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Effect of pre harvest application of salicylic acid on plant growth parameters and yield of strawberry cv. Chandler

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Abstract
The present investigation entitled the effect of pre harvest application of salicylic acid on plant growth parameters and yield of strawberry cv. Chandler was conducted in the Department of Horticulture, Khalsa College Amritsar during 2017-2018. The runners of strawberry cv. Chandler were planted in mid October with a spacing of 45 × 30 cm on raised beds. The investigation was laid out in Randomized Block Design with four treatments which replicated thrice. The pre harvest applications of salicylic acid (2 mm, 4 mm and 6 mm) was done at flowering stage, fruit setting, 30, 20 and 10 days before fruit harvest. The result of the study revealed that salicylic acid (SA) significantly improved the plant growth parameters and fruit yield. Maximum plant height (10.15 cm), total leaf area (215.96 cm^2), fruit set (82.15 %), number of runners (3.0) and fruit yield (282.06 g/plant) was noticed in plants sprayed with SA 4 mm which was closely followed by SA 2 mm and minimum plant height (7.13 cm), total leaf area (86.51 cm^2), fruit set (71.02 %), number of runners (1.0) and fruit yield (170.50 g/plant) was found under control.

Keywords: Chandler, Salicylic acid, plant growth and yield.

Introduction
Strawberry (*Fragaria x ananassa* Duch.) is one of the most popular fruit in the world which belonging to family Rosaceae and sub family Rosoidae. The name "strawberry" may have derived from the practice of using straw mulch for cultivation, or it may have come from the Anglo-Saxon word "strew" meaning "to spread" (Kaur 2010) [12]. The major strawberry producing countries of the world are USA, Spain, Poland, Korea and Russian federation (Sharma *et al.* 2008) [23]. India is the second largest producer of strawberry fruits in the world after China. In India, strawberry was initially grown in temperate zones of the country but now it has become possible in the subtropical zones (Asrey and Singh 2004) [1]. It is grown in Maharashtra, Haryana, Punjab, Uttar Pradesh and lower hilly area of Himachal Pradesh with an area of about 1 thousand hectares and an annual production of 5 thousand MT per hectare (Anonymous 2016-2017) [3]. Strawberries are very rich in nutrients, amino acids vitamins and anthocyanins (Dhillon 2013) [6]. These are also a relevant source of bioactive compounds due to high levels of vitamin C, vitamin E, β-carotene and phenolic compounds such as anthocyanins, substances related to health benefits. It contains relatively high qualities of Ellagic acid, which has a wide range of biological activity (Meyers *et al.* 2003) [16]. Exogenous application of Salicylic acid at nontoxic concentrations to susceptible plants could enhance their resistance to fungal pathogens. It also act as a potential non-enzymatic antioxidant as well as plant growth regulator and play an important role in regulating a number of plant physiological processes including heat production or thermogenesis, ion uptake and transport, disease resistance, seed germination, sex polarisation, crop yield and glycolysis (Zhang *et al.* 2003) [25]. Salicylic acid significantly improved the overall plant growth in terms of shoot length, leaf area, fresh and dry weight of roots and shoots of strawberry (Karlidag *et al.* 2009) [15] and also induced flowering and fruit setting with increased fruit weight and yield in many crops (Fariduddin *et al.* 2003) [9].

The present study entitled the effect of pre harvest application of salicylic acid on plant growth parameters and yield of strawberry cv. Chandler was carried out in a well-managed experimental field of Departmental nursery of Khalsa College, Amritsar during the year 2017-18. This place falls at 31^0 to 38^0 latitude and 75^0 to 52^0 longitude with an elevation of 774 feet above sea level. The soil of experimental field was sandy loam in texture. The runners of strawberry were procured from the Strawberry Cultivars Welfare Society located at village Sahowal near Ranjit Bagh, Gurdaspur. The runners were transplanted in well prepared raised beds each measuring 2m x 1m in size. The transplanting was done on 17 October at a planting distance of 45 x 30 cm. Uniform dose of farm yard manure (FYM) @ 50 t/ha was applied to all plots before field bed preparations. In the present study, the pre harvest applications of salicylic acid (2 mm, 4 mm and 6 mm) was done at flowering stage, fruit setting, 30, 20 and 10 days before fruit harvest. Experiment was laid out in RBD with four treatments and three replications for each treatment and five plants were selected randomly for each replication. The height of plants was measured randomly with a measuring scale from the crown level to the apex of primary leaf and results were expressed as average height in centimetres. Total leaf area was recorded at the end of growing season. The leaf area was measured with the help of Systronics leaf area meter. The total leaf area was worked out by multiplying number of leaves with an average leaf area and expressed in square centimetres. The total number of flowers per plant was counted and the number of fruit set in these plants was recorded after every five days. The number of runners was recorded and results were expressed as average runners per plant. The yield (g/plant) was calculated on the basis of product of average fruit weight and the total number of fruits per plant.

