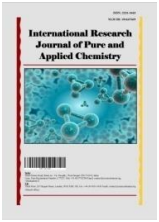

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Effect of Integrated Nutrient Management on Fruit Yield and Quality of Peach (*Prunus persica* L. Batsch) cv. July Elberta

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Authors' contributions

This work was carried out in collaboration among all authors. Author SPSS performed the experiment and wrote the protocol also performed the statistical analysis and wrote the first draft of the manuscript. Author NCS designed the study. Authors JSC and DH managed the analyses of the study and managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The present studies were carried out in Experimental Block, Department of Fruit Science, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during the year 2015-16. Nine years old trees of uniform size and vigour planted at 4.0 x 2.0 m spacing were selected for the studies. The experiment was laid out in a randomized block design with 11 treatments. The maximum increased in fruit set (87.70%) and yield (20.16 kg/tree) were observed significantly higher under 75% RDF + vermicompost 15 kg/tree. Maximum fruit length (64.06 mm), breadth (61.89 mm), fruit weight (129.51 g), total soluble solids (13.33 ºB) and total sugars (7.51%) were recorded under 75% RDF + vermicompost 15 kg/tree, however, highest fruit firmness (6.56 kg/cm^2) and lowest titratable acidity (0.50%) were found with 4 applications of jeevamrut.

Keywords: Nutrient management; jeevamrut; vermicompost; neem cake; wild apricot cake.

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1. INTRODUCTION

Peach (*Prunus persica* L. Batsch) belongs to the family Rosaceae, and is one of the economically potential fruit grown in temperate zone of India. It is a favourite table fruit and highly valued for its taste, nutritive properties and therapeutic uses. Peach is rich source of sugars, vitamins and minerals [1]. 'July Elberta' is an important commercial cultivar of peach due to its adaptability to wider range of climatic conditions [2]. The fruits are large, round, regular and symmetrical with excellent quality. Skin of the fruit is pale yellow with red splash and flesh is firm, yellow, juicy, and very sweet. It is a freestone cultivar and adored for its high quality as a dessert fruit [3].

The key to plant nutrition is the judicious application of manures and fertilizers to meet the requirement of nutrient elements. The heavy production of fruits year after year depletes the soil nutrient reserves and necessitates nutrient element application in order to have economic returns every year and to maintain soil fertility at optimum level. The nutrients run-off and leaching losses in Himalayan region, increasing cost of fertilizers, and their negative effects on soil health has led to intensified attempts to increased use of different composts, oil cakes and other organic preparations along with inorganic fertilizers. Vermicompost considerably reduced the incidence of diseases, proportion fruits free from any physiological disorders indicating that application of vermicompost had significant role in producing healthy fruits and thereby increasing the fruit yield with better quality parameters [4]. The strategy involves balanced supply of nutrients through integrated application of organic manure, bio-fertilizers and inorganic fertilizers in the most appropriate manner [5]. The integrated nutrient management influences long term sustainability in the production level by improving the soil physico-chemical and biological properties and increase availability of nutrient in the soil for next season crop. Incorporation of organic manures is a common practice to improve the yield and quality of fruit crops, which limits chemical intervention and finally minimizes the negative impact of chemical fertilizers on the environment and soil health.

2. MATERIALS AND METHODS

The present studies were carried out in experimental block of the Department of Fruit Science, Dr. YS Parmar UHF, Nauni, Solan, (H.P.) during 2015-16. Nine years old trees of uniform size and vigour planted at 4.0 × 2.0 m spacing were selected for the studies. Uniform cultural practices were given to each tree during the entire course of investigations to keep the plants in a good health. The experiment was laid out in a randomized block design with eleven treatments with the three replications of each treatment. The detail of the treatments viz. T_1 (Recommended dose of fertilizers), T_2 (75% RDF + wild apricot cake 2.5 kg/tree), T_3 (50% RDF + wild apricot cake 5.0 kg/tree), T_4 (75% RDF + neem cake 2.5 kg/tree), T_5 (50% RDF + neem cake 5.0 kg/tree, T_6 (75% RDF + vermicompost 15 kg/tree), T_7 (50% RDF + vermicompost 30 kg /tree), T_8 (75% RDF + jeevamrut (one application at full bloom), T_9 50% RDF + jeevamrut (one applications at full bloom), T_{10} jeevamrut (4 applications at monthly intervals starting from full bloom), T_{11} (25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (one application at full bloom). (Recommended dose of fertilizers)-N/P/K @ (500/250/700 g/tree) + (FYM 40 kg/tree).

