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Effect of chemical and hand thinning on growth, yield and fruit quality of nectarine (*Prunus persica* Batsch var. *nucipersica*)

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ABSTRACT

A field experiment was conducted during 2009 and 2010 to study the influence of fruit thinning on growth, yield, proportion of different grades fruit and fruit quality of nectarine. The thinning treatments consisted of foliar spray of NAA at 20, 40 and 60 ppm, ethrel at 100, 200 and 300 ppm, thidiazuron at 10, 20 and 30 ppm 3 weeks after petal fall, selective mannual removal of fruits to the intensity of 10, 20 and 30 per cent at pea stage and unthinned control. The results revealed that both chemical and manual thinning significantly improved fruit size, weight and proportion of 'A' grade fruits. Among the chemical thinning treatments, application of 300 ppm ethrel judiciously thinned fruitlets (24.15 & 25.38%), improved size and weight (89.90 & 92.75 g/ fruit) of fruits, proportion of 'A' and 'B' grades fruits without any adverse effect on total yield as compared to other chemical treatments. Trees sprayed with 60 ppm NAA attained highest shoot length, tree volume and leaf area. Ethrel at 300 ppm and NAA at 60 ppm significantly increased TSS (14.23 & 14.31%), total and reducing sugars as compared to control. The net return of Rs. 668 and 982 per tree during 2009 and 2010, respectively and fruit quality attributes were also better with 300 ppm ethrel treatment.

Key words: Ethrel, fruit thinning, fruit quality, NAA, nectarine, yield.

INTRODUCTION

The peach is third most important temperate fruit crop in India and is mainly cultivated in mid hills of Himachal Pradesh, Uttarakhand, Jammu and Kashmir and sub-tropical areas of Punjab. In recent years, the cultivation of nectarines, smooth skinned fuzzless peaches are gaining momentum.

Among the different nectarine cultivars of grown in H.P., Silver King is most important because of attractive red coloured medium size fruits. For profitable nectarine production and higher return, the large sized fruits having strong market demand is very important. However, nectarine invariably bears heavily, thus resulting in the production of small sized fruits, which are less remunerative. Therefore, fruit thinning is necessary to improve size and quality of fruits, besides reducing limb breakage and maintain optimum crop load and vegetative growth for sustainable production. Fruit thinning can be done manually, however, it is time consuming and expensive. Some plant growth regulators like ethrel, NAA and thidiazuron have shown promise as fruit thinner in fruit crops. Therefore, the present study was undertaken to assess the effect of ethrel, NAA and thidiazuron on fruit thinning, and to find best method for improving production of better size and quality nectarine fruits.

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MATERIALS AND METHODS

A field experiment on chemical and hand thinning was conducted in the experimental orchard of Department of Fruit Science, Dr YS Parmar University of Horticulture and Forestry, Solan during 2009 and 2010. Six-year-old nectarine trees of cv. Silver King having uniform growth and vigour, planted at 3 m × 3 m spacing and trained on open centre system were selected for present study. The recommended cultural practices were given to all the experimental trees during the course of investigation. In chemical thinning, NAA (20, 40 and 60 ppm), ethrel (100, 200 and 300 ppm) and thidiazuron (10, 20 and 30 ppm) were sprayed three weeks after petal fall. In hand thinning, 10, 20 and 30 per cent fruitlets were removed manually in respective treatments at pea stage of fruit growth.

The observation on initial fruit set was recorded at one week after petal fall stage and final fruit set at five week after petal fall. Per cent fruit thinning was calculated by subtracting the final fruit set from initial fruit set and dividing the difference with initial fruit set and multiplying with 100. The observations on annual shoot growth, tree height and spread were taken with standard procedures as suggested by Westwood (11). Leaf area was measured with the help of leaf area meter (LiCor-3100). Leaf to fruit ratio was obtained by dividing total number of leaves with total number

of fruits on four selected branches on each tree. After harvest, the weight of total fruits was recorded to express the total yield per tree. The harvested fruits were also graded on the basis of their diameter. The fruits having a diameter of 5.5 cm or above were graded as 'A', 5.0- 5.4 cm 'B' grade and below 5.0 cm 'C' grade and graded yield was expressed in percentage of total yield. Data on fruit size, weight and pulp to stone ratio, TSS, acidity and sugars were recorded as per standard procedures (AOAC, 1). Economic viability of various thinning treatments was ascertained by comparing the net benefits of various treatments with that of control. For this purpose, the current grade-wise farm gate prices of nectarine fruits, *viz*., 'A' grade Rs. 80, 'B' grade Rs. 60 and 'C' grade 30 Rs. per kg were used. Costs of thinning under different treatments included the labour charges and cost of growth regulators, other management costs for different treatments and control were the same and hence not included in the analysis. The data were statistically analyzed as suggested by Gomez and Gomez (4).

