Indian Journal of Agricultural Sciences **80** (11): 981–7, November 2010

Conjoint application of bio-organic and inorganic nutrient sources for improving cropping behaviour, soil properties and quality attributes of apricot (*Prunus armeniaca*)

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Received: 17 December 2009; Revised accepted: 11 August 2010

ABSTRACT

The study was carried out during 2006–08 on 20-year-old ‘New Castle’ apricot (*Prunus armeniaca* L.) trees to investigate the conjoint efficacy of bio-organics used along with chemical fertilizers on cropping behaviour, soil properties and quality attributes. Conjoint application of biofertilizers 60 g/tree, vermicompost 30 kg/tree, cow urine 12.5% and 50% NPK resulted in significantly maximum bloom density (25.08%), fruit set (62.38%), yield (29.85 kg/tree), fruit firmness (7.06 kg/cm^2), total soluble solids (17.04 °Brix), reducing sugars (3.97%), ascorbic acid (7.29 mg/100 g) and total carotenoids (0.96 mg/100 g). This combination also significantly improved physical, chemical and biological properties of the soil rhizosphere. Available N, P and K content of rhizosphere soil was increased by 34.8, 88.3 and 16.6%, respectively. Micronutrients (Fe, Cu, Zn, Mn) were improved by 15.1, 25.3, 28.7 and 24.1% respectively. The microbial biomass pool in terms of *Pseudomonas*, *Bacillus*, *Azotobacter chroococcum* and *Arbuscular mycorrhizal* fungi increased by 208.25, 113.40, 383.50 and 442.50% respectively over control.

Key words: Biostabilization, Cow urine, Integrated nutrient management, Vermicompost

Application of nutrients has a significant and vital effect on yield and quality attributes of apricot (*Prunus armeniaca* L.) (Asma *et al.* 2007). Integrated nutrient management is essential to maintain or improve soil fertility and plant nutrient supply to an optimum level to sustain desired crop productivity by optimizing the benefits from all sources of plant nutrients in an integrated manner. In North-western Himalayan region either continuous sole application or imbalanced use of costly chemical fertilizers in apricot has led to decrease in nutrient uptake efficiency. This has ultimately resulted in either stagnation or decrease in yield. Hence, integrated use of chemical fertilizers along with bio-organics, like biofertilizers, vermicompost and cow urine may be an effective alternative to increase crop production by saving costly chemical fertilizers input.

Organics are effective alternatives as a source of macro- and micronutrients and have required potential to improve yield to save costly chemical fertilizers. The bio-organic technology is based on an eco-biotechnological approach, utilizes the bio-transformation of energy-rich and complex organic substances into bio-stabilized composted product. The epigeic earthworms recycle organic waste materials into enrich vermicompost. The resultant vermicompost, besides increasing natural fertility of the soil, also promotes infiltration and increase porosity of the soil (Suthar 2007). Cow urine is also proving a vital component in improving soil fertility to increase fruit productivity. Urine possesses an inherent property of acting not only as fertilizer but also as a mild biocide. Besides, biofertilizers are renewable source of low cost biological inputs and have been described as a viable component for integrated nutrient management to enhance crop production.

Apricot (*Prunus armeniaca* L.) is an important stone fruit of mid-hills of Himachal Pradesh falling under Shiwalik hill range. The average annual productivity of apricot is 4.2 MT/ha which is far less than an international level. Being a prolific bearer, proper nutrient management is a pre-requisite for maintaining sustained productivity and quality. However, the

Based on the complete information of M Sc thesis of the first author submitted to Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh

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use of costly and scarce chemical fertilizers is much exorbitant to poor hill farmers of the region. The present study therefore, was conducted to evaluate the effect of conjoint use of bio-organics and chemical fertilizers on cropping behaviour, soil physical, chemical and biological properties, yield and quality attributes of apricot as the information on these aspects is still lacking in the region.

