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Health and available nutrient status of plum orchard soil under integrated nutrient management

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ABSTRACT

The present investigation was carried out at Dr YS Parmar University of Horticulture and Forestry, Horticultural Research Station, Kandaghat, Solan, HP for two successive years 2010-11 and 2011-12 on plum cv Santa Rosa to find out the effect of integrated nutrient management (INM) on soil health and nutrient status. Among the eight treatments fully organic, INM and fully inorganic treatments comprised of the application of chemical fertilizers (urea, SSP and MOP), FYM, vermicompost, biofertilizers (*Azotobacter*, PSB and VAM) and green manure (sunhemp). Results revealed that the treatment T_5 (75% NPK + biofertilizers (60 g each/tree basin) + green manuring (sunhemp @ 25 g seeds/tree basin) performed best for PSB count, soil N and P. The maximum soil *Azotobacter* and AMF count, soil K and Cu content were obtained with the treatment T_7 (50% NPK + biofertilizers (60 g each/tree basin) + green manuring (sunhemp @ 25 g seeds/tree basin) + FYM (40 kg) + vermicompost (11.5 kg). The treatment T_2 (biofertilizers (60 g each/tree basin) + green manuring (sunhemp @ 25 g seeds/tree basin) + FYM (40 kg) + vermicompost (24 kg) recorded maximum soil water holding capacity, pH, organic carbon, soil Mg and Zn content. Based on the performance of these treatments it can be advocated that INM plays an important role in improving soil health and fertility.

Keywords: INM; plum; nutrient; vermicompost; biofertilizers

INTRODUCTION

Plum (*Prunus salicina* Lindl) is one of the important fruit crops of the temperate region and the plum variety Santa Rosa due to its large, attractive and juicy fruits has assumed the importance accorded to apple in the higher hills. A balanced nutrition programme is mandatory to maintain a sustained productive life of orchard in addition to quality production. The continuous use of chemical fertilizers hampers the soil health and causes pollution. Integrated nutrient management (INM) paves away to control this problem. Therefore it is imperative to switch over to other possible sources of nutrition to specific soil and agro-climatic conditions for better fruit yield and quality. In this approach a field experiment was conducted to assess the integrated effect of organic manures, biofertilizers, green manures and inorganic fertilizers on soil health in plum orchard.

MATERIAL and METHODS

A field experiment was carried for two consecutive years 2011 and 2012 at Dr YS Parmar University of Horticulture and Forestry, Horticultural Research Station, Kandaghat, Solan, HP. The initial soil physico-chemical properties have been listed in Table 1. The experiment was laid out in randomized block design (RBD) comprising of eight treatments viz T_1 (biofertilizers *Azotobacter*, AMF, PSB @ 60 g each/tree basin + FYM 40 kg + vermicompost 25 kg), T_2 (biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin + FYM 40 kg + vermicompost 24 kg), T_3 (NPK 75% + biofertilizers 60 g each/tree basin), T_4 (NPK 50% + biofertilizers 60 g each/tree basin), T_5 (NPK 75% + biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin), T_6 (NPK 50% + biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin + FYM 40 kg), T_7 (NPK 50% + biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin + FYM 40 kg + vermicompost 11.5 kg) and T_8 (N 500 g + P 250 g + K 700 g + FYM 40 kg).

The required quantity of inorganic fertilizers (full dose of P_2O_5 and K_2O) were applied during mid December along with FYM. The nitrogen was applied in split doses; half during spring before flowering and remaining half dose was applied one month after first application. Biofertilizers along with vermicompost were used one month after chemical fertilizers application. The seeds of sunhemp were sown during June. Composite soil samples from 0-15 cm and 15-30 cm depth were collected from four sides under the drip line of each experimental tree with the help of screw type auger before the application of fertilizers and again in the month of July during both the years. The soil samples thus

Table 1. Initial soil physico-chemical properties

Property	Content	Property	Content
Water Holding Capacity (%)	38.41	Available K (kg/ha)	285.00
Bulk Density (g/cc)	1.26	Exchangeable Ca (ppm)	21.73
Soil pH	7.01	Exchangeable Mg (ppm)	15.01
Organic Carbon (%)	1.02	Fe (ppm)	40.45
Available N (kg/ha)	210.52	Zn (ppm)	0.95
Available P (kg/ha)	9.30	Cu (ppm)	1.38

collected were dried in shade, ground, sieved through 2 mm plastic sieve and stored in cloth bags. The soil water holding capacity (WHC) and organic carbon (OC) were determined by the procedure as described by Piper (1966) and soil bulk density and pH by the procedures as described by Baruah and Barthakur (1998) and Jackson (1967) respectively. The samples were analyzed for the nutrient status of soil as per the standard methods (Anon 1980).