Jeevamrut was prepared at experimental site. Jeevamrut was prepared using Ten kg cow dung and 10 liters of cow urine were mixed properly with the help of wooden stick 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. The required quantity of single super phosphate and muriate of potash along with farm yard manure was applied during mid-January. Nitrogen was applied in two split doses; first half dose was applied through urea during February about two weeks before flowering and remaining half dose was applied through calcium nitrate one month after first application. Oil cakes along with vermicompost were applied at about two weeks before flowering, during February with the first dose of nitrogen. Jeevamrut was applied at full bloom stage to the trees where single application was required. However, 3 subsequent applications at monthly interval were made to the trees where 4 applications were required. The manures and fertilizers were broadcasting in the

basin under the spread of trees, 30 cm away from the tree trunk and thoroughly mixed with soil. Jeevamrut was used for drenching of the basin area 30 cm away from the tree trunk and applied @ one litre per tree after diluting it with 10litre of water. Fruit set was determined as per the procedure suggested by [6]. The per cent fruit set was calculated as per formula Fruit set (%) = Total number of fruits set on fruiting branch/ Total number of flowers on fruiting branch×100, Fruit drop: The percentage of fruit drop was calculated as per the formula Fruit drop (%) = Total number of fruits set on fruiting branch - fruits retained at the time of harvest/ Total number of fruits set on fruiting branch×100. For calculating the yield efficiency, firstly trunk cross sectional area (TCSA) of each experimental tree was calculated by the formula πr^2 (where r = trunk diameter (cm)/2). Yield efficiency was calculated as per the formula: Yield efficiency = Yield efficiency (kg/tree)/ TCSA (cm^2) of corresponding tree. Fruit size was calculated with the length (from calyx end to tip of styler end) and breadth at widest portion of shoulder of ten selected fruits were measured with the help of digital vernier callipers and average value for length and breadth of fruits were expressed in millimetre (mm). Fruit weight was calculated from the weight of ten randomly selected fruits per replication were taken on electronic balance and results were expressed as average fruit weight in gram (g). Fruit volume was calculated with the volume of fruits was measured by water displacement method. Ten selected fruits taken for measuring size and weight were immersed in a measuring cylinder filled with water up to a certain graduation. The difference between initial and final readings gave the measure of volume of fruit samples, which were averaged and expressed in cubic centimetre (cc) per fruit. The fruit firmness was taken with the help of Penetrometer. Thin layer of fruit skin was peeled off with stainless steel knife at three places of a fruit and penetrometer was inserted inside fruit and pressure was recorded in terms of kg/cm^2. The total soluble solids content in fruit were determined by Erma hand refractometer (0-32º Brix). The refractometer was calibrated with distilled water before use and a few drops of fruit juice were placed on the prism and the reading was recorded. A temperature correction was applied when it was above or below 20ºC [7]. The total soluble solids in fruit were expressed as $^{\circ}$Brix. Titratable acidity was calculated as per the formula [7]. Titratable acidity (%) =Titre× Normality of alkali × Volume made up × equivalent weight of acid/Weight of fruit pulp taken × volume of extract taken for estimation× 100. TSS/acid ratio was obtained by dividing the corresponding value of total soluble solids to the titratable acid content of the fruit juice. Sugars was calculated as per formula [7]. Total sugar (%) =*Factor × Dilution × Dilution/Titre value × Weight or Volume of sample taken× 100, (*Factor = 0.05), Reducing sugars content were estimated as per cent and calculated as per formula [7]. Reducing sugars (%) = Factor × Volume made up × Dilution/Titre value × Weight or Volume of samples taken×100, The contents of non-reducing sugars were calculated by subtracting the reducing sugars content from the total sugar and multiplying the difference by standard factor 0.95. The results were expressed as per cent non-reducing sugars.

