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Anshul Kumar
Department of Fruit Science, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

DD Sharma
Department of Fruit Science, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

DP Sharma
Department of Fruit Science, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

Bunty Shylla
Subject Matter Specialist, HR&TS&KVK, Kandaghat, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

Sumeet Sharma
Department of Fruit Science, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

Correspondence
Anshul Kumar
Department of Fruit Science, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

Effect of integrated nutrient sources on fruit quality of apricot (*Prunus armeniaca* L.) under mid hill conditions of Himachal Pradesh

Anshul Kumar, DD Sharma, DP Sharma, Bunty Shylla and Sumeet Sharma

Abstract
An experiment was conducted to assess the responses of different combinations of FYM, vermicompost, PSB, *Azotobacter*, nitrogenous sources (calcium nitrate and urea) along with Jeevamrut during 2015-2017 on full grown (20 years) apricot trees of New Castle cultivar, planted at a distance of 5 × 5 m. The experiment had fourteen treatments with three replicates. It has been found that different treatments had a sighificant effect on fruit quality parameters. Maximum fruit length, fruit firmness and fruit breadth, fruit suture, fruit weight and fruit volume was recorded with the application of 50% N (CN) + 50% N (Urea) + *Azotobacter* + PSB + Vermicompost and 0% N (CN) + 50% N (Urea) + *Azotobacter* + PSB + Vermicompost, respectively. While, maximum TSS, TSS/acid ratio, total sugars (11.45%), reducing sugars and minimum titratable acidity was recorded under 50% N (CN) + 50% N (Urea) + *Azotobacter* + PSB + FYM]. Also, maximum yield was recorded with application of 50% N (CN) + 50% N (Urea) + *Azotobacter* + PSB + Vermicompost during the present course of study.

Keywords: Apricot, fruit quality, Jeevamrut, vermicompost, yield

Introduction
Apricot (*Prunus armeniaca* L.) is an important fruit crop of temperate regions of India. In India, it is mainly grown in the states of Jammu and Kashmir, Himachal Pradesh and Uttrakhand and on a limited scale in North Eastern states. In Himachal Pradesh, it is one of the most important fruit crop in low as well as mid-hills. Among stone fruits, apricot ranks next only to plum and peach in area and production of 3650 ha and 11514 MT, respectively (Anonymous, 2017) [1]. 'New castle' is the commercially accepted cultivar of apricot for the mid-hills of Himachal Pradesh, owing to excellent quality attributes, ripens towards the end of May when no other fruit is available in the market and is a source of good income to the orchardists of mid-hill regions.

Continuous use of chemical fertilizers has degraded the soil health and also causes environmental and water pollution. INM is the most efficient and practical way to mobilize all the available, accessible and affordable plant nutrient sources in order to optimize the productivity of the crops and economic return to the farmer. The application of organic manures or biological products can also play significant role in qualitative and quantitative production of fruits. The judicious combination of inorganic and organic fertilizers along with bio-fertilizers may be helpful in increasing the fruit production in apricot. Fertilizers are one of the major inputs accounting for nearly one third of the cost of cultivation and its production consumes a lot of energy used in horticulture. Due to non-availability of calcium ammonium nitrate (CAN), the only option for nitrogenous fertilizers in hilly areas is calcium nitrate, which is very costly therefore, integration of cheaper source of N with calcium nitrate is necessary to reduce the cost of cultivation without affecting the yield component and soil health. Therefore, keeping in view these facts, the present study was conducted in order to study the effect of integrated nutrient sources on growth and yield of apricot cv. New Castle.

Materials and Methods
The present investigation was carried out in experimental orchard of 20 years old apricot planted at spacing of 5.0 x 5.0 m at Horticultural Research and Training station and Krishi Vigyan Kendra, Kandaghat (located at 30-50 °N latitude, 77.8 °E longitude with an elevation of 1325 m above mean sea level), Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) during 2015-2017. The experiment consisted of fourteen treatments replicated thrice in randomized block design (Table 1).

