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Effect of chemical thinning, gibberellic acid and pruning on growth and production of nectarine (*Prunus persica* (L.) Batsch var. *nucipersica*) cv. May fire

Rimpika*, N. Sharma and D.P. Sharma

Department of Fruit Science, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan-173230 (H.P.), INDIA

*Corresponding author. E-mail: rimpikathakur@yahoo.in

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Abstract: The present investigation was carried out on 12-year old trees of nectarine (*Prunus persica* (L.) Batsch var. *nucipersica*) cultivar May Fire raised on wild peach seedling rootstocks, Farmer's orchard at Kotla- Barog in District Sirmour during the years 2014 and 2015. In this experiment, experimental trees were subjected to seventeen different treatments;$T_{1:}$ Pruning to retain 60 fruiting shoots tree^{-1} (control), $T_{2:}$ Pruning to retain 50 fruiting shoots tree^{-1}, $T_{3:}$ Pruning to retain 40 fruiting shoots tree^{-1} ,$T_{4:}$ NAA 40 ppm, 2 WAPF (week after petal fall) ,$T_{5:}$ Ethrel 300 ppm, 2 WAPF, $T_{6:}$ GA_3 100 ppm, 4 WAPF, $T_{7:}$ GA_3 200 ppm, 4WAPF, $T_{8:}$ GA_3 100 ppm, 6 WAPF $T_{9:}$ GA_3 200 ppm, 6 WAPF, $T_{10:}$ Pruning to retain 50 fruiting shoots tree^{-1} + NAA 40 ppm (T_4), $T_{11:}$ Pruning to retain 50 fruiting shoots tree^{-1} + Ethrel 300ppm (T_5), $T_{12:}$ Pruning to retain 50 fruiting shoots tree^{-1} + $GA_3$100 ppm (T_6), $T_{13:}$ Pruning to retain 50 fruiting shoots tree^{-1} + GA_3 100 ppm (T_8),$T_{14:}$ Pruning to retain 40 fruiting shoots tree^{-1} + NAA 40 ppm (T_4), $T_{15:}$ Pruning to retain 40 fruiting shoots tree^{-1} +Ethrel 300 ppm (T_5),$T_{16:}$ Pruning to retain 40 fruiting shoots tree^{-1} + GA_3 100 ppm (T_6), $T_{17:}$ Pruning to retain 40 fruiting shoots tree^{-1} + GA_3 100 ppm (T_8), pertaining to alternative approach to chemical thinning, chemical thinner were more effective in improving the production of superior grade fruits than reducing the crop load directly by pruning or indirectly by GA3 (Gibberellic Acid) treatments. Treatments with NAA (naphthalene acetic acid**)** at 40 ppm when applied two weeks after petal fall reduced the crop load to the greatest extent and improve the yield of superior grade fruits and increase the leaf to fruit ratio and decrease the fruit drop. Pruning to retain 40 fruiting shoots tree^{-1} + NAA 40 ppm, 2WAPF increased the shoot growth (160.80, 170.20cm), tree height (3.70,4.50 cm), tree spread (2.84,3.60), leaf area (42.71, 40.63cm) during both the year. However, effect of chemical were less pronounced on trees subjected to severe pruning.

Keywords: Growth, Nectarine, Pruning, Production, Thinning

INTRODUCTION

Nectarines [*Prunus persica* (L.) Batsch var. *nucipersica*] are the group of peaches having a smooth skin, often referred as "fuzzy-less peaches" or "shaven peaches" due to lack of fuzz or short hair on the fruit surface. The absence of fuzz (pubescence) on the nectarine fruit surface fundamentally is the only difference between peach and nectarine, though fuzzy peaches and nectarines are regarded commercially as different fruits. Several genetic studies have concluded that nectarines are created due to a recessive gene, whereas in peach fuzziness is controlled by the dominant gene. May Fire is one of the most important among the different cultivars of nectarine grown in Chamba, Mandi, Solan, Shimla and Kangra districts of Himachal Pradesh. Its fruit is an early maturing, attractive coloured, medium sized; having smooth skin of green to white with deep red over colour. Fruit thinning is an important cultural practice to remove excessive fruit-lets from trees (Rimpika *et al*., 2015) and one of the most effective measures to improve fruit size, and next season's flower bud initiation, colour and quality at harvest, and increases return bloom the following year, thereby reducing alternate bearing. Performance of nectarine trees depends heavily on the annual pruning. In terms of pruning, both peach and nectarines can be treated in the same way as their flowering and fruiting habits are the same. The nectarine fruits are born on one year old shoot which becomes barren afterwards and no flower bud differentiation or subsequent fruit formation takes place in this part of the branch. If the trees are not pruned annually, the volume of fruiting wood reduces each year and the fruiting shoot move higher and higher getting out of reach. The unpruned trees are often subjected to overcrowding between the trees in close planting, exhibiting reduction in productivity and fruit quality. Hence, proper pruning is quite instrumental in regulating the tree vigour, fruit quality and productivity potential in nectarine plants. Pruning can be looked upon as an "early" fruit-thinning practice. This technique is espe-

