Research Article

Efficacy of Blossom Thinners on Flowering, Fruit Retention and Yield Attributes in Plum (*Prunus Saliciana* L.) cv. 'Kala Amritsari'

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Abstract

Plum cv. 'Kala Amritsari' being a self fertile cultivar flowers abundantly that leads to small, numerous and unmarketable fruits with degraded quality. Chemical thinning with blossom thinners enhanced final fruit retention and yield attributes with reduced days to maturity in comparison to control. Ammonium thiosulphate (ATS @ 2.0 %) showed lowest bloom density (41.84%) while, Ethephon @ 150 ppm advanced maturity and took least number of days taken from fruit set to maturity (81.21 days). Maximum number of days from fruit set to maturity was taken under control (85.12) which took days to reach maturity (ATS @ 2.0% retained least initial fruit set (35.85%). ATS @ 1.5% showed least fruit drop (65.05%) which further resulted in highest final fruit retention (34.95%). The maximum yield (33.96 kg) was recorded under ATS @ 1.5%. Applications of ATS @ 1.5% appeared promising, but good blossom coverage is critical for thinning. Furthermore, blossom thinners formulations need improvement to ensure uniform coverage for more predictable thinning.

Keywords: ATS, Blossom, Plum, Thinning, Days to maturity

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Introduction

Plum (*Prunus saliciana* Lindl.) an important deciduous fruit crop belongs to the family *Rosaceae* and subfamily Amygdaloideae. Among the stone fruits it ranks next to peaches in economic importance. It requires varying types of climates. It is grown from subtropical to the temperate high hills. European plum thrives best at 1300-2000 m above mean sea level. It requires about 1000-1200 chilling hours during winter to break rest period, whereas Japanese plum requires 300-500 hrs chilling which is met in mid hills and plains. Plums bloom early in the season thus is prone to frost injury.

The self-fertile plum cultivar 'Kala Amritsari' (*Prunus saliciana* L.) blossom abundantly and most of the flowers set fruits. If these excessive fruitlets remain on the trees until harvest, the crop results in small, unmarketable fruits of low fruit quality. Fruits compete with each other and with other vegetative parts of the tree such as shoots and roots for water, nutrients and assimilates. To achieve annual yields of high quality fruits, the commercial practice for many years has been to blossom-thin these cultivars with a chemical agent and make further crop load adjustments by hand post-bloom. This management technique saves labour costs and improves the value of the crop. Hand thinning of flowers or fruitlets alone is regarded too time-consuming. Chemical thinning of blossoms permits reduction of the potential overset at the earliest possible stage. Thinning is a pre-requisite for sustainable production of high quality fruits and also a measure to overcome the problem of irregular bearing [1]. Thus, an experiment was conducted to examine the effect of various chemical thinners on flowering, fruit retention and yield attributes..

Materials and Methods

The present investigation was undertaken at Horticultural Research Centre, Patharchatta and Department of Horticulture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar (Uttarakhand) in the year 2015. The experiment was conducted on 8 years old healthy fruit bearing trees of plum cultivar 'Kala Amritsari' having uniform size and vigor. All the trees were maintained under uniform cultural practices during the course of investigation. The spray solution of GA_3 and NAA were prepared by dissolving their required amount in 100 ml of 80 per cent ethanol solution before making the final volume with water. BA (Benzyl Adenine) solution was prepared by dissolving the required amount in 100 ml of 0.1 N NAOH solutions before making final volume with water. Ethephon and Ammonium Thiosulphate (ATS) were however, prepared by dissolving requisite quantities directly in water. The pH of various treatments was maintained by using pH meter to ensure effectiveness of different treatments. However, in unthinned control treatment only water spray was given. The spraying operation was performed on a clear and calm day during morning hours to obtain better results.