The recommended dose of fertilizers ($N/P_2O_5/K_2O$ @ 500/250/700 g/tree) given to apricot plants as per as package of practices of university (Anonymous, 2014) [2]. The required quantity of single super phosphate (SSP) and muriate of potash (MOP) along with farm yard manure (40 kg/tree) was applied during end of December. *Azotobacter* (25g/tree) and PSB (20g/tree) was mixed along with FYM and vermicompost (10kg/tree). Nitrogen was applied through urea and calcium nitrate in two split doses according to treatments, first half dose was applied about two weeks before flowering and remaining half dose was applied one month after first application. 800 g of lime was added for every 1 kg of urea used in the treatments. 1st application of Jeevamrut was done at full bloom stage after on three applications of Jeevamrut were done at one month interval. Jeevamrut was used for drenching of basin soil after diluting one litre with 10 litre of water. The manures and fertilizers were broadcasted in the basin under the spread of trees, 30 cm away from the tree trunk and thoroughly mixed with soil. Jeevamrut was prepared by mixing ten kg of cow dung and 10 liters of cow urine in a plastic drum. To the well mixed cow dung and cow urine, 2 kg old jaggery, 2 kg gram flour and 1 kg live soil was added. Ingredients were again mixed properly and the volume was made to 200 litre. The mixture in the drum was then allowed to ferment and during the process of fermentation, solution was stirred clockwise regularly three times a day. The process of fermentation was completed within 7 days and Jeevamrut was ready to use. Prepared stock solution was diluted 10 times with water and used for drenching.

Table 1: Complete details of treatments for experiment

Treatment number	Treatment Details
T_1	RDF*(Recommended dose of fertilizers)
T_2	Jeevamrut (3 applications at one month interval)
T_3	FYM + *Azotobacter* + PSB
T_4	Vermicompost + *Azotobacter* + PSB
T_5	100% N (CN) + 0% N (Urea) + *Azotobacter* + PSB + FYM
T_6	75% N (CN) + 25% N (Urea) + *Azotobacter* + PSB + FYM
T_7	50% N (CN) + 50% N (Urea) + *Azotobacter* + PSB + FYM
T_8	25% N (CN) + 75% N (Urea) + *Azotobacter* + PSB + FYM
T_9	0% N (CN) + 100% N (Urea) + *Azotobacter* + PSB + FYM
T_{10}	100% N (CN) + 0% N (Urea) + *Azotobacter* + PSB +Vermicompost
T_{11}	75% N (CN) + 25% N (Urea) + *Azotobacter* + PSB + Vermicompost
T_{12}	50% N (CN) + 50% N (Urea) + *Azotobacter* + PSB + Vermicompost
T_{13}	25% N (CN) + 75% N (Urea) + *Azotobacter* + PSB + Vermicompost
T_{14}	0% N (CN) + 100% N (Urea) + *Azotobacter* + PSB + Vermicompost

After harvesting of fruits, both physical and bio-chemical traits of fruit quality were evaluated. For fruit size ten randomly selected fruits from each experimental tree were recorded in terms of length and breadth with the help of digital Vernier Calliper (Mitutoyo, Japan). The average values of fruit length and breadth were expressed in millimetre (mm). For fruit weight, selected fruits taken for recording the fruit size data were weighed on electronic top pan balance and the average fruit weight was expressed in gram per fruit (g/fruit). Volume of fruits was measured by water displacement method and expressed in cubic centimetre per fruit. The fruit firmness was determined by digital pressure tester (FHP-802) which recorded the pressure necessary for the plunger to penetrate the peeled flesh of nectarine fruits. Five fruits were tested from each tree and results were expressed in kg per cm^2. Bio-chemical analysis of fruits for evaluation of quality was done as per standard procedure described by AOAC (1980) [3].

The data was statistically analyzed with the standard procedure as suggested by Gomez and Gomez (1984) [4]. The level of significance for different variables was tested at 5% value of significance.

Results and Discussion

The results of experiment pertaining to various aspects of fruit quality and fruit yield is summarized as follows:

Fruit quality

a) Physical parameters: The integrated nutrient management treatments had a significant on fruit size (length, breadth), fruit suture, fruit weight, fruit volume and fruit firmness during the present course of study. Maximum fruit length (32.38 mm) and fruit firmness (5.61 kg/cm^2) was observed in treatment T_{12} [50% N (CN) + 50% N (Urea) + *Azotobacter* + PSB + Vermicompost], while maximum fruit breadth (31.57 mm), fruit suture (32.05 mm), fruit weight (32.81 g) and fruit volume (33.82 cc) was recorded in treatment T_{11} [75% N (CN) + 25% N (Urea) + *Azotobacter* + PSB + Vermicompost]. Minimum value of these parameters was recorded under T_2 [Jeevamrut (3 applications at one month interval)].

b) Bio-chemical parameters: The integrated nutrient management treatments had a significant on fruit TSS, fruit titratable acidity, TSS/acid ratio, total sugars and reducing sugars, while non-significant for non-reducing sugars during the present course of study. The fruits from the trees under the treatment T_7 [50% N (CN) + 50% N (Urea) + *Azotobacter* + PSB + FYM] had maximum TSS (13.38 °Brix), TSS/acid ratio (19.52), total sugars (11.45%), reducing sugars (5.42%) and minimum titratable acidity (0.99%). Minimum value of these parameters (maximum in case of acidity) was recorded under T_2 [Jeevamrut (3 applications at one month interval)].