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cially attractive in peach/nectarine varieties having tendency to bear copiously. Fruiting shoot removal can be attained by either thinning cuts or heading cuts. Thinning cuts are preferred with respect to fruit bearing hangers since they are less likely to produce a vigorous growth response. In a comparison of thinning cuts to reduce crop load in nectarine, heading cuts reduced fruit size and delayed color and maturity. In "July Elberta" peach pruning to retain 40 fruiting shoots (600 nodes) per tree, each headed back to 15 nodes increased the production of superior grade fruits (Shukla *et al.,* 2007).

Gibberellins have been widely studied for use in reducing flower numbers in both stone and pome fruit. Gibberellin application is thought to inhibit flower bud development during the inductive period (late May through July in stone fruit), however, only the higher concentration of GA_3 was effective in reducing the floral to vegetative bud ratio and decreasing the return bloom in peach (Autio and Krupa, 2012).

Keeping in views of these points, the present study studies were undertaken on crop regulation in nectarine (*P. persica* (L.) Batsch var. *nucipersica*) cv. May Fire by employing chemical thinning and alternate approaches with the objective to study the effects of chemical fruit thinning, gibberellic acid and pruning on crop load and growth and production of nectarine.

MATERIALS AND METHODS

Experiment was conducted on 12-year-old trees of nectarine (*P. persica* (L.) Batsch var. *nucipersica*) cultivar May Fire raised on wild peach seedling rootstocks at the Farmer's orchard at Kotla-Barog in District Sirmour during the years 2014 and 2015. Trees at these sites were spaced 3 × 3 meters apart and trained as open centres. Fifty one uniform trees were selected at each location and subjected to seventeen treatments with three replications in a Randomized Block Design. Experimental trees kept under uniform cultural practices during the entire course of investigation. Initial and final fruit set were recorded on five randomly selected branches on each tree at petal fall and 30 days after petal fall and per cent fruit thinning was calculated by

Thinning percentage = Initial fruit set - Final fruit set/ Initial fruit set × 100 -------------(1)

The average length of annual shoots was measured with measuring tape at the end of growing period. The tree height was measured in meter (m) with the help of graduated flag staff and tree spread was measured in meter (m) in two directions (East-West and North-South). These measurements were recorded, once before the start of the experiment in January and again after the end of growing season. On each experimental tree, the number of flowers on four branches each with four fruiting shoots was counted and the cross sectional area of these branches in square centimeters was recorded. From these observations, the blooming intensity was determined as per formula given below:

Blooming intensity = Number of flower per branch/ Cross sectional area of branch ×100 ----------------(2)

The blooming intensity was expressed as number of flower/ cm^2branch cross sectional area. The results were expressed in percentage.

The leaf area was measured with the help of Automatic Leaf Area Meter (Licor Model 3100). Leaf/fruit ratio was worked out by dividing the total number of leaves with total number of fruits on five randomly selected shoots on each tree. The fruit drop was worked out by subtracting the number of fruit retained at harvest from

Table 1. Effect of chemical thinning, gibberellic acid and pruning on percent fruit thinning in nectarine cv. May fire.