3. RESULTS AND DISCUSSION

3.1 Fruiting Characteristics

The perusal of data presented in Table 1 reveals that conjoint application of organic and inorganic fertilizers exhibited significant effect on fruit set. The maximum fruit set (87.70%) was observed in treatment 75% RDF + vermicompost 15 kg/tree (T_6), which was closely followed by T_7 i.e. 50% RDF + vermicompost 30 kg/tree (85.65%) and both these treatments were statistically at par with recommended dose of fertilizers (T_1), 75% RDF + neem cake 2.5 kg/tree (T_4) and 50% RDF + neem cake 5.0 kg/tree (T_5) but significantly superior to all other treatments under study. The minimum fruit set (72.76%) was recorded with four applications of jeevamrut (T_{10}), which was statistically at par with 75% RDF + wild apricot cake 2.5 kg/tree (T_2), 50% RDF + wild apricot cake 5.0 kg/tree (T_3), 75% RDF + jeevamrut (T_8), 50% RDF + jeevamrut (T_9) and 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}). It is evident from the data (Table 1) that integrated application of organic and inorganic fertilizers significantly influenced fruit drop. The lowest fruit drop (33.24%) was recorded in 75% RDF + vermicompost 15 kg/tree (T_6) treatment, which was statistically at par with fruit drop in trees treated with 75% RDF + wild apricot cake 2.5 kg/tree (T_2), 50% RDF + wild apricot cake 5.0 kg/tree (T_3), 75% RDF + neem cake 2.5 kg/tree (T_4), 50% RDF + vermicompost 30 kg/tree (T_7) and 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}). However, highest fruit drop (50.61%) was observed in trees treated with 50%

RDF + jeevamrut (T_9) and this treatment was statistically at par with 50% RDF + neem cake 5.0 kg/tree (T_5), 75% RDF + jeevamrut (T_8) and four application of jeevamrut (T_{10}). It is evident from the present investigation that the integrated nutrient management treatments significantly influenced the fruit set and fruit drop. Fruit drop in peaches probably occurs due to competition among the fruits for water and nutrients and this competition decreased under integrated application of chemical fertilizers and vermicompost in a proper proportion due to increased availability of nutrients to the plants. On the other hand higher chlorophyll contents might have accounted for increased synthesis and translocation of photosynthates, which resulted in retention of developing and competing fruit lets. The results of present studies are in conformity with those of [8], who recorded significantly increase in fruit set and decrease fruit drop in peach with integrated nutrient management. It is apparent from the data presented in Table 1 that fruit yield was significantly affected by integrated nutrient management treatments. The highest fruit yield (20.16 kg/tree) was obtained in trees treated with 75% RDF + vermicompost 15 kg/tree (T_6), closely followed by trees received 50% RDF + vermicompost 30 kg/tree (19.56 kg/tree). Fruit yield obtained in these two treatments was significantly higher than those of 75% RDF + neem cake 2.5 kg/tree (T_4), 50% RDF + neem cake 5.0 kg/tree (T_5), 50% RDF + jeevamrut (T_9) and four application of jeevamrut (T_{10}). However, lowest fruit yield (15.16 kg/tree) was recorded in trees treated with four applications of jeevamrut (T_{10}), which was statistically at par with 75% RDF + neem cake 2.5 kg/tree (T_4), 50% RDF + neem cake 5.0 kg/tree (T_5), 75% RDF + jeevamrut (T_8) and 50% RDF + jeevamrut (T_9) treatments. The cursory glance of data in Table 1 indicates that yield efficiency of the trees was not affected significantly by integrated application of organic and inorganic fertilizers. However, maximum yield efficiency (0.205 kg/cm^2 TCSA) was recorded in 75% RDF + vermicompost 15 kg/tree (T_6) and minimum yield efficiency (0.117) was observed in trees fertilized with four applications of jeevamrut (T_{10}). The yield is of paramount importance in commercial fruit production. Results of present studies indicate that integrated application of inorganic fertilizers and organic manures was successful in maintaining higher levels of peach productivity. The higher fruit yield under integrated application of 75 or 50% RDF and vermicompost may be attributed to relative increase in the availability of nutrients and better solute uptake by the plants, which resulted in higher fruit set and lower fruit drop and greater size and weight of fruits in the present studies. Vermicompost contribute to more C/N ratio and higher essential plant nutrients required for better metabolic activities in the plant which increase protein and carbohydrate synthesis and finally increased the fruit yield [9]. The present findings of increasing fruit yield by combined application of organic manures with inorganic fertilizers are in congruence with the findings of [10] who recorded higher yield of aonla with 50% inorganic fertilizers + 50% vermicompost. Similarly, [11] in acid lime and [12] in guava, also reported significant increase in yield with integrated nutrient management.

