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Short Research Article

Effect of Integrated Nutrient Management on Soil Nutrient and Biological Status of Plum cv. Santa Rosa

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Abstract

The present study entitled "Effect of integrated nutrient management on soil nutrient and biological status and yield of plum cv. Santa Rosa" was conducted at Horticulture Research Station, Kandaghat, Dr Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2011 and 2012. Among eight treatments, highest available potassium (326.02 kg ha^{-1}), *Azotobacter* count (19.30×10^6 CFU g^{-1} soil) as well as mycorrhizal spore population (242.39 spores 50 g^{-1} soil) were obtained with 50% NPK+Biofertilizers (60 g each tree $basin^{-1}$)+Green manuring (Sun hemp @ 25 g seeds tree $basin^{-1}$)+FYM (40 kg)+Vermicompost (11.5 kg). However, the application of 75% NPK+Biofertilizers (60 g each tree $basin^{-1}$)+Green manuring (Sunhemp @ 25 g seeds $tree^{-1}$ basin) recorded maximum available nitrogen (345.06 kg ha^{-1}), phosphorus (20.95 kg ha^{-1}), PSB count (16.18×10^6 CFU g^{-1} soil) in orchard soil as well as the maximum fruit yield (20.11 kg $tree^{-1}$) and gave the maximum net income (₹ 499.62) and benefit cost ratio (3.75). Thus, the combined application of nutrients in treatments T_5 and T_7 were found to be superior as compared to other treatments for enhancing the soil nutrient and biological status which in turn lead to increase in fruit yield and quality. The integrated nutrient management was highly effective than the application of chemical fertilizers alone.

1. Introduction

Plum (*Prunus saliciana* Lindl.) is one of the important fruit crops of the temperate region. In India, it is predominantly grown in the states of Himachal Pradesh, Jammu and Kashmir and Uttarakhand. In Himachal, it is grown in an area of about 8530 ha with a production of 9842 mt and is next in importance to apple in the state (Anonymous, 2012). Santa Rosa is the most important table variety and is cultivated successfully in the mid hills ranging from 1000 to 1600 m above mean sea level. It is an early variety and bears large, attractive and juicy fruits. It has thus proved to be a money spinner for the people of mid hills and has assumed the importance accorded to apple in the higher hills. This is a well known fact that increase in productivity of fruits remove large amounts of essential nutrients from the soil. Without proper management, continuous fruit production reduces nutrient reserves from soil. Another issue of great concern is sustainability of soil productivity, as land began to be intensively exhausted to produce higher yields. Overtime, cumulative depletion decreases fruit production, yield and soil fertility and lead to soil degradation. Concerns about the possible consequences of using increasing amount of chemical fertilizers have led to strong interest in alternative strategies to ensure competitive yields.

Integrated nutrient management envisages the use of chemical fertilizers in conjugation with organic manures, green manures, crop residues, legumes in a cropping system and locally available resources with the objectives of sustaining soil organic matter, increasing nutrient use efficiency, maintaining nutrient balance between the supplied nutrients and nutrient removed by the plant and to improve soil health and productivity.

2. Materials and Methods

A field trial was conducted at research farm of Horticulture Research Station, Kandaghat, Dr. Y.S. Parmar University of

Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. The experiment was laid out in randomized block design with eight treatments and three replications. The treatments were as follows: T_1:Biofertilizers (*Azotobacter*, Arbuscular Mycorrhizal Fungi, Phosphate Solubilizing Bacteria @ 60 g each tree basin^{-1})+FYM (40 kg)+Vermicompost (25 kg), T_2: Biofertilizers (60 g each tree basin^{-1})+Green manuring (Sunhemp @ 25g seeds tree basin^{-1})+FYM (40 kg)+Vermicompost (24 kg), T_3:75% NPK+Biofertilizers (60 g each tree basin^{-1}), T_4:50% NPK+Biofertilizers (60 g each tree basin^{-1}), T_5:75% NPK+Biofertilizers (60 g each tree basin^{-1})+Green manuring (Sunhemp @ 25 g seeds tree basin^{-1}), T_6:50% NPK+Biofertilizers (60 g each tree basin^{-1})+Green manuring (Sunhemp @ 25 g seeds tree basin^{-1})+FYM (40 kg), T_7:50% NPK+Biofertilizers (60 g each tree basin^{-1})+Green manuring (Sunhemp @ 25 g seeds tree basin^{-1})+FYM (40 kg)+Vermicompost (11.5 kg) and T_8:500g N+250g P +700g K+40 kg FYM. These fertilizers were applied in different doses by calculating the amount of N, P and K supplied by them to fulfil the requirement of the recommended doses. The chemical fertilizers (SSP and MOP) along with FYM were applied at the mid of December except N (urea) which was applied in two split dozes i.e., first during spring before flowering and remaining half one month after first application. Biofertilizers along with vermicompost were used one month after chemical fertilizers application. The seeds of sun hemp were sown during June. Observations on soil available N, P, K, *Azotobacter,* PSB and AMF count as well as fruit yield were recorded. The data of two years was pooled and analyzed statistically as per Cochram and Cox (1963) for interpretation of results and drawing conclusions. Regarding economics of different treatments, cost incurred per tree on each treatment was worked out by calculating expenditures on variable as well as fixed inputs of each treatment. Simultaneously, gross return was also calculated by existing market rate of produce and unit fruit production of each treatment. Benefit was calculated by deducting expenditure from the gross return. Ratio of cost and benefit was then calculated for each treatment.

3. Results and Discussion

3.1. Effect on soil nutrient status

It is evident from the study that the soil nutrient status was significantly affected by different integrated nutrient management treatments (Table 1). The maximum soil K (326.02 kg ha^{-1}) content was observed with the treatment 'T_7' - 50% NPK+Biofertilizers (60 g each tree basin^{-1})+Green manuring (Sun hemp @ 25 g seeds tree basin^{-1})+FYM (40 kg)+Vermicompost (11.5 kg), while maximum content of soil N (345.06 kg ha^{-1}) and P (20.95 kg ha^{-1}) was observed with T_5 -75% NPK+Biofertilizers (60 g each tree basin^{-1})+Green manuring (Sun hemp @ 25 g seeds tree basin^{-1}). Addition of farmyard manure improved the physical properties of soil thus creating favourable conditions for microbial activity resulting in increase in the nutrient availability of the soil. Release of P in the soil from unavailable to available forms was because of reaction of organic acids produced after decomposition of organic manure. The slight increase in soil K content might be due to release of fixed K owing to reaction of organic acids. These findings are in agreement with the results of Mishra et al. (2011); Rani et al. (2013) who observed in litchi that the application of FYM resulted in highest amount of soil N, P and Zn. Sharma and Sharma (2006) reported a higher status of soil N with microbial population and root colonization. Positive and significant correlation of *Azotobacter* count with soil available N might be due to higher N level owing atmospheric nitrogen fixing property of this microflora (Milosevie et al., 1995). Celano et al. (1997) observed that after green manuring the availability of mineral nitrogen in the soil increased which

Table 1: Effect of integrated nutrient management on soil nutrient status of plum

Treatment	Nitrogen (kg ha^{-1})			Phosphorus (kg ha^{-1})			Potassium (kg ha^{-1})		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
T_1 (B+FYM+V_1)	227.86	295.62	261.74	9.82	10.87	10.34	301.32	316.18	308.75
T_2 (B+GM+FYM+V_2)	253.60	284.87	269.24	11.51	13.55	12.53	311.13	318.45	314.79
T_3 (75% NPK+B)	255.81	300.32	278.07	12.41	15.01	13.71	312.47	320.27	316.37
T_4 (50% NPK+B)	268.40	320.46	294.43	14.55	15.46	15.00	318.11	321.16	319.63
T_5 (75% NPK+B+GM)	329.60	360.52	345.06	20.44	21.46	20.95	320.54	327.44	323.99
T_6 (50% NPK+B+GM+FYM)	305.58	322.10	313.84	14.75	16.15	15.45	319.97	324.46	322.22
T_7 (50% NPK+B+GM+FYM+V_3)	319.13	333.27	326.20	18.12	19.35	18.74	320.68	331.35	326.02
T_8 (500 g N+250 g P+700 g K+FYM)	310.25	325.38	317.81	16.33	17.74	17.03	318.47	321.18	319.83
CD (p=0.05)	0.92	1.21	1.04	0.45	0.60	0.51	0.75	0.51	0.62

