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Effect of Potassium Nitrate, GA3 and Salicylic acid on Fruit Yield and Quality of Peach [*Prunus persica* (L) Batsch] cv. Shan-i-Punjab

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Abstract

The present Study entitled Effect of Potassium nitrate, GA_3 and Salicylic acid on fruit yield and quality of peach cv. Shan-i-Punjab was carried out in a well maintained Peach orchard of Khalsa College, Amritsar during 2016-2017. In the trial, 30 peach trees with uniform size and vigour were selected and were sprayed with KNO_3 @ 1.00, 2.00 & 3.00 per cent and plant growth regulators SA @ 0.50, 1.00 & 1.50 mM and GA_3 @ 25, 50 & 100 ppm before harvesting to find out the optimum concentration of these chemicals for improving the fruit yield and quality characters. The investigation was laid out in RBD (Randomised Block Design) with ten treatments which replicated thrice.The results of present study revealed that the fruit physical characteristics were significantly improved with the application of GA_3 and biochemical characters were significantly improved with the spray of potassium nitrate. Significant fruit length (6.25 cm), fruit breadth (5.35 cm), fruit weight (93.04 g), fruit set (69.70%) and fruit yield (63.23 kg/tree) were recorded under treatment GA_3 100 ppm whereas fruit TSS (11.33 %), TSS: acid ratio (24.39), reducing sugars (2.69 %), total sugars (6.91 %) and organoleptic rating (9.00) were recorded under treatment T_3 (KNO_3 3.00 %). The former treatment also produced yellow colored fruits with red blush and reduced titratable acidity.

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Introduction

Peach [*Prunus persica* (L) Batsch] is widely grown on commercial basis in the temperate and sub-tropical regions of the world. It belongs to family Rosaceae and sub family Prunoideae. It is commercially cultivated in Italy, USA, France, Japan, China, Greece, Mexico, Argentina, Canada and India. In India, its cultivation limits according to the requirement of the chilling hours of different cultivars. Low chilling peach cultivars are grown in sub-montaneous and plains of Jammu, Himachal Pradesh, Punjab, Haryana and Western Uttar Pradesh (Dhillon, 2013). Peach is one of the important temperate fruit which has become pride to poor and marginal hilly farmers of sub mountainous regions, plains of northern India and Southern hills (Jana, 2015). Shan-i-Punjab is a potential cultivar of peach adapted well under Punjab conditions and is highly desirable due to less susceptibility to diseases and insect pest. The quality and the yield of the peach fruit depend upon various pre harvest factors. So in order to improve the productivity of peaches in terms of fruit set and fruit quality several cultural practices were performed and out of them, the foliar application of plant growth regulators and nutrients considered to be the most promising practice as peach plant has shown a great response to

these foliar applications. The nutrients and plant growth regulators sprayed at the proper stage of the fruit growth not only increase the fruit yield but also gives the fruit good colour, size, firmness and increases its palatability which are desirable by the consumer and in result, providing farmer higher economic returns. Foliar spray of potassium nitrate could be attributed to enhance the photosynthetic efficiency of leaves and a possible increase in translocation of assimilates into the fruits resulting in larger fruit size and also plays an important role in the interplay of metabolic events involved in fruit ripening and senescence (Kaur *et al.,* 2012). Salicylic acid is an endogenous growth regulator of phenolic nature which participates in the regulation of several physiological processes in plants such as growth, transport of nutrients, photosynthesis, nitrate metabolism and ethylene production (Hayat *et al.,* 2007). Sprays of GA_3 have been widely adopted in commercial orchards because they have consistently been shown to increase fruit firmness and size (Clayton *et al.,* 2006 and Ozkaya *et al.,* 2006). Gibberellic acid is also known to delay ripening and senescence of fruits (Khadar, 1988). Therefore the present investigation was under taken to find out the effect of pre harvest application of nutrients and plant growth regulators on physiochemical quality of peach cv. Shan-i-Punjab.