The improvement in different physico-chemical fruit characteristics of apricot by the application of above nutrient sources in different combinations may be explained by the fact that phosphorus enters into the composition of phospholipids and nucleic acids, and latter combines with proteins and result in the formation of nucleo proteins which are important constituents of the nuclei of the cells. Potassium acts as a catalyst in the formation of more complex substances and in the acceleration of enzyme activity and also improves the quality of fruits. Nitrogen enhances the uptake of phosphorus and potassium and the nutrient combinations

accelerate the metabolic activities of the plant. Nitrogen positively influence the vegetative growth of the plant, manufacturing greater amount of food materials and the same when translocated into the fruit bearing areas leading to enhancement in weight and size of the fruits. The chain reactions in these components might have possibly been reason of the improvement in quality of the fruit. *Azotobacter* and PSB inoculation resulted in overall increase in fruit quality which can be explained in a way that *Azotobacter* and PSB contribute up to 20-30% N and 25-50% P_2O_5 in soil, respectively.

Results of the present experiment are in line with the findings of Mohit (2016) [7] who reported maximum fruit length, fruit breadth and fruit weight under the trees treated with the T_1 (urea 0% + Ca $(NO_3)_2$ 100%) treatment and Jeet (2016) [6] conducted a field trial on apple cv. Oregon spur and observed best results in respect of various physico-chemical properties of fruits treated with calcium nitrate + urea. The findings of present studies are also supported by earlier observations of Sharma *et al*. (2011) [8] in their studies on potential use of bioorganic nutrient source dynamics on cropping behaviour, soil properties and quality attributes of apricot observed that through the application of Vermicompost 50 kg/tree + Biofertilizers 60 g/tree + Cow urine at 12.5% in water + Vermiwash at 12.5% in water resulted in maximum fruit firmness (7.40 kg cm^{-2}), TSS (17.95 º B) and reducing sugars (3.34%). However, Singh *et al*., (2010) [10] reported that the conjoint applications of bio-fertilizers (60 g/tree), vermicompost (30 kg/tree), cow urine (12.5%) and 50% recommended dose of NPK significantly increased the fruit firmness (7.06 kg/cm^2), total soluble solids (17.04 ºB), reducing sugar (3.97%), ascorbic acid (7.29 mg/100 g) and total carotenoids (0.96 mg/100 g) over control.

Fruit Yield

The data pertaining to the effect of different fertilizer applications on yield of apricot are presented in Figure 1. It is evident from the figure 1 that maximum yield (25.16 tonnes/ha) was observed in T_{12} [50% N (CN) + 50% N (Urea) + *Azotobacter* + PSB + Vermicompost] However, minimum yield (18.20 tonnes/ha) was observed in T_2 [Jeevamrut (3 applications at one month interval)].

This might be due to better nutrient availability in T_{12} which in turn increased the flower primordial, carbohydrates and nutrients essential to promote flowering and fruit retention in plants which ultimately lead to increase in apricot fruit yield. The results of present experiment are also in line with the observations of Singh *et al.* (2012) [9] who reported maximum fruit yield per plant of aonla with the standard doze of NPK + FYM. Highest fruit yield (28.11 kg/ha) was recorded in the plum with the application of 75% NPK + biofertilizers (60 g each/tree basin) + green manuring (Sunhemp @ 25 g seeds/tree basin) (Thakur and Thakur, 2014) [11]. Also, Goswami *et al.* (2015) [5] reported that maximum fruit set in rainy (83.33%) and winter (34.32%) were recorded with the application of 225 g N_2O, 195 g P_2O_5 and 150 g K_2O along with 50 kg FYM enriched with 250g *Azospirillum* $tree^{-1}year^{-1}$.