RESULTS AND DISCUSSION

Chemical as well as manual thinning significantly increased growth and vigour of tree, leaf to fruit ratio and yield of better grade fruits as compared to control (Table 1). Fruitlets thinning increased with the increase in concentration of NAA, ethrel and thidiazuron, and also with the intensity of manual thinning during both the years. Among the chemical thinning treatments, ethrel at 300 ppm induced the maximum fruit thinning (24.15 and 25.38%), followed by 200 ppm ethrel. NAA at 40 and 60 ppm also caused

Table 1. Effect of chemical and manual thinning on per cent thinning, vegetative growth and fruit yield of nectarine.

Treatment	Fruit thinning (%)		Leaf to fruit ratio		Shoot growth (cm)		Increase in tree volume (m^2)		Leaf area (cm^2)		Fruit yield (kg/tree)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
NAA 20 ppm	10.29 (18.70)	12.46 (20.66)	29.14	31.16	47.31	42.56	3.50	3.26	28.03	26.68	8.93	14.68
NAA 40 ppm	13.49 (21.54)	13.84 (21.83)	32.33	32.81	49.48	44.79	3.83	3.43	28.75	27.04	8.75	13.15
NAA 60 ppm	16.33 (23.83)	18.26 (25.29)	34.68	35.10	52.39	48.32	3.94	3.68	28.52	27.01	8.25	12.86
Ethrel 100 ppm	19.18 (25.96)	18.38 (25.38)	30.26	30.78	41.11	42.24	3.39	3.12	22.63	24.07	10.53	15.13
Ethrel 200 ppm	21.31 (27.48)	23.16 (28.76)	33.08	34.36	39.02	42.67	4.04	3.21	25.31	25,94	10.26	14.84
Ethrel 300 ppm	24.15 (29.42)	25.38 (30.24)	35.86	36.72	38.53	41.84	3.47	3.06	24.63	25.86	10.14	14.67
Thidiazuron 10 ppm	4.62 (12.41)	5.16 (13.12)	27.79	30.15	37.53	38.23	3.09	2.87	29.48	27.65	10.48	15.61
Thidiazuron 20 ppm	5.13 (13.09)	5.74 (13.86)	28.92	29.48	35.37	39.02	3.30	2.98	32.02	28.81	10.08	15.01
Thidiazuron 30 ppm	7.37 (15.75)	8.06 (16.49)	30.58	31.70	32.74	36.56	3.38	3.14	31.29	27.69	9.88	15.34
Hand thinning 10%	10.38 (18.79)	11.04 (19.40)	33.81	34.14	46.95	47.68	3.88	3.41	36.77	34.55	9.70	13.42
Hand thinning 20%	19.81 (26.42)	20.68 27.04)	43.08	42.15	47.72	47.97	3.95	3.69	38.45	35.32	8.42	12.01
Hand thinning 30%	29.94 (33.16)	30.21 (33.33)	49.89	48.64	51.23	50.13	3.99	3.72	39.77	36.04	8.08	11.36
Control (no thinning)	4.04 (11.59)	3.98 (11.50)	26.54	24,56	39.97	41.05	2.31	2.32	26.74	24.67	12.20	16.53
$CD_{(0.05)}$	2.56	3.39	2.03	3.14	0.83	0.96	0.28	0.32	5.87	4.25	1,52	1.64

Figures in parenthesis are Arc Sin transformed values

significantly higher fruitlet thinning as compared to control. Ethylene is known to promote abscission of leaves and fruits (Carns, 2) by increasing the activity of cellulose at abscission zone and weakens the cell wall and leads to abscission (Monselise, 8) of fruits. These findings are in line with those of Morini *et al*. (9), who reported that ethrel at 250 and 500 ppm applied before pit hardening resulted in optimum fruit thinning in peaches. Exogenous application of NAA may increase auxin in seeds to supra-optimal level, which interfere in the development of embryo and endosperm (Krishnamoorthy, 5) and stimulate ethylene evolution (Zhu, 12) causing abscission of young fruitlets. An increase in ethylene production preceding abscission might hamper the polar auxin transport from seeds down through the stalk and cause fruitlet abscission. Earlier, Sharma *et al*. (10) also found that NAA at 40 ppm caused optimum fruit thinning in July Elberta peach.