Materials and Methods

The trial was conducted on 8 years old uniform vigorous peach trees growing at peach orchard, Khalsa College, Amritsar. On the selected trees concentrations of various nutrients and growth regulators (KNO_3, SA and GA_3) were sprayed before harvesting to find out the optimum concentration of these growth regulators. The experimental trees were sprayed with potassium nitrate @ 1, 2 and 3 per cent, salicylic acid @ 0.50, 1.00 and 1.50 per cent and gibberellic acid @ 25, 50 and 100 ppm. The trees were sprayed with salicylic acid at flower bud initiation stage and during the fruit set, GA_3 at pit hardening stage and 14 days before harvesting whereas potassium nitrate was sprayed at 10 days and 5 days before harvesting. Physiologically mature peach fruits of uniform size, disease and bruise free were picked randomly from all the four directions of the treated plants. Then these fruits were washed and air dried at room temperature. After drying the fruits were analyzed for their physico-chemical characteristics in the laboratory of Department of Horticulture, Khalsa College Amritsar. The recorded data were analyzed by randomized block design. Fruit size was measured in terms of length and breadth of fruit with the help of Vernier's Calliper and fruit size was worked out in centimetres. Average weight per fruit was worked out by weighing 5-6 fruits with Physical balance and expressed in grams. The fruits were evaluated for colour rating by panel of five judges on the score card based on the colour and for organoleptic rating by the same panel of judges on the score card (maximum 10 points) keeping in view the general appearance, taste and flavour. For calculation of fruit set per cent, two branches in all the directions were selected and tagged for recording data of total number of flowers at full-bloom and fruits after fruit set (developed fruitlets). Then the fruit set per cent was computed by dividing total number of flowers to total number of developed fruits and then percentage was worked out. Yield was calculated by multiplying total number of fruits with average fruit weight and expressed as Kg/tree. The fruit TSS was analyzed with the help of hand refractometer. Titratable acidity was calculated by titrating diluted juice against N/10 NaOH by using phenolphthalein as an indicator. The diluted juice was prepared by adding distilled water in the ratio of 1:10. The endpoint of the titration was permanent pink colour. The acidity was calculated and expressed in terms of citric acid (AOAC method) by using the below given formula,

$$\text{Titratable acidity}(\%) = \frac{0.064 \times \frac{N}{10}\text{NaOH}}{\text{Volume of juice taken}} \times 100$$

Reducing sugars and total sugars were analyzed by Lane and Eynon method (Rangana 1977a). Ascorbic acid was analysed by Indophenol dye method (Rangana 1977b).

Results and Discussion

Fruit set and yield

The data (Table 1) shows that most of the treatments significantly increased the fruit set and yield per tree as compared to the control trees which exhibited the lowest significant values of these parameters in the study. Maximum fruit set per cent was obtained in trees treated with the treatment T_9 (GA_3 100 ppm) with the fruit set of 69.70 per cent and was found to be significant over control trees (58.00 %). The former treatment was found to be at par with the treatments T_4 (SA 0.50 mM), T_5 (SA 1.00 mM) and T_7 (GA_3 25 ppm) with the fruit set of 68.86, 68.78 and 68.78 per cent respectively. Yield is a complex character and is characterized by increase in weight of individual fruit and number of fruits.

Maximum fruit yield (63.23 Kg) was registered from the trees treated with GA_3 100 ppm.