MATERIALS AND METHODS

The field experiment was conducted on 'New Castle' apricot during 2006–08. The experimental orchard is situated at an elevation of 1 240 m above mean sea level lying between 30° 50′ 45″ N and 77° 08′ 30″ E longitude. The trees of uniform age group (20 years old) were planted at 6 m×6 m apart. The climate is sub-temperate with an annual rainfall in the range between 100 and 130 cm. The orchard soil was sandy in texture with *p*H 6.5, 0.61 dS/m electrical conductivity and 0.63% organic carbon content. Water-holding capacity, bulk density and porosity of surface soil at 15 cm depth were 31.93%, 1.29% and 47.77%, respectively. The initial available N, P and K contents of the soil were 308.94, 12.72 and 341.80 kg/ha, respectively. DTPA extractable micro-nutrients namely, iron (Fe), copper (Cu), zinc (Zn) and manganese (Mn) were 58.85, 2.51, 2.20 and 46.31 ppm, respectively. The experimental soil also contained an initial viable microbial population of *Pseudomonas* spp (3×10^6 colony forming units (cfu)/g soil, *Bacillus* spp (5×10^6 cfu), *Azotobacter chroococcum* (2×10^6 cfu) and 600 spores of arbuscular mycorrhizal (AM) fungi/ kg of soil.

The experiment was laid out considering 2 levels of NPK fertilizers (75 and 50% of recommended dose), bio-fertilizers, vermicompost and cow urine in different conjoint combinations. The treatments were replicated thrice in a randomized block design. Different inputs of bio-organic and inorganic nutrient sources, namely biofertilizers: 30 g/ tree (BF_{30}); biofertilizers: 60 g/tree (BF_{60}); vermi-compost: 30 kg/tree (VC_{30}) and cow urine: 12.5% in water ($CU_{12.5}$) were applied in different conjoint combinations (T_1–T_8) along with a control. The treatments comprised following combinations, ie $BF_{30}VC_{30}CU_{25}NPK_{50}$ (T_1); $BF_{30}VC_{30}CU_{25}NPK_{75}$ (T_2); $BF_{30}VC_{30}CU_{12.5}NPK_{50}$ (T_3); $BF_{30}VC_{30}CU_{12.5}NPK_{75}$ (T_4); $BF_{60}VC_{30}CU_{25}NPK_{50}$ (T_5); $BF_{60}VC_{30}CU_{25}NPK_{75}$ (T_6); $BF_{60}VC_{30}CU_{12.5}NPK_{50}$ (T_7); $BF_{60}VC_{30}CU_{12.5}NPK_{75}$ (T_8) and control (recommended NPK fertilizers along with farmyard manure as used by the farmers-traditional practice) (T_9).

The bio-fertilizers consortia comprised *A. chroococcum* strain-A_{41}, phosphorus-solublizing bacteria (*Pseudomonas* spp and *Bacillus* spp) and AM fungal species namely, *Glomus fasciculatum* (Thaxter sensu Gerdemann). Microbial cultures were applied through band application in the basin of each tree at 15 cm depth being followed by a light irrigation for the proliferation of the cultures. A range of agricultural residues, all dry wastes, dry leaves of crops and trees, mixed vegetable residues (organic waste) were inoculated along with adult epigeic earthworms (*Eisenia foetida*) for the purpose of vermicomposting. Vermicompost used in the experiment contained 2.12% N, 0.93% P_2O_5, 1.11% K_2O, 174.8 ppm Fe, 96.31 ppm Mn, 24.23 ppm Zn and 4.78 ppm Cu. Another input, cow urine is supplemented with 1.20% N, P_2O_5 in traces and 1.00% K. The foliar application of cow urine was done between 15 and 30 days of fruit set. The doses of different bio-organics were determined on the basis of nutrient composition to compensate the full recommended dose of NPK to the trees. Farmyard manure contained 0.50% N, 0.25% P, 0.40% K, 0.004% Zn, 0.0003% Cu, 0.007% Mn and 0.45% Fe. The NPK fertilizers sources used were urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O). Nitrogen was applied in 2 splits, ie first half during first week of March before flowering and rest half 30 days after fruit set. Phosphatic and potassic fertilizers were applied along with farmyard manure/vermicompost as band application during December. Traditionally, farmers use recommended dose of 40 kg of farmyard manure, 600 g of N, 250 g of P_2O_5 and 700 g of K_2O per full bearing trees with age of more than 10 years. Full dose of farmyard manure, P_2O_5 and K_2O are applied in December–January before the onset of winters. Half dose of N was applied in the second fortnight of February and the remaining balanced dose is applied during first fortnight of May.