Bloom density

Bloom density was finally calculated by using the following formula.

$$\text{Bloom density (\%)} = \frac{\text{No. of flower clusters}}{\text{No. of flower clusters} + \text{No. of vegetative buds}} \text{ x } 100$$

Days to maturity

Number of days from fruit set to the date of maturity was counted manually.

Initial Fruit set

The number of fruit set on four tagged shoots in different directions on each tree after pollination were counted and average initial fruit set (%) was calculated on the basis of total number of flower per 30 cm shoot length.

$$\text{Initial fruit set (\%)} = \frac{\text{Number of fruits set}}{\text{Total number of flowers}} \text{ x } 100$$

Fruit drop

Observation on fruit drop was recorded just prior to harvest by using following formula and finally an average was estimated by taking the mean of all four shoots tagged in all four directions.

$$\text{Fruit drop (\%)} = \frac{\text{No. of initial fruits} - \text{fruits retained till harvesting}}{\text{No. of initial fruits}} \times 100$$

Fruit retention

Fruit retention was recorded just prior to harvest by using following formula:

$$\text{Fruit retention(\%)} = \frac{\text{No. of initial fruits} - \text{fruits drop till harvesting}}{\text{No. of initial fruits}} \times 100$$

Fruit yield

The data on the fruit yield per plant was recorded by weighing all the fruits from the tree under each treatment at the time of harvesting by using 20 kg capacity balance.

Statistical Analysis

The observations were subjected to statistical analysis by using Randomized Block Design (RBD) as per procedure given by [2]. Mean differences were tested by ‘F’ test at 5 per cent level of significance (LOS). Critical difference (CD) at 5 per cent level of probability was used for comparison among treatments. The results were presented by way of tables and graphs.

Results and Discussion

Bloom density

The response of bloom density among different chemical blossom thinners has been presented in table 1. Bloom density ranges from 41.84 per cent to 49.62 per cent under different treatments. The highest bloom density (49.62%) was noted in control followed by BA @ 25 ppm (48.44%) and BA 50 ppm (47.62%). T_{15} (ATS @ 2.0 %) however, observed significantly the lowest bloom density (41.84%) in comparison to all other treatments. A wide difference of 7.78% was observed between T_{16} (Control) and T_{15} (ATS @ 2.0 %). Bloom density depends upon the number of flowers opened to the total number of flower and vegetative buds present. As ATS thinned blossoms aggressively, bloom density reduced and the number of flowers opened was lesser in comparison to control. Moreover, ethephon enhanced the process of abscission and decreased blossom load which further resulted in reduced bloom density. In contrast, the lack of thinning treatment under control showed maximum bloom density. Similar results were obtained by [3] who examined efficacy of bloom thinning in European plum using chemical thinning for crop load management by Ammonium Thiosulphate (ATS) @ 1.5% and 3% and mechanically thinned trees. ATS (3%) showed the highest reduction in flowering intensity in comparison to ATS (1.5%) followed by mechanically thinned trees. [4] also concluded a strong thinning effect in relation to bloom density comparable to hand thinning treatment occurred in the case of BA @ 100 ppm alone or NAA @ 10 ppm alone in ‘Summer Red’ cultivar of apple.

Days taken from fruit set to maturity

Days taken from fruit set to maturity ranged from 81.21 to 85.01 under different treatments sprayed on plum cv. ‘Kala Amritsari’ (Table 1). The treatment T_{11} (Ethephon @ 150 ppm) advanced maturity and took least number of days taken from fruit set to maturity (81.21 days) followed by T_{14} (ATS @ 1.5%) and T_8 (BA @ 50 ppm) while, maximum number of days from fruit set to maturity was taken by T_{16} (control) which took 85.01 days to reach maturity. The average number of days taken to maturity ranges from 85-90 days. Ethephon not only reduced blossom load but also reduces number of days taken from fruit set to maturity (81 days) as it releases ethylene, a ripening hormone. Ethylene is responsible for the changes in texture, softening, color and other processes involved in ripening. This earliness in the peak period may reduce the competition between plum and peach which would be beneficial for farmers in gaining net returns. The results are in conformity with [5] who also investigated that except GA_3 (75 ppm) and Urea (4%) all the ethephon treatments reduced the time of harvesting and showed significant effect on reducing days taken from fruit set to maturity in apple. However, [5] investigated flower thinning of apple cultivar ‘Braeburn’ using different concentrations of ammonium and potassium thiosulphate and revealed that flower thinning with ammonium and potassium thiosulfate increased days taken from fruit set to maturity.