Fruit quality parameters

Fruit size was markedly increased with the application of GA_3 and the fruit trees treated with GA_3 100 ppm gave the fruits with maximum size i.e. fruit length of 6.25 cm and fruit breadth of 5.35 cm (Table 2). The above treatment found to be superior over the control with fruit length 5.57 cm and fruit breadth 4.34 cm. The trees treated with GA_3 100 ppm produced the fruits with maximum fruit weight (93.04 g) and proved to significant over the fruits yielded from the trees under control (65.42 g). Results showed the positive effect of chemicals and growth regulators on fruit coloration of peach, and were assessed by a panel of five judges on point basis. The trees treated with KNO_3 3.00 per cent yielded yellow coloured fruits with red blush. The enhancement in fruit colour with potassium nitrate might be due to the reason that potassium appears to enhance anthocyanin accumulation and resulting in red coloration of fruits (Ritenour and Khemira, 2007). The least colour development was observed in the fruits under control. The organoleptic rating was awarded by judges and the maximum organoleptic rating was recorded in the fruits obtained from the trees applied with potassium nitrate 3.00 per cent had attained highest organoleptic rating with sweet taste, was followed by treatments potassium nitrate 2.00 per cent and GA_3 100 ppm with organoleptic rating of 8.33 and 8.33 respectively.

Potassium significantly improves the quality parameters of peach fruits. However the treatments did not show significant effect on the TSS contents in peach fruits, but maximum TSS content (11.33%) was reported in fruits harvested from trees treated with KNO_3 3.00 per cent. The presented data also demonstrates that potassium nitrate helps in reducing the acidic content in fruits. Minimum titratable acidity (0.46 %) was found under the treatment T_3 (KNO_3 3.00 %). Significantly maximum TSS: acid ratio (24.39) was registered in fruits under KNO_3 3.00 per cent and minimum TSS: acid ratio (19.22) under control. A direct correlation between increased TSS with the corresponding decrease in acidity could have resulted in higher TSS: acid ratio. Sugars increased significantly in most of the treatments as compared to control. However maximum reducing sugars (2.69 %) and total sugars (6.91 %) were registered in the fruits produced from trees treated with KNO_3 3.00 per cent. And the fruits obtained from the trees under control contained 2.73 and 6.56 per cent respectively.

Table.1 Effect of Potassium nitrate, GA_3 and Salicylic acid on fruit yield parameters of peach [*Prunus persica* (L) Batsch] cv. Shan-i-Punjab

Treatments	Fruit set per cent (%)	Fruit yield (Kg/tree)
T_1 - KNO_3 (1.00 %)	63.93	59.97
T_2 - KNO_3 (2.00 %)	65.01	58.93
T_3 - KNO_3 (3.00 %)	65.28	59.23
T_4 – SA (0.50 mM)	68.87	62.47
T_5 - SA (1.00 mM)	68.78	62.37
T_6 - SA (1.50 mM)	64.90	58.83
T_7 – GA_3 (25 ppm)	68.78	62.37
T_8 - GA_3 (50 ppm)	66.61	60.43
T_9 - GA_3 (100 ppm)	69.70	63.23
T_{10} – Control	58.00	52.60
CD (p= 0.05)	**1.76**	**2.90**

**CD (p=0.05) means critical difference among treatments at 5 percent level of significance*

Table.2 Effect of Potassium nitrate, GA_3 and Salicylic acid on fruit physical parameters of peach [*Prunus persica* (L) Batsch] cv. Shan-i-Punjab

Treatments	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (g)	Fruit color	Organoleptic rating
T_1 KNO_3 (1.00 %)	6.08	5.12	83.12	8.50	8.00
T_2 KNO_3 (2.00 %)	5.80	5.34	86.23	9.30	8.33
T_3 KNO_3 (3.00 %)	6.06	5.23	88.67	9.63	9.00
T_4 SA (0.50 mM)	6.13	4.88	71.88	7.26	7.66
T_5 SA (1.00 mM)	6.15	5.06	74.70	6.70	7.67
T_6 SA (1.50 mM)	6.20	4.96	79.66	7.23	7.33
T_7 GA_3 (25 ppm)	6.00	5.25	83.86	7.03	7.67
T_8 GA_3 (50 ppm)	6.10	5.18	85.48	7.43	8.00
T_9 GA_3 (100 ppm)	6.25	5.35	93.04	8.23	8.33
T_{10} Control	5.57	4.34	65.42	6.66	7.33
CD (p=0.05)	**0.22**	**0.18**	**2.55**	**0.24**	**0.90**