Twenty uniform and healthy shoots were selected randomly from the current season's growth for measuring annual shoot extension growth. To calculate bloom density, the representative number of branches of 1 m length was selected. The numbers of flowers present on these branches were counted and expressed per meter of shoot length. The per cent fruit set was computed using standard method (Westwood 1988). The quantity of fruit harvested was calculated for total yield (kg/tree). The harvested fruits were also utilized for analyzing physical-biochemical characteristics. Fruit firmness was determined using Effigy Penetrometer model FT, and total soluble solids (TSS), acidity, reducing sugars, ascorbic acid and total carotenoids were estimated following standard procedures (AOAC 1980).

Composite soil samples (30 cm deep), weighing 1 kg were collected, taken to the laboratory in polythene bags and stored in refrigerator at 4°C. These samples were analyzed for various physical, chemical and biological properties using standard methods. Bulk density and particle density was determined according to Specific Gravity method (Kanwar and Chopra 1976). Soil porosity was calculated using standard formula. Water-holding capacity of soil was estimated using Keen-Raczkowski Box method (Piper 1966). Soil *p*H and EC were measured in a 1 : 5 (w/v) aqueous solution, using a Crison GLP 21 *p*H meter and a Crison GLP 31 conductivity meter, respectively. Soil organic carbon was determined according to wet oxidation method (Walkley and Black 1934).

Available N was estimated using alkaline potassium permanganate method (Subbiah and Asija 1956), available P was estimated by Olsen's method (Olsen *et al.* 1954) and available K was extracted in 1N neutral normal ammonium acetate using a flame photometer (Merwin and Peach 1951). Available micro-nutrients, viz Fe, Cu, Zn and Mn were estimated by 0.005 M DTPA extraction method (Lindsay and Norvell 1978) on atomic absorption spectrophotometer model Z-6100.

The isolation of pure and viable bacterial count was done by serial dilution technique on nutrient agar (*Pseudomonas*, *Bacillus*) and Jenson's medium (*A. chroococcum*). 10 g soil from each sample was drawn and serially diluted aseptically to 10^{-4}, 10^{-5} and 10^{-6} dilution. One ml of each sample dilution was spread on specified medium. AM fungal spores present in the soil were recovered through wet sieving and decanting method (Gerdemann and Nicolson 1963) and the spore count was done according to most probable number method described by Porter (1979).

The experiment to observe the effect of conjoint combinations of bio-organic and inorganic nutrient sources was laid out in randomized block design according to Panse and Sukhatme (1985). The data thus obtained were subjected to statistical analysis to evaluate the comparative efficacy among different treatment combinations applied. The significance of variation among the treatments was observed by applying 'F' test and thus critical difference was calculated at 5% level of probability.

RESULTS AND DISCUSSION

Growth and fruit yield

Among all of the conjoint application, the treatment T_8 ($B_{60}VC_{30}CU_{12.5}NPK_{75}$) resulted in maximum annual shoot extension growth (41.09 cm). The shoot extension growth was recorded 30.24% higher than control (Table 1). The increase in growth attributed to improved nutrient uptake and favourable environment prevalent in the rhizosphere to release of auxins, gibberellins and cytokinins under bio-organics-based treatments. In apple trees, an increased biological N_2 fixation with the application of *A. chroococcum* caused higher vegetative growth (Sharma *et al.* 2005). The treatment combination T_7 ($B_{60}VC_{30}CU_{12.5}NPK_{50}$) resulted in maximum fruit yield (29.85 kg/tree) which was statistically at par with T_5 (28.74 kg/tree), whereas minimum fruit yield (25.86 kg/tree) was recorded under T_2 treatment. The significant increase in fruit yield in T_7 might be due to sustained availability of N, P, Cu, and Zn as evident from the higher accumulation of these nutrients through soil. Application of the highest dose of NPK in combination with vermicompost, cow urine and biofertilizers in T_8 declined yield in comparison to T_7 treatment. The excessive growth also attributed to the larger part of the metabolites that have been utilized instead of flowering and fruiting. Moreover, the application of biofertilizers along with the chemical fertilizers favoured the nutrients availability in the soil and thereby better uptake by the crop reflected on higher fruit yield (Sharma *et al.* 2008). The increase in growth is also expected due to increased microbial biomass in the soils receiving vermi-compost which increased nutrient mineralization. Atiyeh *et al.* (2002) suggested that the increase in growth and yield was more probably due to the production of plant growth regulators by micro-organisms or to the effects of humates in the vermicompost (Canellas *et al.* 2000).