Results and Discussion.

The maximum plant height (10.65 cm) was recorded in plants applied with 4 mm salicylic acid (Treatment T_3). The stimulatory effect on plant height could be attributed to the positive effect of salicylic acid upon the endogenous phytochromes specially the growth promoters such as auxins, gibberellins and cytokinins which promotes cell division and cell enlargement (Mady 2014) [17] and thus leads to increase in plant height. However, the minimum plant height (7.13 cm) was recorded under control. These results are in accordance with Qureshi *et al.* (2013) [22], Abo-sedera *et al.* (2014) [2], and Youssef *et al.* (2017) [24] in strawberry plants. The plants treated with treatment T_3 (SA 4mM) exhibited maximum total leaf area (215.96 cm^2). The increment in total leaf area might be due to anti-senescence effect of salicylic acid on plant organs due to which vegetative growth may be prolonged and leading to the higher leaf area in strawberry plants (Jamali *et al.* 2011) [11]. Whereas the minimum total leaf area (86.51 cm^2) was recorded under control. The present results are in accordance with the findings of Kazemi (2011) [13], Gaderi *et al.* (2015) [10], Eshghi *et al.* (2016) [8], in strawberry plants. The maximum fruit set percentage (82.15 %) were recorded in treatment T_3 (SA 4mm) while the minimum fruit set (71.02 %) were recorded under T_1 (control). Similar result have been favoured by Qureshi *et al.* (2013) [22] in strawberry plants, Ngullie *et al.* (2014) [21] in Mango trees, and Mohamadi and Pakkish (2013) in peach trees the maximum number of runners (3.0) was found with treatment T_3 (SA 4 mm). This increment in runner formation might be due to increase in epidermal and parenchymatous cell growth that lead to runner production (Denis and Bennett 1969) [7]. These result of the present study are in close agreement with the findings of Kazemi *et al.* (2013) [14] and Qureshi *et al.* (2013) [22] in strawberry plants However, minimum number of runners (1.0) was recorded under control (T_1). It was noted that SA 4 mM registered maximum fruit yield (282.06 g/plant), while minimum fruit yieid (170.50 g/plant) was recorded under treatment T_1 (control). The higher yield might be due to the increased flowering and more fruit set with higher fruit weight by the application of SA (Muneshwar *et al.* 2012 and Karlidag *et al.* 2009) [18, 15]. These results were in congruent with Metwally *et al.* (2013), Aghaeifard *et al.* (2014) [4], Jamali *et al.* (2011) [11] in strawberry, Champa *et al.* (2014) in table grapes.

Table 1: Effect of pre harvest application of salicylic acid on the vegetative growth of strawberry cv. Chandler.

Treatments	Plant height (cm)	Total Leaf area (cm^2)	Number of runners
T_1: control	7.13	86.51	1.0
T_2: SA 2 mM	9.36	194.98	2.33
T_3: SA 4 mM	10.65	215.96	3.0
T_4: SA 6 mM	8.45	124.0	1.33
Mean	8.89	155.36	1.91
CD (p = 0.05)	0.80	38.19	1.20

Table 2: Effect of pre harvest application of salicylic acid on fruit set (%) and fruit yield (g/plant) of strawberry cv. Chandler.

Treatments	Fruit set (%)	Fruit yield (g/plant)
T_1: control	71.02	170.50
T_2: SA 2 mM	80.19	271.46
T_3: SA 4 mM	82.15	282.06
T_4: SA 6 mM	72.21	195.0
Mean	76.39	229.75
CD (p = 0.05)	6.40	43.86

Conclusion

Results of the present study revealed that the pre harvest application of salicylic acid @ 4 mm proved to be most significant treatment in enhancing the plant growth parameters in terms of plant height, total leaf area, fruit set percentage, number of runners and fruit yield.

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