Both manual and chemical thinning significantly increased shoot growth, tree volume and leaf area. Trees sprayed with 60 ppm NAA attained the highest shoot growth, tree volume and leaf area during both the years. Hand thinning to the intensity of 30 per cent and ethrel application at 200 and 300 ppm also increased vegetative growth as compared to control. Fruits are the greater metabolic sink and heavy crop load in control trees may reduce vegetative growth because of competition for metabolites among these sinks. The reduction in crop load in both chemical and hand thinning might have channelized the supply of more photosynthates and nutrients to the developing shoots thus causing vigorous growth. Total yield per tree decreased with the increase in severity of hand thinning and with the increase in concentration of growth regulators.

The highest total yield (12.20 and 16.53 kg/ tree during 2009 and 2010) was recorded in control, which, however produced lowest percentage of 'A' and 'B' grade fruits. Similarly, the total yield was not affected by lower concentrations of 10 and 20 ppm thidiazuron, but was significantly reduced with higher concentration of 30 ppm in comparison to control. Lesser fruit thinning and more number of fruits in 20 and 30 ppm thidiazuron treatments may account for higher yield. Jindal *et al*. (6) also found that thidiazuron resulted in lesser fruit thinning as compared to ethrel and NAA treatments in kiwifruit. Trees sprayed with 300 ppm ethrel produced significantly higher percentage of 'A' grade fruits (49.8 and 52.5% during 2009 and 2010, respectively) and lower percentage of 'C' grade fruits without any adverse effect on total yield (Fig. 1). This treatment lead to optimum thinning and retention of optimum crop load (Table 1), which resulted in the higher production of better size and A grade fruits due to less competition among developing fruits for nutrients and metabolites. Sharma *et al.* (10) also obtained higher proportion of 'A' grade fruits in peaches following 200 and 300 ppm ethrel spray.

Data in Table 2 showed significant variation in fruit size and weight under thinning treatments. Fruit size and weight increased with the increase in intensity of thinning. The maximum fruit size and weight was recorded in 300 ppm ethrel treatment during

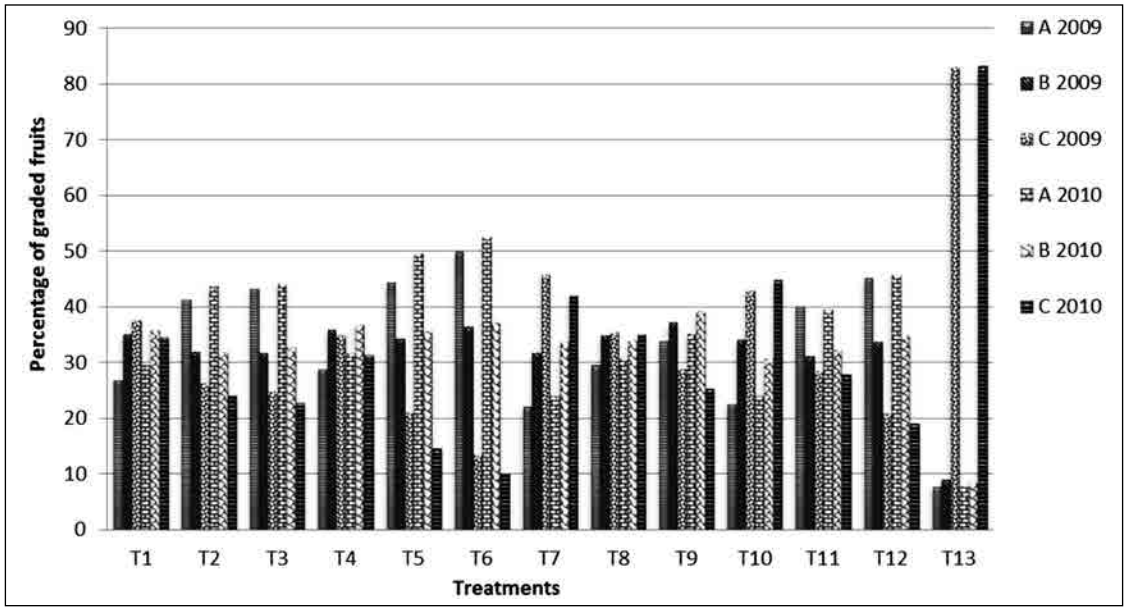

Fig. 1. Effect of chemical and manual thinning on proportion of different grade fruits in nectarine.

Table 2. Effect of chemical and manual thinning on physico-chemical characteristics of nectarine fruits and net benefits.