Bloom density and fruit set

Maximum bloom density (25.08%) was recorded with application of T_7 treatment combination, which was statistically at par with T_8 (23.83%) (Table 1). This conjoint combination also registered 22.3% increase of bloom density

Table 1 Effect of conjoint application of bio-organic and inorganic nutrient sources on growth, fruit set, yield and quality attributes of apricot

Treatment	Treatment	Annual shoot extension growth (cm)	Bloom density (%)	Fruit set (%)	Fruit yield (kg/tree)	Fruit firmness (kg/cm²)	TSS (°Brix)	Reducing sugars (%)	Acidity (%)	Ascorbic acid (mg/100g)	Carotenoids (mg/100g)
T_1	$BF_{30}VC_{30}CU_{25}NPK_{50}$	33.59	20.50	56.79	27.70	6.88	15.16	3.71	1.00	6.72	0.63
T_2	$BF_{30}VC_{30}CU_{25}NPK_{75}$	34.19	20.21	53.48	25.86	5.63	15.23	3.56	1.09	6.49	0.46
T_3	$BF_{30}VC_{30}CU_{12.5}NPK_{50}$	33.17	22.38	58.27	27.66	6.85	15.27	3.74	0.98	7.02	0.70
T_4	$BF_{30}VC_{30}CU_{12.5}NPK_{75}$	34.85	23.25	54.71	27.05	6.01	15.29	3.66	1.05	6.92	0.46
T_5	$BF_{60}VC_{30}CU_{25}NPK_{50}$	36.24	21.88	61.18	28.74	6.91	15.73	3.84	0.96	7.24	0.94
T_6	$BF_{60}VC_{30}CU_{25}NPK_{75}$	38.43	22.00	56.60	27.43	6.52	15.68	3.74	1.06	6.91	0.51
T_7	$BF_{60}VC_{30}CU_{12.5}NPK_{50}$	37.80	25.08	62.38	29.85	7.06	17.04	3.97	0.90	7.29	0.96
T_8	$BF_{60}VC_{30}CU_{12.5}NPK_{75}$	41.09	23.83	59.93	28.71	6.78	16.19	3.80	1.03	7.09	0.83
T_9	Control (NPK)	31.55	20.50	53.33	26.21	6.15	15.95	3.51	1.15	6.41	0.49
	CD (P=0.05)	1.33	1.41	1.55	1.18	0.19	0.53	0.02	0.03	0.17	0.06

BF_{30} Biofertilizer: 30 g/tree; BF_{60} biofertilizer: 60 g/tree; VC_{30} vermicompost: 30 kg/tree; CU_{25} cow urine: 25% in water; $CU_{12.5}$ cow urine: 12.5% in water over control (T_9). This is attributed to the stimulating effect of biofertilizers and vermicompost on flower bud differentiation through the synthesis of auxins, gibberellins and cytokinins in the plant system. The cumulative effect of biofertilizers and vermicompost on soil micro-organisms, and moisture retention stimulated the metabolic processes relating to flower induction (Rosario and Barea 1975). Turemis (2002) reported an accelerated bloom density of strawberry with the application of composted material. Similarly, maximum fruit set (62.38%) was observed in treatment T_7 which was 16.97% higher than the control. This treatment combination was also found statistically at par with treatment T_5 with 61.18% of fruit set. The increased availability of nutrients in the rhizosphere with conjoint application of bio-organics and chemical fertilizers have increased translocation of metabolites from roots to flower to enhance pollen germination and pollen tube growth and hence increased fruit set.