Initial fruit set

Table 1 also reveals data pertaining to initial fruit set ranges from 35.85 per cent to 43.55 per cent under different treatments sprayed on plum cv. ‘Kala Amritsari’. ATS (2.0%) retained least initial fruit set (35.85%) while, highest initial fruit set (43.55%) was observed under the control in comparison to all other treatments. Chemical thinning posses a negative interaction with initial fruit set as it interferes in osmoregualtion and production of abscission layer at higher concentration. Higher the concentration lesser the initial fruit set. ATS and ethephon treatments showed reduced bloom density which eventually reduced initial fruit set. Control in which no thinning treatment was sprayed however, showed maximum initial fruit set. The results are in conformity with [6] who showed an increase in fruit set and yield when gibberellic acid was applied to flower clusters. [7] also indicated that foliar spray of NAA at 40 ppm significantly reduced the fruit set per cent in comparison to unthinned treatment in peach.

Fruit drop

T_{14} (ATS @ 1.5%), T_8 (BA @ 50 ppm), T_7 (BA @ 25 ppm), T_6 (NAA @ 75 ppm), T_5 (NAA @ 50 ppm), T_4 (NAA @ 25 ppm) and T_1 (GA_3 @ 25 ppm) showed significant reduction in fruit drop over control (Table 1). Fruit drop ranged from 65.05 per cent to 71.05 per cent under different treatments sprayed on plum cv. ‘Kala Amritsari’ trees. The treatment T_{14} (ATS @ 1.5%) showed least fruit drop (65.05%) while, maximum fruit drop (71.05%) was observed under control treatment. The difference of 6 per cent was estimated between T_{14} (ATS @ 1.5%) and control. Chemical thinning has varied interaction with fruit drop, which is concentration dependent on chemical applied. Most of the plant bio-regulators at lower concentration reduces fruit drop while, at higher concentration they function as chemical thinners. GA_3 reduced fruit drop by increasing flower and fruit retention. In contrast, ATS and Ethephon at higher concentrations thinned aggressively and enhanced fruit drop thereby reducing sink competition among fruits. Similar results were obtained by [7] who observed in peach cv. 'Mayfire' that the fruit drop was highest in control in both the years and lowest in the NAA @ 60 ppm. Post petal fall application of NAA though caused abscission of young fruitlets but decreased the drop of the remaining fruits until harvest. [8] while working on 'Satluj Purple' cultivar of plum revealed that pre-harvest fruit drop was also found to be significantly reduced by different growth regulators treatments. Ethrel applied @ 100 ppm (4th week of March) was the most effective to check the drop followed by NAA (10 ppm).

Table 1 Efficacy of blossom thinners on flowering and yield attributes in Plum cv. 'Kala Amritsari'