Treatment	Fruit length (cm)		Fruit breadth (cm)		Fruit weight (g)		Pulp: stone ratio		TSS (°B)		Acidity (%)		Total sugars (%)		Reducing sugar (%)		Net benefit (Rs./tree)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
NAA 20 ppm	5.19	5.24	4.28	4.29	67.31	69.63	9.65	9.78	12.67	12.61	0.41	0.39	9.04	9.12	3.43	3.48	477	810
NAA 40 ppm	5.74	5.81	5.11	5.23	78.15	80.12	10.97	10.81	12.87	12.92	0.39	0.37	9.34	9.46	3.54	3.59	522	801
NAA 60 ppm	5.83	5.88	5.20	5.29	80.10	84.63	11.43	11.62	12.90	12.96	0.34	0.31	9.42	9.52	3.55	3.60	497	788
Ethrel 100 ppm	5.82	5.79	5.11	5.12	78,70	79.85	11.23	11.40	13.33	12.87	0.39	0.38	9.14	9.24	3.49	3.54	576	836
Ethrel 200 ppm	5.97	6.04	5.12	5.23	86.46	89.04	12.17	12.68	14.17	14.09	0.37	0.37	9.45	9.58	3.54	3.58	635	965
Ethrel 300 ppm	6.06	6.27	5.61	5.68	89.90	92.75	12.52	12.96	14.23	14.31	0.36	0.33	9.48	9.64	3.68	3.71	668	982
Thidiazuron 10 ppm	5.58	5.54	5.15	5.12	68.50	72.10	9.13	9.37	12.17	12.21	0.46	0.48	9.06	9.19	3.06	3.13	522	807
Thidiazuron 20 ppm	5.33	5.38	4.67	4.96	61.00	66.41	9.38	9.61	11.87	12.23	0.40	0.44	8.12	8.23	3.17	3.19	546	824
Thidiazuron 30 ppm	5.70	5.69	5.36	5.08	74.94	76.08	9.60	9.89	11.17	12.28	0.35	0.36	8.30	8.39	3.21	3.26	561	900
Hand thinning 10%	5.74	5.79	5.05	5.12	76.70	77.36	9.44	9.48	12.67	12.58	0.45	0.40	8.24	8.35	3.22	3.25	490	673
Hand thinning 20%	5.79	5.77	5.08	5.09	84.74	85.71	11.88	10.76	12.72	12.81	0.38	0.41	8.85	9.01	3.45	3.50	490	607
Hand thinning 30%	5.89	5.90	5.15	5.18	87.30	86.90	12.27	11.54	13.10	13.26	0.41	0.40	9.06	9.30	3.56	3.60	476	706
Control (no thinning)	4.31	4.34	4.16	4.26	49.47	50.18	8.88	9.13	10.93	10.84	0.61	0.58	8.05	8.17	2.28	2.35	174	673
$CD_{(0.05)}$	0.67	0.81	1.18	0.96	7.88	6.05	0.27	0.34	0.70	0.86	0.25	0.28	0.60	0.56	0.15	0.12	-	-

both the year of study. NAA at 40 and 60 ppm and hand thinning to the intensity of 20 and 30 per cent also significantly increased fruit size and weight as compared to control. Increased fruit size and weight under thinning treatments can be attributed to less crop load and higher leaf to fruit ratio, which resulted in translocation of assimilates and nutrients to the remaining fruits after thinning. Sharma *et al.* (10) also observed that both manual and chemical thinning reduced crop load and improved size and weight of peaches. Thidiazuron at higher concentration (30 ppm) significantly increased size and weight of fruits in comparison to control. Thidiazuron stimulate endogenous cytokinin biosynthesis and increased level of natural cytokinin (Mok *et al.*, 7), which might have increased fruit size and weight due to increased cell division.

The highest pulp to stone ratio was recorded in 300 ppm ethrel treatment, which can be attributed due to increased fruit size. Dhiman (3) found significant increase in pulp to stone ratio of apricot with the foliar spray of ethrel. Significant variation in respect of total soluble solids, titratable acidity and sugar contents was recorded under different thinning treatments (Table 2). Ethrel at 200 and 300 ppm and NAA at 40 and 60 ppm resulted in significantly higher TSS, total and reducing sugars, and lower acidity as compared to control during both the years. This may be attributed to increased translocation of organic metabolites from leaves to fruits. These findings are inconformity with those of Sharma *et al.* (10), who also observed that post-bloom spray of ethrel and NAA increased TSS and sugars and decreased acidity in peaches. Results of economic viability of different thinning treatments indicated that fruit thinning with 300 ppm ethrel gave highest net benefit as compared to other treatments and control. The higher benefit may be due to more production of 'A' grade fruits, which have higher market price.

In conclusion, the present study showed that spray of 300 ppm ethrel induced optimum fruit thinning, gave high yield of "A" grade fruits of better size and quality. On the basis of economic feasibility of applied treatments, 300 ppm ethrel was found to be the most economical treatment, which gave highest net benefit.

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