Table 1. Effect of integrated nutrient management on fruit set, fruit drop, fruit yield, and yield efficiency of peach cv. July Elberta

Treatments	Fruit set (%)	Fruit drop (%)	Fruit yield (kg/tree)	Yield efficiency (kg/cm2 TCSA) **
T_1	80.37±5.55	36.73±1.98	18.80±1.91	0.177±0.05
T_2	74.40±3.41	38.09±1.56	18.66±1.86	0.173±0.05
T_3	74.45±5.19	39.59±1.91	18.50±1.85	0.166±0.01
T_4	83.20±2.90	41.67±1.54	17.16±1.81	0.150±0.02
T_5	84.23±5.50	43.94±7.53	16.50±1.62	0.139±0.04
T_6	87.70±2.64	33.24±4.33	20.16±1.96	0.205±0.02
T_7	85.65±5.43	40.58±4.99	19.56±1.15	0.185±0.07
T_8	75.45±2.23	43.25±7.07	17.00±1.95	0.130±0.03
T_9	76.89±2.46	50.61±5.60	16.50±1.43	0.154±0.07
T_{10}	72.76±7.16	43.67±4.15	15.16±1.05	0.117±0.01
T_{11}	77.07±2.14	40.87±2.34	18.33±1.10	0.156±0.02
$CD_{0.05}$	7.37	7.83	2.82	NS

***TCSA-trunk cross sectional area*

3.2 Physical Fruit Quality Characteristics

It is clear from the data given in Table 2 that fruit length was significantly influenced by combined application of organic and inorganic fertilizers. The maximum fruit length (64.06 mm) was recorded in trees treated with 75% RDF + vermicompost 15 kg/tree (T_6), which was statistically at par with fruit length in trees under recommended dose of fertilizers (T_1), 75% RDF + wild apricot cake 2.5 kg/tree (T_2), 50% RDF + wild apricot cake 5.0 kg/tree (T_3), 50% RDF + neem cake 5.0 kg/tree (T_5) and 50% RDF + vermicompost 30 kg/tree (T_7). However, the minimum fruit length (57.23 mm) was observed in trees treated with four applications of jeevamrut (T_{10}), which was statistically at par with 75% RDF + neem cake 2.5 kg/tree (T_4), 75% RDF + jeevamrut (T_8), 50% RDF + jeevamrut (T_9) and 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}). The perusal of data presented in Table 2 reveals that fruit breadth was significantly influenced by conjoint application of organic and inorganic fertilizers. The fruits with maximum breadth (61.89 mm) were harvested from trees received 75% RDF + vermicompost 15 kg/tree (T_6), which was statistically at par with fruit length in the trees under recommended dose of fertilizers (T_1), 75% RDF + wild apricot cake 2.5 kg/tree (T_2), 50% RDF + wild apricot cake 5.0 kg/tree (T_3), 50% RDF + neem cake 5.0 kg/tree (T_5) and 50% RDF + vermicompost 30 kg/tree (T_7). However, fruits with minimum breadth (56.38 mm) were obtained from trees treated with four application of jeevamrut (T_{10}), which was statistically at par with fruit breadth in trees under 75% RDF + wild apricot cake 2.5 kg/tree (T_2), 75% RDF + neem cake 2.5 kg/tree (T_4), 75% RDF + jeevamrut (T_8), 50% RDF + jeevamrut (T_9) and 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}).