**CD (p=0.05) means critical difference among treatments at 5 percent level of significance*

Table.3 Effect of Potassium nitrate, GA_3 and Salicylic acid on fruit bio-chemical parameters of peach [*Prunus persica* (L) Batsch] cv. Shan-i-Punjab

Treatments	TSS (%)	Titratable acidity (%)	TSS:acid ratio	Reducing sugars (%)	Total sugars (%)
T_1 KNO_3 (1.00 %)	11.06	0.520	21.31	2.63	6.75
T_2 KNO_3 (2.00 %)	11.26	0.486	23.30	2.69	6.87
T_3 KNO_3 (3.00 %)	11.33	0. 463	24.39	2.69	6.91
T_4 SA (0.50 mM)	10.83	0.540	20.06	2.40	6.78
T_5 SA (1.00 mM)	10.70	0.550	19.44	2.33	6.57
T_6 SA (1.50 mM)	10.43	0.560	18.64	2.30	6.51
T_7 GA_3 (25 ppm)	11.06	0.526	21.05	2.64	6.55
T_8 GA_3 (50 ppm)	11.16	0.483	23.11	2.66	6.76
T_9 GA_3 (100 ppm)	11.30	0.490	23.02	2.68	6.81
T_{10} Control	10.36	0.540	19.22	2.37	6.56
CD (p=0.05)	**NS**	**0.026**	**1.887**	**0.042**	**0.064**

**CD (p=0.05) means critical difference among treatments at 5 percent level of significance*

Fruit set and yield

Nafea and Abdulfatah (2014) studied the effect of foliar application of gibberellic acid (75, 100 and 125 mg/l) and naphthalene acetic acid (50, 100 mg/l) after 15 days of fruit set for two seasons 2010 and 2011 in olive trees cv. Ashrasie. As a result the trees treated with GA_3 125 mg/l and GA_3 125 mg/l + NAA 50 mg/l gave maximum fruit set as compared to the control trees. Tuan and Chung–Ruey (2013) also reported significant increase in fruit set in wax apple by the foliar spray of 30 ppm GA_3 when applied at small bud and petal fall stage. This increase in the fruit set per cent might be due to the increased availability of nutrients from leaves by gibberellins. Similar results were also found by Moneruzzaman *et al.,* (2011) in wax apple and Fahad and Rab (2014) in sweet orange. Yield is a complex character and is characterized by increase in weight of individual fruit and number of fruits. El-Shazly *et al.,* (2013) carried out the study during two successive seasons of 2012 and 2013 in order to study the effect of ascorbic acid (AsA), citric acid (CiA), salicylic acid (SA) each at (0, 200, 400 and 600 ppm), gibberellic acid (GA_3) at (0, 100, 200 and 300 ppm) and calcium chloride ($CaCl_2$) at (0, 0.5, 1.0 and 2 %) on the yield and fruit quality of six years old "Swelling" peach trees. Results showed that gibberellic acid significantly increased total yield as compared with other different agro-chemicals in the first season. GA_3 200 ppm recorded the maximum yield of 44.19 Kg and 34.38 Kg in the year 2012 and 2013 respectively. It might be due to the fact that GA_3 increased the translocation and mobilization of

photosynthates from source to sink (Krishnamoorthy, 1981). These results are also in accordance with Southwick *et al.,* (1995) in peach cv. Loadel and Stern and Arie (2008) in nectarine cv. Snow-Queen, Queen Giant and Arctic Mist and in peach cv. Scarlet Snow.

Fruit quality parameters

Fruit size was markedly increased with the application of GA_3 and the fruit trees treated with GA_3 100 ppm gave the fruits with maximum size in terms of length and breadth. Stern and Arie (2008) applied GA_3 at 25 mg/l during flower bud induction stage to nectarine cv. Snow-Queen, Queen Giant and Arctic Mist and peach cv. Scarlet Snow. The results demonstrated that the fruit size was improved in all the cultivars.