*V_1: 25 kg vermicompost; V_2: 24 kg vermicompost; V_3: 11.5 kg vermicompost; **B: Biofertilizers; GM: Green manure

was due to the mineralization process due to green manuring and it was higher than non green manured areas.

3.2. Effect on soil biological properties

Soil biological properties were significantly influenced by application of different combination of fertilizers (Table 2). The maximum population of *Azotobacter* (19.30×10^6 CFU g^{-1} soil) and AMF (242.39 spores 50^{-1} g soil) was recorded with T_7 viz., 50% NPK+Biofertilizers (60g each tree $basin^{-1}$)+Green manuring (Sun hemp @ 25 g seeds tree $basin^{-1}$)+FYM (40 kg)+Vermicompost (11.5 kg) while maximum count of PSB (16.18×10^6 CFU g^{-1} soil) was observed with T_5 viz., 75% NPK+Biofertilizers (60 g each tree $basin^{-1}$)+Green manuring (Sun hemp @ 25 g seeds tree $basin^{-1}$). Organic amendments produced more microbial biomass than inorganic fertilizers because they increase the proportion of labile carbon and nitrogen, directly stimulating the activity of microorganisms. It was concluded that the use of organic nutrient sources combined with chemical nutrient sources enhanced soil microbial population as compared to chemical nutrient sources alone, which can maintain and sustain the crop productivity and soil fertility. Increase in population might be due to release of CO_2 during organic matter decomposition. Thus the increase in root colonization of plum tree by biofertilizer inoculation might be attributed to higher spore population which also accounted for increased availability of soil phosphorus and their primitive effect on plant growth. Tandon (1992) also reported significant increase in microbial population by addition of organic manures. The increased microbial population might be due to the fact that organic manures provide food and microenvironment for their multiplication and growth (Kumari and Kumari, 2002). The results are in conformity with the findings of Tiwari et al. (2001) and Naranjane et al. (1993) who observed increased population of soil microbes like bacteria and fungus with the application of organic manures, green manures as a sole or in combination with the inorganic fertilizers. Marathe et al. (2012) reported that the organic manures were highly effective in increasing the microbial population in the soil as compared to inorganic fertilizers and control. Highest bacterial population was recorded with the sole application of FYM followed by green manuring with sunhemp+50% recommended dose of fertilizer. Green manure acts as an excellent substrate for soil microbes in increasing their population. Bacterization with *Azotobacter* and PSB increased their abundance and their multiplication efficiency in presence of organic manures, due to greater availability of organic carbon and mineralized nutrients for their proliferation and further cellular development.

3.3. Effect on fruit yield

The highest fruit yield (28.11 kg ha^{-1}) as presented in Table 1 was recorded with the application of 75% NPK+Biofertilizers (60 g each tree $basin^{-1}$)+Green manuring (Sun hemp @ 25 g seeds tree $basin^{-1}$). These findings indicated that integrated application of inorganic fertilizers, FYM, vermicompost, biofertilizers and green manures was successful in maintaining

Table 2: Effect of integrated nutrient management on soil biological properties and yield of plum