It is clear from the data given in Table 2 that fruit weight was significantly influenced by integrated nutrient management treatments. The highest fruit weight (129.51 g) was recorded in trees treated with 75% RDF + vermicompost 15 kg/tree (T_6), which was closely followed by T_1 i.e. recommended dose of fertilizers (126.91 g) and T_7 i.e. 50% RDF + vermicompost 30 kg/tree (126.36 g). The trees under these three treatments had significantly higher fruit weight than those under 75% RDF + wild apricot cake 2.5 kg/tree (T_2), 50% RDF + wild apricot cake 5.0 kg/tree (T_3), 75% RDF + neem cake 2.5 kg/tree (T_4), 75% RDF + jeevamrut (T_8), 50% RDF + jeevamrut (T_9), four application of jeevamrut (T_{10}) and 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}). However, lowest fruit weight (96.33 g) was recorded in trees treated with four applications of jeevamrut (T_{10}), which was statistically at par with 75% RDF + jeevamrut (T_8) treatment under study. It is evident from the data given in Table 2 that fruit volume was significantly influenced by integrated application of organic and inorganic fertilizers. The highest fruit volume (135.92 cc) was recorded in trees treated with 75% RDF + vermicompost 15 kg/tree (T_6). This treatment was closely followed by T_7 i.e. 50% RDF + vermicompost 30 kg/tree (134.81 cc) and both these treatments had significantly higher fruit volume than all other treatments. However, lowest fruit volume (97.86 cc) was recorded in trees treated with four applications of jeevamrut (T_{10}), which was significantly lower than all other treatments. The perusal of data presented in Table 2 reveals that combination of organic and inorganic fertilizers significantly affected the firmness of fruits. The maximum fruit firmness (6.56 kg/cm^2) was recorded in trees subjected to four application of jeevamrut (T_{10}), which was statistically at par with firmness in fruits obtained from trees treated with 50% RDF + wild apricot cake 5.0 kg/tree (T_3), 50% RDF + neem cake 5.0 kg/tree (T_5), 50% RDF + vermicompost 30 kg/tree (T_7), 75% RDF + jeevamrut (T_8), 50% RDF + jeevamrut (T_9) and 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}). The lowest fruit firmness (5.23 kg/cm^2) was observed under recommended dose of fertilizers (T_1), which was statistically at par with 75% RDF + neem cake 2.5 kg/tree (T_4) treatment.

Present findings indicate that fruit size, weight, volume and firmness were markedly improved by integrated application of chemical fertilizers and organic manures. The continuous supply of nutrients especially nitrogen for longer period under combined application of inorganic fertilizers and vermicompost may have accounted for improvement in physical fruit quality characteristics. Nitrogen is directly related with the synthesis of protein through amino acids, which enhances the production of spongy type cells of fruits. Moreover, N is extremely mobile and developing fruits act as metabolic sink for nutrient elements and photosynthates [13]. The higher fruit firmness under the trees having higher proportion of organic fertilizers and

lower proportion of chemical fertilizers, perhaps corresponds to higher accumulation of leaf Ca and lower leaf N content under these treatments in the present studies. The results of present studies are corroborated by [14], who recorded significantly higher weight and size of sapota fruits with combined application of inorganic fertilizers + FYM + vermicompost. Similarly, [15] also obtained sapota fruits with highest weight with the application of 50 per cent dose of fertilizers along with vermicompost.

3.3 Biochemical Fruit Quality Characteristics

The data presented in Table 3 depicts the effect of integrated nutrient management on total soluble solids in peach fruit. It is clear from the data that application of integrated application of organic and inorganic fertilizers produced significant effect on total soluble solids content of the fruits. The maximum total soluble solids content (13.33ºB) was exhibited by fruits born on trees under 75% RDF + vermicompost 15 kg/tree (T_6). This treatment was closely followed by T_7 i.e. 50% RDF + vermicompost 30 kg/tree (13.00 ºB) and both these treatments had significantly higher total soluble solids content than those of 50% RDF + neem cake 5.0 kg/tree (T_5), 75% RDF + jeevamrut (T_8), 50% RDF + jeevamrut (T_9) and 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}). The lowest total soluble solids content (10.91 ºB) was found in treatment 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}), which was significantly lower than those of recommended dose of fertilizers (T_1), 50% RDF + wild apricot cake 5.0 kg/tree (T_3), 75% RDF + neem cake 2.5 kg/tree (T_4), 75% RDF + vermicompost 15 kg/tree (T_6), 50% RDF + vermicompost 30 kg/tree (T_7) and four application of jeevamrut (T_{10}). Data pertaining to effect of integrated nutrient management on titratable acidity is given in Table 3. The data shows that conjoint application of organic and inorganic fertilizers had significant effect on titratable acidity. The lowest titratable acidity (0.50%) was exhibited by the fruits born on trees received four application of jeevamrut (T_{10}), which was statistically at par with titratable acidity in fruits harvested from trees treated with 50% RDF + wild apricot cake 5.0 kg/tree (T_3), 50% RDF + neem cake 5.0 kg/tree (T_5) and 50% RDF + jeevamrut (T_9). However, Fruits of trees, which received 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}) had highest titratable acidity (0.62%), which was statistically at par with titratable acidity in the fruits produced by trees under recommended dose of fertilizers (T_1), 75% RDF + wild apricot cake 2.5 kg/tree (T_2), 75% RDF + neem cake 2.5 kg/tree (T_4) and 50% RDF + vermicompost 30 kg/tree (T_7). A cursory glance of data in Table 3 indicates that TSS: acid ratio was significantly influenced by different combinations of organic and inorganic fertilizers. The maximum value of TSS: acid ratio (26.33) was recorded with four application of jeevamrut (T_{10}), followed by T_6 i.e. 75% RDF + vermicompost 15 kg/tree (23.99). Both these treatments had significantly higher TSS: acid ratio than those of 75% RDF + wild apricot cake 2.5 kg/tree (T_2), 75% RDF + neem cake 2.5 kg/tree (T_4), 50% RDF + neem cake 2.5 kg/tree (T_5), 75% RDF + jeevamrut (T_8), 50% RDF + jeevamrut (T_9) and 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}). However the lowest value of TSS: acid ratio (17.61) was observed in trees fertilized with, 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}), which was significantly lower than all other treatments under study.