The number of large sized fruits was increased significantly in peach cv. Scarlet Snow and nectarine cv. Arctic Mist with the application of GA_3 25 mg/l. The increase in the fruit size with the application of gibberellic acid is mainly due to the reason that GA_3 promotes growth by increasing plasticity of cell followed by hydrolysis of starch into sugars which reduce the cell water potential resulting in the entry of water into cell wall and causing in development of fruit size (Richard, 2006). Coneva and Cline (2006) found similar results in peach fruits cv. Red Heaven and Rani and Brahmchari (2004) in mango. El-Shazly *et al.,* (2013) carried out the study during two successive seasons of 2012 and 2013 in order to study the effect of ascorbic acid, citric acid, salicylic acid each at 0, 200, 400 and 600 ppm, gibberellic acid (0, 100, 200 and 300 ppm) and calcium chloride (0, 0.5, 1.0 and 2 %) on yield and fruit quality of six years old "Swelling" peach trees.

GA_3 (300 ppm) caused a significant increase in fruit weight as compared with the other agrochemicals in both seasons. This increase in weight could be attributed to cell enlargement which is possibly due to the reason that GA_3 creates sink strength in the fruit cells, thus attracts water and nutrients (Elade, 1992). These results are in positive correlation with Amarante *et al.,* (2005) in peach fruits cv. Rubidoux, Yadav and Chaturvedi (2005) in ber fruits and Yehia and Hassan (2005) in pear cv. Le Conte. Sheikh (2015) examined the effect of chemicals (KH_2PO_4 and KNO_3) on the rind color development in pomegranate fruit cv. Ganesh and he found effective improvement in rind colour (red or red yellow) by the use of 1.00 per cent KNO_3. The enhancement in fruit colour with potassium nitrate might be due to the reason that potassium appears to enhance anthocyanin accumulation and resulting in red coloration of fruits (Ritenour and Khemira, 2007). The fruits harvested from the trees treated with potassium nitrate 3.00 per cent exhibited higher organoleptic rating which might be due to the reason that potassium enables higher accumulation of sugars and organic acids in fruits, hence improves the taste of fruit (Liwerant, 1960 and Lalatta, 1975). Potassium significantly affects the fruit biochemical parameters in peach fruits. Prasad *et al.,* (2015) conducted an experiment to study the effect of foliar spray of micro nutrients on pear cv. Pathernakh. Fifteen year old pear was treated with three concentrations of calcium and potassium nutrients viz. calcium chloride, calcium nitrate, potassium nitrate, potassium sulphate and water spray as control at 30 days interval starting from fruit set.

The results showed that the fruits treated with potassium nitrate at 1.5 per cent showed highest TSS, TSS: acid ratio, total sugars, reducing sugars and thereby decreasing the titratable acidity. It might be possible due to the reason that potassium treatment could be attributed to enhance photosynthetic efficiency of the leaves and a possible increase in translocation of assimilates into the fruit (Singh *et al.,* 1982)**.** The increase in TSS: acid ratio with KNO_3 treatment could be attributed to the enhanced photosynthetic efficiency of the leaves (Singh *et al.,* 1982). A direct correlation between increased TSS with the corresponding decrease in acidity could have resulted in higher TSS: acid ratio. Sugars increased significantly in most of the treatments as compared to control. It was due to the fact that potassium enables higher accumulation of sugars and organic acids in fruits by promoting the translocation of assimilates from source to sink (Liwerant, 1960 and Lalatta, 1975). The present findings are in accordance with Kaur *et al.,* (2012) in peach fruits and Prasad *et al.,* (2015) in pear fruits.

Overall, from the present study it has been concluded that the peach trees treated with GA_3 100 ppm significantly gave maximum fruit set per cent and yield per tree and thereby improving the fruit physical parameters in terms of size and weight. Whereas the fruit biochemical parameters were enhanced with the use of KNO_3 3.00 per cent.

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