Table 2: Effect of integrated nutrient management on physical parameters of fruit quality in apricot cv. New Castle

Treatments	Fruit length (mm)	Fruit breadth (mm)	Fruit suture (mm)	Fruit weight (g)	Fruit volume (cc)	Fruit firmness (kg/cm^2)
T_1	27.64	27.98	29.27	25.26	26.87	4.11
T_2	25.31	26.25	26.31	20.94	21.78	4.01
T_3	25.57	26.90	25.39	22.25	24.02	4.04
T_4	26.01	27.27	26.77	23.62	24.65	4.08
T_5	30.50	30.42	30.90	27.61	29.74	4.40
T_6	29.60	31.29	30.50	26.21	28.01	4.88
T_7	31.38	30.69	31.74	31.92	33.52	5.53
T_8	30.26	30.53	30.77	28.32	29.72	4.30
T_9	30.06	30.26	30.67	29.88	31.84	4.57
T_{10}	27.76	29.58	27.07	26.95	27.86	4.75
T_{11}	30.96	31.57	32.05	32.81	33.82	5.10
T_{12}	32.38	31.03	31.82	30.81	31.47	5.61
T_{13}	28.34	29.65	29.71	28.46	29.75	4.57
T_{14}	30.20	30.48	30.71	29.15	30.81	4.82
$CD_{0.05}$	1.84	1.94	2.12	1.91	2.11	0.65

Table 3: Effect of integrated nutrient management on bio-chemical parameters of fruit quality in apricot cv. New Castle

Treatments	TSS (° Brix)	Titratable acidity (%)	TSS/acid ratio	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)
T_1	11.15	0.91	12.23	9.90	3.67	5.92
T_2	10.07	0.99	10.22	8.71	3.12	5.31
T_3	10.49	0.97	10.85	8.83	3.22	5.33
T_4	10.35	0.98	10.56	9.30	3.37	5.63
T_5	12.01	0.84	14.24	10.74	4.11	6.30
T_6	12.35	0.73	16.87	10.50	4.92	5.30
T_7	13.38	0.69	19.52	11.45	5.42	5.73
T_8	12.21	0.78	15.64	10.39	3.94	6.13
T_9	12.03	0.81	14.78	10.98	4.15	6.48
T_{10}	11.60	0.86	13.43	10.32	4.30	5.73
T_{11}	12.62	0.75	16.90	10.93	4.72	5.90
T_{12}	13.08	0.71	18.37	11.22	4.92	5.99
T_{13}	11.50	0.82	13.98	10.26	4.48	5.49
T_{14}	11.53	0.84	13.80	10.44	4.38	5.76
$CD_{0.05}$	1.26	0.05	1.84	0.80	0.49	N/S

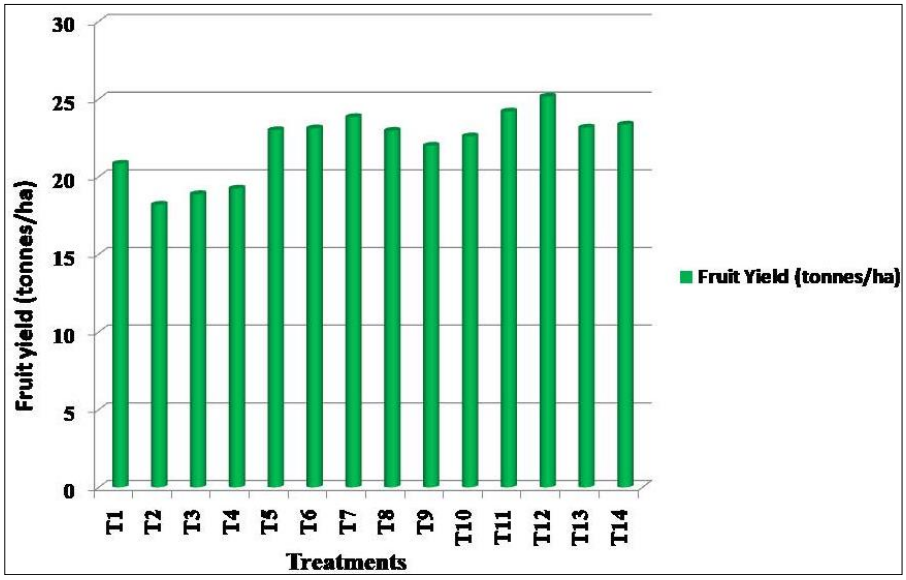

Fig. 1: Effect of integrated nutrient management on fruit yield of apricot cv. New Castle

Fig 2: Fruits of apricot cv. New Castle under treatment T_{12} [50% N (CN) + 50% N (Urea) + Azotobacter + PSB + Vermicompost]

Conclusion

Application of 50% N (CN) + 50% N (Urea) + *Azotobacter* + PSB + Vermicompost and 50% N (CN) + 50% N (Urea) + *Azotobacter* + PSB + FYM improved fruit quality (both physical and bio-chemical) along with fruit yield in apricot.

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