing crop tomato takes first rank among the vegetables. It is very much beneficial for health because of its high nutrient status. Tomato is an important commercial vegetable crop of Himachal Pradesh. Himachal Pradesh is endowed with certain climatic advantages which offer numerous opportunities for production of a variety of high value horticultural crops like tomato as an off-season crop particularly in high hills. In the peak demand period when no produce

is available in the markets of plains, its cultivation as off-season crop in the high-hill temperate zone with scientific nutritional management can fetch good prices and prove to be remunerative cash crop for the farmers of this region. Moreover, the major cash crop *i.e.* Pea in the region is facing root rot complex, so it can be replaced by tomato. The tomato a heavy feeder crop, which is rich source of minerals and possess high yield potential, need balanced use of organic manures, biofertilizers and chemical fertilizers to produce desired yield of higher nutritive quality (Singh and Ramashrey, 9). Since, no such systematic study has so far been undertaken in high hills (Zone-IV), where the conditions were quite different than from lower zones of H.P., the present investigation was undertaken to study the influence of INM on production and economics of tomato.

MATERIALS AND METHODS

Field experiment was conducted at Highland Agricultural Research and Extension Centre, Kukumseri (2772 m amsl), Lahaul and Spiti during *kharif* seasons of 2007 and 2008. The experiment consisted of fifteen treatment combinations of five organic sources of plant nutrients *viz*. FYM @ 5 t/ha (Oven dry weight basis), *Azotobacter* (strain A-HP-1(Kangra)) (@200g/10 kg seed), Phosphate Solubilizing Bacteria (Indigenous strain from Kangra) (@200g/10 kg seed), FYM @ 2.5 t/ha + *Azotobacter* and FYM @ 2.5 t/ha + Phosphate Solubilizing Bacteria in main plots and three fertility levels *viz*. 50, 100 and 150 per cent of the recommended (90:75:55 kg/ha) NPK in sub plot. The experiment was laid out in Split-plot design with three replications. The soil was sandy loam in texture, neutral in reaction (pH 6.9), high in organic carbon (2.2%) & phosphorus (45.8 kg/ha), medium in available nitrogen (263 kg/ha) and low in available potassium (175 kg/ha). The nursery was raised under poly house conditions. The Tomato crop, var. EC-129601(Him Pragti)) was transplanted on May 29 and May 14, during 2006 and 2007 respectively, using 60 × 45 cm row to row and plant to plant spacing. The plot size was 2.7 × 2.4 = 6.48 m^2 during both the years of study. Half dose of N and full doses of P and K were applied at the time of sowing and remaining half after one month of transplanting. Weed control was done using pendimethalin @ 1.2 kg a.i. /ha within 48 hr. of transplanting. Crop was irrigated as and when required using sprinkler system. Plant height (cm) and Number of branches per plant were recorded before first picking. Number of fruits/ plant, fruit weight (g), fruit weight/ plant (kg), fruit diameter (cm^2) were recorded at the time of picking. Economics was calculated on the basis of prevalent market prices of inputs and outputs. Productivity and profitability was worked out by dividing the yield and net returns, respectively with the duration of crop in particular treatment.

RESULTS AND DISCUSSION

Impact of organics and bio-fertilizers on productivity

The pooled data recorded in Table 1 & 2 depicted the effect of organic, bio-fertilizers and levels of NPK on the yield contributing characters, yield and productivity of tomato crop. It was observed from the data that all the treatments having organic sources of plant nutrients as well as bio-fertilizers influenced the yield attributes, yield and overall productivity of tomato crop. Application of FYM @ 2.5 t/ha in combination with PSB produced significantly taller plants followed by PSB alone and FYM @ 5 t/ha treatments, the later remained statistically at par with each other. Significantly smaller plants were recorded with *Azotobacter* treatment. Similarly, the values of number of branches per plant, number of fruits per plant, fruit weight, fruit weight per plant and fruit diameter were significantly superior in the treatment having FYM @ 2.5 t/ha + PSB followed by FYM 5 t/ha. Owing to the positive influence of FYM @ 2.5 t/ha + PSB on yield contributing characters of tomato crop, the effect was manifested in the significantly highest tomato yield and productivity (q/ha/day).