Treatment	*Azotobacter* ($\times10^6$ CFU g^{-1} soil)			PSB ($\times10^6$ CFU g^{-1} soil)			AMF (spores 50^{-1} g soil)			Fruit yield (kg $tree^{-1}$)		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
T_1 (B+FYM+V_1)	9.92	15.08	12.50	11.00	12.11	11.55	149.48	145.10	147.29	22.20	24.67	23.44
T_2 (B+GM+FYM+V_2)	13.10	15.53	14.32	11.65	11.57	11.61	144.00	141.66	142.83	23.11	24.74	23.92
T_3 (75% NPK+B)	13.52	16.86	15.19	12.62	13.89	13.26	156.82	196.47	176.64	24.01	24.78	24.4
T_4 (50% NPK+B)	13.12	16.25	14.69	11.88	13.87	12.88	152.88	159.51	156.19	23.04	24.88	23.96
T_5 (75% NPK+B+GM)	17.45	18.80	18.13	16.33	16.03	16.18	208.80	260.65	234.72	27.60	29.22	28.11
T_6 (50% NPK+B+GM+FYM)	14.15	20.50	17.32	12.77	14.67	13.72	193.61	220.33	206.97	25.72	27.55	27.47
T_7 (50% NPK+B+GM+FYM +V_3)	16.68	21.93	19.30	13.58	16.53	15.05	197.00	287.79	242.39	25.57	28.62	26.56
T_8 (500 g N+250 g P+700 g K+FYM)	5.42	8.49	6.96	7.46	8.58	8.02	92.25	79.69	85.97	25.05	28.53	26.79
CD (p=0.05)	0.74	0.54	0.63	0.81	0.70	0.73	0.71	0.65	0.66	0.95	0.64	0.78

*V_1: 25 kg vermicompost; V_2: 24 kg vermicompost; V_3: 11.5 kg vermicompost; **B: Biofertilizers; GM: Green manure

higher levels of plum productivity. The increase in the yield was mainly attributed to relative increase in the availability of nutrients and better solute uptake by the plants. The effectiveness of inorganic fertilizers was greatly enhanced when it was applied along with FYM, this might have resulted due to better retention of urea in root zone (Mitsui et al., 1960) and better availability of phosphate and potash to the plants by organic matter. Rana and Chandel (2003) obtained the maximum yield (73.60 q ha^{-1}) in *Azotobacter* inoculated plants which was due to more number of fruits $plant^{-1}$ with better fruit size and weight as compared to un inoculated plants in strawberry. Similarly, Pandit et al. (2013) obtained highest yield of strawberry with the application of vesicular *Arbuscular mycorrhizae.*

3.4. Economics of different treatments

The data in Table 3 reveals that the highest gross income (₹ 702.75), net income (₹ 499.62) and benefit cost ratio (3.75) was observed with the treatment T_5 which was followed by T_7 having ₹ 686.75, ₹ 490.71 and 3.36 gross, net income and benefit cost ratio respectively.

From the results of these studies, it may be inferred that the treatment T_5 (75% NPK+Biofertilizers (60 g each tree $basin^{-1}$)+Green manuring (Sun hemp @ 25 g seeds tree $basin^{-1}$) was found most effective in improving the soil nutrient status and maintaining soil biological properties and hence resulting in increase in fruit yield. Further, the highest benefit cost ratio was also observed with this treatment. Hence, the combination of various components of INM in treatment T_5 was the best.

Table 3: Economics of different treatments of integrated nutrient management

Treatment	Gross income (₹)			Net income (₹)			Benefit cost ratio		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
T_1 (B+FYM+V_1)	555.00	616.81	585.91	262.64	324.45	293.55	0.90	1.11	1.00
T_2 (B+GM+FYM+V_2)	577.69	618.44	598.06	289.33	330.08	309.70	1.00	1.14	1.07
T_3 (75% NPK+B)	600.25	619.56	609.91	445.37	479.55	469.90	1.82	1.92	1.87
T_4 (50% NPK+B)	575.88	621.88	598.88	449.75	495.75	472.75	2.69	2.98	2.83
T_5 (75% NPK+B+GM)	690.00	730.50	702.75	466.02	543.37	499.62	3.57	3.93	3.75
T_6 (50% NPK+B+GM+FYM)	639.25	688.63	663.94	455.87	515.40	458.12	2.44	2.90	2.67
T_7 (50% NPK+B+GM+FYM+V_3)	643.00	715.50	686.75	460.24	522.65	490.71	3.29	3.43	3.36
T_8 (500 g N+250 g P+700g K+FYM)	626.25	713.13	669.69	435.77	470.87	479.21	2.29	2.74	2.52
CD (p=0.05)	23.68	15.90	19.50	21.28	11.34	14.50	0.13	0.09	0.11