Quality characteristics

Amongst all the treatment combinations, the treatment T_7 resulted in maximum fruit firmness (7.06 kg/cm^2), TSS (17.04 °Brix) and reducing sugars (3.97%) in apricot fruits (Table 1). This combination also resulted in 14.80, 6.83 and 13.11%, respectively higher fruit firmness, TSS and reducing sugars compared to control. This treatment combination was also statistically at par with T_5 and T_1 with fruit firmness of 6.91 kg/cm^2 and 6.88 kg/cm^2 respectively. The superior treatment combination of T_7 also gave fruits with minimum acidity (0.90%). The extent of fruit acidity reduction was 21.74% over control (T_9). Similarly, the treatment combination of T_7 also exhibited in maximum ascorbic acid (7.29 mg/100 g) content in fruits which was statistically at par with T_5 (7.24 mg/100 g). Patil *et al.* (2004) also recorded highest ascorbic acid content with 50% recommended doses of fertilizer + 50% vermicompost application. The improvement in these quality attributes might be due to improvement in soil physical properties like porosity, water-holding capacity, decreased bulk density, and tendency of soil towards neutral *p*H soil range which in turn increased the microbial biomass pool in the soil rhizosphere. The increase in carotenoids content resulted from increased chlorophyll content in leaves due to increased N uptake by the addition of organic components which increased photosynthetic efficiency, translocation of nutrients and other metabolites towards fruits.

Soil biological properties

Application of conjoint combination of T_7 resulted in maximum count (cfu/g soil) of *Pseudomonas* (12.33×10^6), *Bacillus* (10.67×10^6) and *A. chroococcum* (9.67×10^6) in soil which was 208.25, 113.40 and 383.50%, respectively tremendously higher than control (Table 2). The data presented also showed maximum AM fungal spore count (1627.50/50 g soil) recorded in T_7 treatment combination with an increase of 442.50% over control. This gradual decrease in microbial biomass of the soil was noticed with increasing levels of NPK fertilizers, whereas, increasing trend was noticed with the higher levels of bio-organics application. Maheshwarappa *et al*. (2001) reported higher bacterial population in organic manure treatments compared to NPK fertilizers. Naidu *et al*. (2002) also observed increased microbial biomass under manures and vermicompost-based treatments than un-inoculated plots. Higher microbial pool also ascribed to an increased organic matter content that provided food and energy for microbial cultures in the rhizosphere. Furthermore, the inoculation of AM fungi increased root colonization attributed to higher sporulation and accounted for increased available P content of the soil rhizosphere. It is well established that P sufficiency of soil provides enough accumulation of metabolites required to promote mycorrhizal formation and thereby roots exudates enough photosynthates to sustain ongoing colonization process. In another study, Kumari and Kumari (2002)

Table 2 Effect of conjoint application of bio-organic and inorganic nutrient sources on soil biological properties in rhizosphere of apricot

Treatment	Treatment	*Pseudomonas* (×10^6 cfu/g soil)	*Bacillus* (×10^6 cfu/g soil)	*A. chroococcum* (×10^6 cfu/g soil)	AM spore count (/50 g soil)
T_1	$BF_{30}VC_{30}CU_{25}NPK_{50}$	6.50	6.33	4.83	1373.17
T_2	$BF_{30}VC_{30}CU_{25}NPK_{75}$	4.33	2.83	3.00	1261.50
T_3	$BF_{30}VC_{30}CU_{12.5}NPK_{50}$	7.50	6.33	6.00	1451.83
T_4	$BF_{30}VC_{30}CU_{12.5}NPK_{75}$	5.00	3.67	3.83	1285.67
T_5	$BF_{60}VC_{30}CU_{25}NPK_{50}$	8.67	7.33	6.33	1433.17
T_6	$BF_{60}VC_{30}CU_{25}NPK_{75}$	6.00	5.00	4.00	1316.50
T_7	$BF_{60}VC_{30}CU_{12.5}NPK_{50}$	12.33	10.67	9.67	1627.50
T_8	$BF_{60}VC_{30}CU_{12.5}NPK_{75}$	7.00	5.50	6.17	1371.17
T_9	Control (NPK)	4.00	5.00	2.00	300.00
	CD (*P*=0.05)	2.25	2.15	1.81	20.18