Treatment receiving FYM @ 2.5 t/ha along with PSB gave tomato yield of 700.9 q/ha, which was significantly highest than all other treatments. It was followed by the treatment receiving FYM @ 5 t/ha (670.9 q/ha). Significantly lowest tomato yield of 617.7 q/ha was recorded with application of *Azotobacter* alone. It has been observed that with FYM @ 2.5 t/ha along with PSB, an increase to the tune of 4.47% and 7.29% in the yield was recorded over FYM @ 5t/ha and application of PSB alone, respectively. Higher tomato yield with the combination of FYM

Table 1: Effect of organic/bio-fertilizers and NPK levels on yield attributes of tomato (pooled data of two years)

Treatment	Plant ht. (cm)	No. of branches/ Plant	No. of fruits/ plant	Fruit wt. (g)	Fruit wt./ plant (kg)	Fruit Dia. (cm^2)
Organic/bio-fertilizers						
FYM @ 5 t/ha	50.7	3.9	38.8	53.3	2.3	27.2
Azotobacter	48.4	3.6	35.8	49.7	2.0	26.2
PSB	51.1	3.9	37.3	51.1	2.1	27.0
FYM @ 2.5 t/ha + *Azotobacter*	50.0	4.1	37.3	50.6	2.2	26.8
FYM @ 2.5 t/ha +PSB	51.8	4.3	39.1	54.8	2.4	28.8
CD (P=0.05)	0.43	0.11	0.85	0.72	0.13	0.53
NPK-Levels						
50%	40.8	3.7	31.7	42.8	1.5	23.5
100%	51.1	4.0	39.7	55.0	2.5	28.6
150%	59.2	4.2	41.7	57.8	2.6	29.5
CD (P=0.05)	0.44	0.12	0.88	0.58	0.09	0.31

Note: 100% (recommended dose), ht.-height, wt.-weight, Dia.-Diameter

Table 2: Effect of organic/bio-fertilizers and NPK levels on yield and productivity of tomato

Treatment	Yield (q/ha)			Productivity (q/ha/day)		
	2006	2007	Pooled	2006	2007	Pooled
Organic/bio-fertilizers						
FYM @ 5 t/ha	670.73	671.17	670.9	3.68	3.68	3.68
Azotobacter	616.55	618.80	617.7	3.38	3.39	3.38
PSB	652.28	654.26	653.3	3.58	3.58	3.58
FYM @ 2.5 t/ha + *Azotobacter*	634.36	636.18	635.3	3.47	3.49	3.48
FYM @ 2.5 t/ha +PSB	699.10	702.60	700.9	3.83	3.85	3.84
CD (P=0.05)	35.09	25.42	12.84	0.19	0.14	0.07
NPK-Levels						
50%	466.72	475.02	470.9	2.56	2.60	2.58
100%	728.05	729.11	728.6	3.99	3.99	3.99
150%	769.04	765.67	767.4	4.21	4.19	4.21
CD (P=0.05)	27.18	19.69	18.62	0.15	0.11	0.10

@ 2.5 t/ha and PSB further resulted in significantly highest productivity of 3.84 q/ha/day than all other treatments of organic & bio-fertilizers under study (Table 2). Raut *et al*. (2003) and Choudhury *et al*. (2005) also found complementary effects on tomato yield with the combined use of organic manures and biofertilzer. The beneficial effect of combined use of organic manure (FYM) and biofertilizer (PSB) on yield and other yield attributes of tomato could be attributed to the fact that after proper decomposition and mineralization, FYM improves soil physical & biological environment, supply available nutrients directly to the plant and also has solubilizing effect on fixed form of nutrients in soil (Sharma *et al*. 2003). Moreover, the inoculation with PSB might have complemented it by rendering the nutrients particularly phosphorus available to plant for its growth and metabolism, which otherwise cannot be taped by them. The cumulative effect of improvement in vegetative growth and yield attributes owing to combined use of organic manure (FYM) and biofertilizer particularly PSB resulted in additional improvement in fruit yield.

Impact of NPK levels on Productivity

The perusal of pooled data recorded in Table 1 revealed that increasing the dose of NPK by 50% over recommended could influence the yield contributing characters of tomato crop. Significantly taller plants, more number of branches per plant, more number of fruits per plant, more individual fruit weight, fruit weight per plant and larger fruit diameter were observed with application of 150% NPK. The improvement in yield attributes and yield with increasing doses of NPK may be ascribed to the fact that these nutrients being important constituents of nucleotides, protein, chlorophyll and enzymes, involve in various metabolic processes, which have direct impact on vegetative and reproductive phases of plants (Mengel and Kirkby 1996).