RESULTS and DISCUSSION

Application of organic amendments significantly influenced the physico-chemical properties of soil (Table 2). The highest bulk density (1.37 g/cc) was recorded with the application of T_4 (NPK 50% + biofertilizers 60 g each/tree basin) while highest soil water holding capacity (48.39%), soil pH (7.92) and soil organic carbon (2.03%) were recorded with the application of T_2 (biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin + FYM 40 kg + vermicompost 24 kg).

The improvement in physical properties of the soil with organic manures might be attributed to increased organic matter status of the soil and improved soil structure. These results are in conformity with the findings of Trivedi et al (2012) who reported that incorporation of FYM resulted in maximum organic carbon content in the soil and was statistically at par with bio-compost and vermicompost treatments. These results clearly indicate that the application of organic amendments had a positive effect on the availability of organic carbon as compared to recommended dose of fertilizers. Naik and Babu (2007) reported that there was increase in soil pH due to the application of different organic amendments. This could be due to low buffering action of organic fertilizers and soil (Biswas et al 1971). Application of organic manures was found more efficient in maintaining the soil pH near to neutral, besides keeping EC and bulk density at lower level. The increase in total salts from added organic manures was probably high which in turn affected EC of the soil (Beri et al 1992). Positive and significant correlations of *Azotobacter* counts with soil pH and organic carbon might be due to higher N level owing to atmospheric nitrogen fixing property of this micro-flora (Tiwary et al 1999).

It is evident from the study that the soil nutrient status was significantly affected by different integrated nutrient management treatments (Table 3). The maximum soil K (326.02 kg/ha) and Cu (2.27 ppm) content were observed with the application of T_7 (NPK 50% + biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin + FYM 40 kg + vermicompost 11.5 kg) while maximum content of soil N (345.06 kg/ha) and P (20.95 kg/ha) were observed with the application of T_5 (NPK 75% + biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin) and

Table 2. Effect of integrated nutrient management on physico-chemical properties of plum orchard soil

Treatment	Water holding capacity (%)			Bulk density (g/cc)			pH			Organic carbon (%)		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
T_1	46.16	48.55	47.36	1.12	1.07	1.09	7.78	7.89	7.84	1.96	1.99	1.98
T_2	46.34	50.45	48.39	1.17	1.08	1.13	7.89	7.95	7.92	2.00	2.07	2.03
T_3	38.85	41.17	40.01	1.44	1.31	1.34	7.09	7.28	7.18	1.07	1.22	1.14
T_4	37.95	41.54	39.75	1.40	1.34	1.37	7.27	7.55	7.41	1.10	1.24	1.17
T_5	41.38	41.78	41.58	1.20	1.19	1.20	7.31	7.58	7.44	1.57	1.69	1.63
T_6	46.15	47.63	46.89	1.31	1.25	1.28	7.57	7.72	7.64	1.64	1.76	1.70
T_7	43.00	46.77	44.88	1.32	1.22	1.27	7.67	7.81	7.74	1.78	1.90	1.84
T_8	42.59	46.01	44.30	1.24	1.21	1.22	7.43	7.64	7.54	1.49	1.72	1.60
$CD_{0.05}$	0.77	0.65	0.69	0.12	0.14	0.13	0.50	0.27	0.39	0.55	0.38	0.46

T_1 (biofertilizers *Azotobacter*, AMF, PSB @ 60 g each/tree basin + FYM 40 kg + vermicompost 25 kg), T_2 (biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin + FYM 40 kg + vermicompost 24 kg), T_3 (NPK 75% + biofertilizers 60 g each/tree basin), T_4 (NPK 50% + biofertilizers 60 g each/tree basin), T_5 (NPK 75% + biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin), T_6 (NPK 50% + biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin + FYM 40 kg), T_7 (NPK 50% + biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin + FYM 40 kg + vermicompost 11.5 kg), T_8 (N 500 g + P 250 g + K 700 g + FYM 40 kg)

Table 3. Effect of integrated nutrient management on available nutrient status of plum orchard soil