BF_{30} Biofertilizer: 30 g/tree; BF_{60} biofertilizer: 60 g/tree; VC_{30} vermicompost: 30 kg/tree; CU_{25} cow urine: 25% in water; $CU_{12.5}$ cow urine: 12.5% in water

Table 3 Effect of conjoint application of bio-organic and inorganic nutrient sources on physical-chemical characteristics of soils of apricot

Treatment	Treatment	Bulk eensity (Mg/m^3)	Particle density (Mg/m^3)	Water-holding capacity (%)	Porosity (%)	*p*H	EC (dS/m)	OC (%)	Macronutrients (kg/ha)			Micronutrients (ppm)			
									N	P	K	Fe	Cu	Zn	Mn
T_1	$BF_{30}VC_{30}CU_{25}NPK_{50}$	1.16	2.35	47.75	50.64	6.83	0.36	1.92	329.43	18.67	366.56	63.44	2.83	2.58	52.01
T_2	$BF_{30}VC_{30}CU_{25}NPK_{75}$	1.16	2.36	45.21	50.86	6.72	0.39	1.84	316.86	16.02	368.06	61.45	2.77	2.49	50.89
T_3	$BF_{30}VC_{30}CU_{12.5}NPK_{50}$	1.15	2.39	48.10	51.90	6.84	0.37	1.97	350.41	19.71	368.04	64.32	2.92	2.66	52.59
T_4	$BF_{30}VC_{30}CU_{12.5}NPK_{75}$	1.16	2.34	47.06	50.54	6.71	0.40	1.87	332.03	17.28	367.53	63.58	2.81	2.55	51.44
T_5	$BF_{60}VC_{30}CU_{25}NPK_{50}$	1.17	2.39	49.80	50.65	6.87	0.25	1.99	392.19	21.90	384.71	65.95	3.18	2.79	57.60
T_6	$BF_{60}VC_{30}CU_{25}NPK_{75}$	1.17	2.36	45.61	50.32	6.61	0.39	1.90	364.46	19.50	372.88	63.75	3.02	2.68	55.27
T_7	$BF_{60}VC_{30}CU_{12.5}NPK_{50}$	1.11	2.43	51.60	54.41	6.93	0.16	2.21	423.08	24.78	404.54	68.76	3.27	2.87	59.64
T_8	$BF_{60}VC_{30}CU_{12.5}NPK_{75}$	1.19	2.45	43.70	51.70	6.60	0.38	1.95	396.62	20.35	390.44	65.22	3.21	2.76	55.91
T_9	Control (NPK)	1.33	2.60	34.41	49.04	6.58	0.56	0.69	313.95	13.16	346.96	59.74	2.61	2.23	48.04
	CD (P=0.05)	0.03	0.07	2.68	1.03	0.04	0.04	0.11	2.79	1.53	5.57	1.94	0.20	0.04	1.66

BF_{30} Biofertilizer: 30 g/tree; BF_{60} biofertilizer: 60 g/tree; VC_{30} vermicompost: 30 kg/tree; CU_{25} cow urine: 25% in water; $CU_{12.5}$ cow urine: 12.5% in water

observed that the application of vermicompost increased population of phosphate-solublizing bacteria (*Pseudomanas* and *Bacillus*) to provide high organic carbon content and caused an increase of the microbial biomass pool.