All these characters showed positive influence in obtaining the significantly higher tomato yield (767.4 q/ha) with the application of 150% NPK (Table 2). Similarly, significantly higher productivity of 4.21q/ha/day was also observed in the same treatment. Increasing 50% NPK beyond recommended could result in 5.33% higher yield of tomato crop. The results are in conformity with those of Mishra *et a*l. (2004[a]) with 150% NPK and Sharma and Sharma (2004) with 125% NPK for recording highest yield over others levels of inorganic fertilization in tomato.

Impact of organics and bio-fertilizers profitability

Pooled data recorded on economics of tomato as influenced by different organic and bio-fertilizer treatments have been depicted in Table 3. It was revealed that significantly highest gross and net returns of ₹ 350426 and 282761/ha, respectively were observed by applying FYM @ 2.5 t/ha in combination with PSB (₹/ha). Similarly, values of economic efficiency and benefit cost ratio were also significantly higher with FYM @ 2.5 t/ha + PSB. Significantly higher values for net returns gained through higher production with this treatment resulted in getting higher B:C ratio and economic efficiency over rest of the treatments. However, in all the parameters this treatment was followed by FYM @ 5 t/ha and PSB which remained statistically at par with each other, except in the case of benefit cost ratio where FYM @ 5 t/ha recorded significantly lower values than PSB. Therefore, when compared with FYM @ 2.5 t/ha + PSB, it was found that increase in net returns to the tune of 8.08 and 8.29%, economic efficiency 8.08 and 8.30% and benefit cost ratio 15.56 and 4.0% were recorded over FYM @ 5 t/ha and application of PSB alone, respectively.

Impact of NPK levels on profitability

The pooled data depicted in Table 3 showed that increasing the level of NPK from 100 to 150% also increased the gross returns (₹ 383685/ha) which resulted in significant increase in net returns (₹ 314171/ha), economic efficiency (₹ 1721.5/ha/day) and benefit cost ratio of 5.50. Significantly highest production with 150% NPK overcome the

Table 3: Effect of organic/bio-fertilizers and NPK levels on profitability of tomato (pooled data of two years)

Treatment	Gross returns (₹/ha)	Net returns (₹/ha)	B:C ratio (₹)	Economic efficiency (₹/ha/day)		
				2006	2007	Pooled
Organic/bio-fertilizers						
FYM @ 5t/ha	335473	261633	4.5	1446.7	1420.5	1433.6
Azotobacter	308830	243290	4.7	1330.0	1336.2	1333.1
PSB	326644	261104	5.0	1428.1	1433.4	1430.7
FYM @ 2.5t/ha+*Azotobacter*	317619	249972	4.7	1370.6	1368.8	1369.7
FYM @ 2.5t/ha+PSB	350426	282761	5.2	1548.0	1550.7	1549.4
CD (P=0.05)	6434	6424	0.1	96.0	69.6	35.2
NPK-Levels						
50%	235420	168844	3.5	917.9	932.5	925.2
100%	364291	296241	5.4	1625.9	1620.6	1623.2
150%	383685	314171	5.5	1730.2	1712.7	1721.5
CD (P=0.05)	9307	9307	0.1	74.4	53.9	51.0

higher cost of production over 100% NPK and resulted in better economic benefits in term of higher net returns and economic efficiency. However, recommended NPK dose remained statistically at par with 150% as far as benefit cost ratio is concerned. With the application of 150% NPK, the net returns have increased about 6.05% over recommended dose of NPK. Similar results were reported by Mishra *et al*. (2004[b]) at Karnataka in tomato and by Rana *et al*. (2009) in pea at high hill dry temperate conditions of H.P.

CONCLUSION

It can be concluded that the application of FYM @ 2.5 t/ha in combination with PSB has positive effects on productivity and economic efficiency of potato with 3.84 q/ha/day and ₹ 1549.4/ha/day, respectively. Similarly, the increase in the dose of NPK by 50% over recommended, the productivity and economic efficiency can be increased to 4.21 q/ha/day and ₹ 1721.5/ha/day, respectively.

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