Treatment	Nitrogen (kg/ha)			Phosphorus (kg/ha)			Potassium (kg/ha)			Calcium (ppm)		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
T_1	227.86	295.62	261.74	9.82	10.87	10.34	301.32	316.18	308.75	25.25	28.58	26.92
T_2	253.60	284.87	269.24	11.51	13.55	12.53	311.13	318.45	314.79	24.12	25.21	24.67
T_3	255.81	300.32	278.07	12.41	15.01	13.71	312.47	320.27	316.37	27.57	31.04	29.31
T_4	268.40	320.46	294.43	14.55	15.46	15.00	318.11	321.16	319.63	28.93	30.34	29.64
T_5	329.60	360.52	345.06	20.44	21.46	20.95	320.54	327.44	323.99	29.81	31.69	30.75
T_6	305.58	322.10	313.84	14.75	16.15	15.45	319.97	324.46	322.22	29.07	30.88	29.97
T_7	319.13	333.27	326.20	18.12	19.35	18.74	320.68	331.35	326.02	29.78	32.30	31.04
T_8	310.25	325.38	317.81	16.33	17.74	17.03	318.47	321.18	319.83	25.36	29.59	27.47
$CD_{0.05}$	0.92	1.21	1.04	0.45	0.60	0.51	0.75	0.51	0.62	4.40	4.62	NS

Treatment	Magnesium (ppm)			Iron (ppm)			Copper (ppm)			Zinc (ppm)		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
T_1	20.33	21.04	20.68	51.86	53.02	52.44	1.56	1.79	1.68	1.95	2.10	2.02
T_2	20.09	22.23	21.16	50.42	52.05	51.24	1.67	1.80	1.73	2.06	2.14	2.10
T_3	19.92	20.28	20.10	50.07	51.15	50.61	1.94	2.06	2.00	1.76	2.00	1.88
T_4	18.86	19.17	19.02	48.79	50.57	49.68	1.71	1.87	1.79	1.71	1.91	1.81
T_5	17.22	17.86	17.54	46.55	48.30	47.43	1.97	2.31	2.14	1.10	1.20	1.15
T_6	18.06	18.38	18.22	47.88	49.78	48.83	1.94	2.21	2.07	1.51	1.92	1.72
T_7	16.31	18.34	17.33	46.62	49.02	47.82	2.17	2.38	2.27	1.13	1.35	1.24
T_8	18.59	18.91	18.75	47.02	49.59	48.31	1.90	1.92	1.91	1.31	1.84	1.57
$CD_{0.05}$	0.73	0.48	0.60	0.39	0.44	0.40	0.18	0.16	0.16	0.43	0.45	0.43

T_1 (biofertilizers *Azotobacter*, AMF, PSB @ 60 g each/tree basin + FYM 40 kg + vermicompost 25 kg), T_2 (biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin + FYM 40 kg + vermicompost 24 kg), T_3 (NPK 75% + biofertilizers 60 g each/tree basin), T_4 (NPK 50% + biofertilizers 60 g each/tree basin), T_5 (NPK 75% + biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin), T_6 (NPK 50% + biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin + FYM 40 kg), T_7 (NPK 50% + biofertilizers 60 g each/tree basin + green manuring sunhemp @ 25 g seeds/tree basin + FYM 40 kg + vermicompost 11.5 kg), T_8 (N 500 g + P 250 g + K 700 g + FYM 40 kg) maximum soil Mg (21.16 ppm) and Zn (2.10 ppm) were recorded with the application of T_2 (biofertilizers 60 g each/ tree basin + green manuring sunhemp @ 25 g seeds/tree basin + FYM 40 kg + vermicompost 24 kg).

Sharma and Sharma (2006) reported a higher status of soil N with microbial population and root colonization. Celano et al (1997) observed that after green manuring the availability of mineral nitrogen in the soil increased which was due to the mineralization process due to green manuring and it was higher than non-green manured areas. Nazir et al (2012) reported that the maximum available nitrogen, phosphorus and potassium were recorded with the treatment poultry manure + *Azotobacter* + wood ash + PSB + oil cake. Higher available soil nitrogen with respect to different organic nutrient sources as compared to inorganic sources with plant growth promoting rhizobacteria might be due to slow releasing nature of organic manures which helps in reducing the nutrient loss and synergetic effect of bio-inoculants enhances their asymbiotic nitrogen fixing capabilities. The higher availability of phosphorus might be due to the production of organic acids by phosphorus solubilizing bacteria which acts as a chelating agent and forms stable complexes with Fe and Al abundantly available in acid soils and thereby releasing phosphorus to the soil solution making it available for more uptake by the plant. Relatively less availability of K_2O in inorganic fertilizers treated soil might be attributed to increased soil pH resulting in K fixation. However with the organic manure decline in potassium status of soil might be due to the fact that humification of plant residues and soil organisms produces a type of organic matter with high CEC capable of holding soil K. Moreover humus retains divalent cation (Mg^{2+}, Ca^{2+}) more strongly than the monovalent cations. Weaker retention of potassium relative to Ca and Mg may increase K availability but at the same time it renders K more liable to leaching (Somani and Kanthaliya 2004). This is in agreement with the findings of Gogoi et al (2004).

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