Treatments	Bloom density (%)	Days taken to maturity	Initial fruit set (%)	Fruit drop (%)	Final fruit retention (%)	Fruit yield (Kg)
T_1 (GA_3 25 ppm)	45.23	82.81	39.85	66.35	33.65	32.36
T_2 (GA_3 50 ppm)	43.85	82.11	38.85	67.95	32.05	31.16
T_3 (GA_3 75 ppm)	42.94	83.41	38.05	68.05	31.95	30.96
T_4 (NAA 25 ppm)	45.94	83.71	39.25	65.65	34.35	33.16
T_5 (NAA 50 ppm)	43.25	83.11	38.35	66.05	33.95	32.06
T_6 (NAA 75 ppm)	42.95	84.26	37.55	66.75	33.25	30.66
T_7 (BA 25 ppm)	48.44	83.91	40.85	65.45	34.55	32.46
T_8 (BA 50 ppm)	47.62	82.11	39.05	66.85	33.15	31.96
T_9 (BA 75 ppm)	44.59	83.26	37.95	69.95	30.05	31.54
T_{10} (Ethephon 100 ppm)	46.52	83.61	39.95	68.95	31.05	32.16
T_{11} (Ethephon 150 ppm)	45.59	81.21	37.65	69.43	30.57	31.66
T_{12} (Ethephon 200 ppm)	43.25	83.46	36.55	70.35	29.65	30.26
T_{13} (ATS 1%)	42.74	82.51	39.65	67.75	32.25	31.76
T_{14} (ATS 1.5%)	42.25	82.01	36.25	65.05	34.95	33.96
T_{15} (ATS 2%)	41.84	83.51	35.85	68.85	31.15	30.46
T_{16} (Control)	49.62	85.01	43.55	71.05	28.95	29.26
S Em±	1.45	0.41	1.23	1.34	0.73	0.43
CD at 5%	4.31	1.23	3.69	4.02	2.17	1.29

Final fruit retention

The highest final fruit retention (34.95%) was estimated in ATS (1.5%) followed by BA @ 25 ppm (34.55%) and NAA @ 50 ppm (33.95%) however, control treatment observed the lowest (28.95%) final fruit retention in comparison to all other treatments (Table 1). A wide difference of 6.00 per cent was observed between T_{14} ATS (1.5%) and T_{16} (control). Final fruit retention depends upon level of thinning frequency. Higher the thinning frequency, lesser the percentage of final fruit retention. Moreover, fruit drop has negative interaction with final fruit retention. GA_3 reduced fruit drop and enhanced final fruit retention while, ATS under all concentrations helped in abscission of fruitlets and reduced final fruit retention. The results are in conformity with [9] who observed that application at 30% full bloom resulted in decreased final fruit retention with increasing concentration of uniconazole, from 50 to 250 ppm. Final fruit retention percentage was negatively correlated with uniconazole concentration and the concentration of 250 ppm resulted in excessive fruit thinning, whereas good results were obtained at 100 ppm (44% reduction in final fruit set percentage).

Fruit yield

Estimation of fruit yield presented in table 1 show that fruit yield ranges from 29.26 kg to 33.96 kg under different treatments. T_{14} (ATS @ 1.5%), T_{13} (ATS @ 1%), T_{12} (Ethephon @ 200 ppm), T_{11} (Ethephon @ 150 ppm) and T_8 (BA @ 50 ppm) were found superior over control treatment. Minimum fruit yield (29.26 kg) was noted in the treatment T_{16} (Control). In contrast, T_{14} (ATS @ 1.5%) showed maximum fruit yield (33.96 kg) followed by T_5 (NAA @ 50 ppm) and T_2 (GA_3@ 50 ppm). Fruit yield not only depends upon number of fruits per tree but also has a positive interaction with fruit size and weight. The results are similar to [8] who while working on ‘Satluj Purple’ cultivar of plum investigated that the fruit yield was significantly higher in ethrel (100 ppm) applied during 4th week of March as compared to other treatments and was followed by ethrel (50 ppm) during 4th week of March. The fruit yield was the lowest in untreated fruits.

Conclusion

The present study suggested that ATS @ 1.5% aggressively thinned flowers thereby reducing the crop load which further enhanced the source sink transport in the developing fruits. With less number of flowers left the source and sink strength of photosynthate reduced competition among remaining fruits resulting in higher yield and quality. ATS @ 1.5% also advanced maturity in plum cv. Kala Amritsari which may be of economic importance. Hence application of ATS @ 1.5% was found beneficial for the plum cv. ‘Kala Amritsari’ under tarai region of Uttarakhand.

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