*V_1:25 kg vermicompost; V_2:24 kg vermicompost; V_3:11.5 kg vermicompost **B:Biofertilizers; GM:Green manure

4. Conclusion

Among the different treatments, the best results in terms of soil nutrient status as well as the soil microbial population were obtained with 75 % NPK+Biofertilizers (60 g each tree $basin^{-1}$)+Green manuring (Sunhemp @ 25 g seeds tree $basin^{-1}$) and 50 % NPK+Biofertilizers (60 g each tree $basin^{-1}$)+Green manuring (Sunhemp @ 25 g seeds tree $basin^{-1}$)+FYM (40 kg)+Vermicompost (11.5 kg) where balanced integration of organic and inorganic fertilizers were applied to the soil.

5. References

Anonymous, 2012. Area and production of fruits in Himachal Pradesh (unpublished report). Department of Horticulture, Shimla, Navbahar (HP).

Celano, G., Dumontet, S., Xiloyannis, C., Nuzzo, V., Dichio, B., 1997. Response of peach orchard system to green manuring and mineral fertilization. Acta Horticultural 448, 289–296.

Kumari, S.M., Kumari, U.K., 2002. Effect of vermicompost enriched with rock phosphate on growth and yield of cowpea (*Vigna unguiculata* L.). Journal of Indian Society of Soil Science 50(2), 223-224.

Marathe, R.A., Bharambe, P.R., Sharma, R., Sharma, U.C., 2012. Leaf nutrient composition, its correlation with yield and quality of sweet orange and soil microbial population as influenced by INM in vertisol of Central India. Indian Journal of Horticulture 69(3), 317-321.

Milosevic, N., Govedarica, M., Jarak, M., Begdanovic, D., Ubavic, M., Luvardic, M., 1995. Number of micro organisms and dehydrogenase activity in soils under peas, onion and cabbage. Microbiologia 32, 259-67.

Mishra, S., Choudhary, M.R., Yadav, B.L., Singh, S.P., 2011. Studies on the response of integrated nutrient management on growth and yield of ber. Indian Journal of Horticulturae 68, 318-21.

Mitsui, S., Namioka, H., Mukai, N.K., 1960. Soil absorption of lurea. In: The mechanism of lad sorption of urea. Soil Pl. Fd. 6, 25-29.

Naranjane, J.P., Puranic, R.B., Somani, R.B., Guhe, Y.S., Deshmukh, S.D., 1993. Microbial population as influenced by incorporation of wheat straw. Journal of Indian Society of Soil Science 41, 368-369.

Pandit, B.A., Hassan, A., Hassan, G., Hayat, S., 2013. Response of biofertilizers on vegetative growth and yield of strawberry under subtropical conditions of U.P. Progressive Horticulture 45(1), 58-62.

Rana, R.K., Chandel, J.S., 2003. Effect of biofertilizers and nitrogen on growth, yield and fruit quality of strawberry. Progressive Horticulture 35(1), 25-30.

Rani, A., Lal, R.L., Uniyal, S., Chand, S., 2013. Response of organic manures on growth, nutrient status and yield of litchi cv. Rose Scented. Progressive Horticulture 45(1), 126-131.

Sharma, S.D., Sharma, N.C., 2006. Studies on correlations between *Endo mycorrhizal* and *Azotobacter* population with growth, yield and soil nutrient status of apple orchards in Himachal Pradesh. Indian Journal of Horticulture 63(4), 379-382.

Tandon, H.S., 1992. Fertilizers and their interpretation with organic and biofertilizers. In: Tandon, H.S. (Ed.), Fertilizer, organic manure recyclable waste and biofertilizers 12-35.

Tiwari, V.N., Benri, I.K., Twari, K.N., Upadhyay, R.M., 2001. Integrated nutrient management through natural green manuring under wheat mung bean cropping sequence. Journal of Indian Society of Soil Science 49, 271-275.