The data with respect to total sugars contents as influenced by different integrated nutrient management treatments are presented in Table 3. The perusal of data indicates that total sugars content of fruit differed significantly with the integrated application of organic and inorganic fertilizers. The maximum total sugars content (7.51%) was registered in the treatments 75% RDF + vermicompost 15 kg/tree (T_6) closely followed by 50% RDF + vermicompost 30 kg/tree (7.47%) and 50% RDF + wild apricot cake 5.0 kg/tree (7.44%). These three treatments had significantly higher total sugars content than those of 50% RDF + jeevamrut (T_9) and 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}). The minimum total sugars content (7.11%) was observed in 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}), which was significantly lower than total sugars content in all other treatments under study.

It is apparent from the data presented in Table 3 that reducing sugars content of fruits were significantly affected by conjoint application of organic and inorganic fertilizers. The maximum reducing sugars content (3.60%) was recorded in fruits produced by trees receiving 50% RDF +

jeevamrut (T_9) and this treatment was statistically at par with 75% RDF + wild apricot cake 2.5 kg/tree (T_2) and 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}) but significantly superior to all other treatments under study. The lowest reducing sugars content (2.20%) was noticed in fruits produced on trees under 75% RDF + vermicompost 15 kg/tree (T_6), which was significantly lower than those of 75% RDF + wild apricot cake 2.5 kg/tree (T_2), 50% RDF + jeevamrut (T_9) and 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}).

The data presented in Table 3 shows that combined application of organic and inorganic fertilizers had significant effect on non-reducing sugars. The highest non-reducing sugars content (5.01%) was exhibited by fruit produced on trees subjected to 50% RDF + vermicompost 30 kg/tree (T_7), which was statistically at par with non-reducing sugars content under recommended dose of fertilizers (T_1), 50% RDF + wild apricot cake 5.0 kg/tree (T_3) 75% RDF + neem cake 2.5 kg/tree (T_4), 50% RDF + neem cake 5.0 kg/tree (T_5), 75% RDF + vermicompost 15 kg/tree (T_6), 75% RDF + jeevamrut (T_8) and four application of jeevamrut (T_{10}). However, lowest non-reducing sugars (3.51%) was found in 50% RDF + Jeevamrut (T_9) and this treatment was stastically at par with 75% RDF + wild apricot cake 2.5 kg/tree (T_2) and 25% RDF + wild apricot cake 1.25 kg + neem cake 1.25 kg + vermicompost 15 kg + jeevamrut (T_{11}) treatments.