Soil physical-chemical studies

Treatment of conjoint bio-organics and chemical fertilizers were effective in decreasing bulk density of the soil. However, T_7 was most effective with maximum (1.11 Mg/m^3) and decreased bulk density of 16.54% over control (Table 3). This treatment also resulted in maximum (51.60%) water-holding capacity and increased porosity (10.95%) over control with a value of 54.41%. Bulk density was also decreased by combination of bio-organic and inorganic sources compared to orchardists' practices (control). Shirani *et al.* (2002) also reported a significant decrease of surface layer bulk density with the application of manures in the field. The lowering of bulk density in combined application of organic manure and NPK fertilizer resulted from high soil organic carbon, more pore spaces and good soil aggregation. Manickam *et al.* (2002) reported a decrease of bulk density, increased porosity and better water conducting properties of the soil due to the action of gum compounds, polysaccharides and fulvic acid compounds of organic matter on the soil structure and hence, an increased microbial and enzymatic activities accelerated by vermicompost application (Ghuman and Sur 2006). Hashemimajid *et al.* (2006) reported that application of vermicompost @ 45% w/w decreased particle density but increased water-holding capacity of soil. Variation in water-holding capacity of soil attributed to the addition of organic matter, difference in quantity and nature of colloidal materials present, *p*H and salt contents of the soil (Laxminarayana 2006). Different treatments of conjoint application changed soil *p*H towards neutral range. A maximum decrease of soil EC was noticed under T_7 treatment combination. In general, organic sources have tendency towards neutral *p*H soil. There is slight decrease in *p*H and EC level with organic sources and that attributed to the production of organic acids, viz oxalo-acetic acid, glutamic acid (Srikanth *et al.* 2000). Similarly, this treatment also resulted in maximum reduction (71.43%) of soil EC level to 0.16 dS/m compared to control. The treatment combination also exhibited a maximum of 2.21% of soil organic carbon content. The treatment T_7 also increased the availability of N, P and K content of the soil by 34.76, 88.30 and 16.60%, respectively over control. In treatments with addition of bio-organics, mycorrhizal infection in combination with *A. chroococcum* stimulated biological N_2 fixation. Increased availability of N due to application of bio-organics attributed to the greater multiplication of microbes which converted organically bound N to inorganic form (Bhardwaj and Omanwar 1994). Subramanian and Kumaraswamy (1989) reported an increase in available P content of soil which enhanced labile P by complex formation of Ca, Mg and Al.

The organic materials also formed a cover on sesquioxides, reduced P-solublizing capacity and hence increased the availability in the soil solution (Bhardwaj and Omanwar 1994). Moreover, phosphorus-solublizing micro-organisms solublized the insoluble phosphate in the soil (Singh *et al.* 2002). Increase in available K due to application of organic manures ascribed to the direct addition of K to the available K pool of the soil and also due to reduction of K fixation. Similarly, the treatment T_7 also increased the availability of micro-nutrients in the soil which significantly resulted in highest built-up of 68.76, 3.27, 2.87 and 59.64 ppm of available Fe, Cu, Zn and Mn, respectively (Table 3). This superior combination of bio-organics and chemical fertilizers also resulted in 15.1, 25.3, 28.7 and 24.1% increase of available Fe, Cu, Zn and Mn content, respectively over the traditional (orchardist's) practice. Prakash *et al.* (2002) observed higher availability of Fe, Cu and Zn in the soil profile under organic based treatments. Webber and Singh (1995) also observed enhanced Zn availability in the soil solution with the application of cow manure. Further, the increase of DTPA extractable ions (Fe, Cu, Zn and Mn) can be ascribed to the addition of these micronutrients by organics and their release from the native sources on account of solublizing action of organic acids produced during decomposition process (Sakal 2001). Moreover, the inoculation of microbial cultures, application of vermi-compost and cow urine in conjunction with chemical fertilizers improved nutrient cycling process to increase the availability of micro-nutrient ions in the soil solution.

Thus, the study investigated dual efficacy of conjoint bio-organic and inorganic nutrient sources on cropping behaviour, soil properties and quality attributes of apricot (*Prunus armeniaca* L.). The results showed that conjoint application of 60 g of biofertilizers [the consortia of *Pseudomonas*, *Bacillus*, *A. chroococcum* and AM fungi (*G. fasciculatum* Thaxter sensu Gerdemann)], 30 kg of vermicompost and spray of 12.5% of cow urine used along with 50% NPK chemical fertilizers was more effective and significantly improved vegetative growth, cropping behaviour, soil physical, chemical and biological properties, fruit yield and quality attributes over full recommended dose of NPK fertilizers used along with farmyard manure being followed in the traditional orchardists' practice.

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