Table 2. Effect of integrated nutrient management on physical fruit quality characteristics of peach cv. July Elberta

Treatments	Fruit size		Fruit weight (g)	Fruit volume (cc)	Fruit firmness (kg/cm^2)
	Length (mm)	Breadth (mm)			
T_1	63.74±2.07	60.91±2.62	126.91±3.07	128.91±1.76	5.23±0.25
T_2	61.20±2.04	59.17±1.73	112.27±4.41	115.66±4.51	6.06±0.23
T_3	61.70±0.72	60.39±3.56	116.06±2.60	118.83±1.62	6.25±0.23
T_4	60.08±3.71	57.62±3.06	119.18±2.51	122.00±4.05	5.66±0.32
T_5	62.55±1.64	61.17±2.75	122.96±1.55	125.26±1.07	6.46±0.35
T_6	64.06±1.52	61.89±1.91	129.51±1.18	135.92±3.21	5.87±0.53
T_7	62.77±1.70	60.24±1.80	126.36±1.47	134.81±7.21	6.26±0.15
T_8	59.43±2.30	57.43±0.67	100.32±3.65	105.34±4.64	6.16±0.15
T_9	58.72±0.72	56.87±3.87	107.89±2.73	108.31±1.99	6.31±0.20
T_{10}	57.23±2.62	56.38±0.73	96.33±2.72	97.86±2.12	6.56±0.18
T_{11}	59.83±2.50	56.58±1.55	115.55±2.96	118.66±3.38	6.35±0.22
$CD_{0.05}$	3.74	3.30	5.63	7.03	0.48

Table 3. Effect of integrated nutrient management on biochemical fruit quality characteristics of peach cv. July Elberta

Treatments	TSS (ºB)	Titratable acidity (%)	TSS: acid ratio	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)
T_1	12.43±0.36	0.57±0.03	22.08±1.13	7.37±0.06	2.66±0.16	4.47±0.12
T_2	12.00±0.58	0.59±0.02	20.22±1.19	7.34±0.01	3.43±0.12	3.71±0.12
T_3	12.06±0.49	0.55±0.03	21.96±1.37	7.44±0.02	2.50±0.10	4.69±0.09
T_4	12.83±0.47	0.61±0.01	21.03±0.86	7.38±0.04	2.53±0.41	4.60±0.41
T_5	11.50±0.50	0.54±0.04	21.37±2.48	7.40±0.08	2.46±0.21	4.59±0.28
T_6	13.33±1.00	0.56±0.02	23.99±2.00	7.51±0.06	2.20±0.06	4.60±0.23
T_7	13.00±0.50	0.58±0.03	22.60±1.51	7.47±0.06	2.56±0.17	5.01±0.11
T_8	11.06±1.04	0.56±0.06	19.90±1.76	7.46±0.08	2.70±0.26	4.52±0.23
T_9	11.43±0.50	0.55±0.03	20.85±1.87	7.29±0.01	3.60±0.10	3.51±0.09
T_{10}	13.16±1.04	0.50±0.06	26.33±2.20	7.35±0.06	2.66±0.15	4.64±0.21
T_{11}	10.91±0.50	0.62±0.06	17.61±1.44	7.11±0.02	3.10±0.49	3.81±0.48
$CD_{0.05}$	1.11	0.05	2.53	0.13	0.77	0.74

The higher total soluble solids and sugars content and lower titratable acidity under the integrated application of chemical fertilizers and vermicompost might be associated with higher accumulation of macro and micronutrients under these treatments in the present studies. The improvement in bio-chemical fruit quality characteristics under combination of lower proportion of fertilizers and higher proportion of organic manures may be ascribed to the improved soil health and enhanced nutrient availability by enhancing the capacity of plant for better uptake of nutrients from rhizosphere thus provided better soil environment to the crop. These results are in symphony with the findings of [16], who reported significant improvement in bio-chemical fruit quality characteristics of apple with the application of 75 per cent RD of fertilizers + vermicompost @ 10 kg/tree. [17] also recorded higher TSS and sugars content with the integrated application of organic and inorganic fertilizers in pomegranate. Similar findings on fruit quality improvement with integrated nutrient management have also reported by [18] in mango, [19] and [20] in guava.

4. CONCLUSION

On the basis of results obtained in the present investigations, it may be concluded that treatment comprising 75% RDF + vermicompost 15 kg/tree (T_6) was found to be the most effective combination of organic and inorganic fertilizers for nutrients application to the July Elberta cultivar of peach under mid-hill conditions of Himachal Pradesh as this treatment significantly improved fruit set, fruit retention, yield, fruit quality.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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