Treatment		Fruit thinning (%)	
		2014	2015
T_1	Pruning to retain 60 fruiting shoots tree^{-1} (control)	22.22(28.06)	16.58(24.00)
T_2	Pruning to retain 50 fruiting shoots tree^{-1}	20.33 (26.78)	15.20(22.88)
T_3	Pruning to retain 40 fruiting shoots tree^{-1}	17.87(24.77)	13.49(21.47)
T_4	NAA 40 ppm, 2 WAPF	50.42 (45.24)	43.54(41.28)
T_5	Ethrel 300 ppm, 2 WAPF	44.58 (41.89)	36.89(37.39)
T_6	GA_3 100 ppm, 4 WAPF	20.38 (26.61)	15.51(23.61)
T_7	GA_3 200 ppm, 4WAPF	21.20 (27.00)	16.15(23.71)
T_8	GA_3 100 ppm, 6 WAPF	21.75 (27.75)	15.38(22.37)
T_9	GA_3 200 ppm, 6 WAPF	22.10(28.04)	15.47(22.79)
T_{10}	Pruning to retain 50 fruiting shoots tree^{-1} + NAA 40 ppm (T_4)	42.10 (40.44)	28.28(32.07)
T_{11}	Pruning to retain 50 fruiting shoots tree^{-1} + Ethrel 300ppm (T_5)	41.73 (40.19)	26.18(30.68)
T_{12}	Pruning to retain 50 fruiting shoots tree^{-1} + $GA_3$100 ppm (T_6)	18.88 (25.89)	14.30(20.42)
T_{13}	Pruning to retain 50 fruiting shoots tree^{-1} + GA_3 100 ppm (T_8)	19.29 (26.62)	13.34(18.84)
T_{14}	Pruning to retain 40 fruiting shoots tree^{-1} + NAA 40 ppm (T_4)	40.90 (39.73)	27.98(31.86)
T_{15}	Pruning to retain 40 fruiting shoots tree^{-1} +Ethrel 300 ppm (T_5)	40.71 (39.64)	26.09(30.69)
T_{16}	Pruning to retain 40 fruiting shoots tree^{-1} + GA_3 100 ppm (T_6)	16.14 (23.95)	13.34(21.91)
T_{17}	Pruning to retain 40 fruiting shoots tree^{-1} + GA_3 100 ppm(T_8)	15.06(22.38)	12.77(20.78)
$CD_{0.05}$		3.44	4.98

Figures in the parentheses are Arc sine transformed values.

number of fruits at final set and dividing the difference with number of fruits at final set and multiplying with 100. At harvest, graded fruits yield was recorded as "A grade"(>50 mm) "B grade" (45 to 49 mm) and "C grade" (<45 mm) and expressed as percentage of total yield.

RESULTS AND DISCUSSION

The perusal of data (Table 1) reveals that fruit thinning percentage of nectarine (*P. persica* (L.) Batsch var. *nucipersica*) was significantly influenced by different treatments, during both the years of study. In the years 2014, the values of fruit thinning varied greatly among the treatments from 15.06 to 50.42 per cent. The maximum fruit thinning (50.42%) was recorded in the T_4 (NAA 40ppm), which was however, statistically at par with the treatment T_5 (Ethrel 300 ppm). The minimum fruit thinning (15.06%) was recorded in T_{17} (pruning to retain 40 fruiting shoots tree^{-1} + GA_3 100 ppm), which was however, statistically at par with the treatments T_{16} and T_3, but significantly lower than the other treatments.

During the year 2015, the fruit thinning values varied from 12.77 to 43.54 per cent under different treatments. The maximum fruit thinning (43.54%), was recorded in the T_4 (NAA 40ppm), which was however, statistically at par with the treatment T_5 (Ethrel 300 ppm). The fruit thinning percentage was observed lowest (12.77%) in T_{17} (pruning to retain 40 fruiting shoots tree^{-1} + GA_3 100 ppm) which was however, statistically at par with the treatments T_1, T_2, T_3, T_6, T_7, T_8, T_9, T_{12} , T_{13} and T_{16} .

In the present study, different chemical thinning treatments exerted a significant effect on per cent fruit thinning. The results with respect to NAA effects on fruit thinning in the present study are in line with the earlier findings that NAA applied two weeks after petal fall induced optimum thinning in nectarine [*P. persica* (L.) Batsch var. *nucipersica*] (Rimpika *et al.*, 2015). The detachment of fruits encompasses the formation of anatomically distinct separation layer which facilitate abscission by cell wall changes due to hydrolysis or dissolution of middle lamella which causes the loss of cementing effectiveness between adjacent cell wall (Ouma, 2010). Earlier studies also demonstrated that post bloom application of ethephon induced fruit thinning in peaches (Sharma *et al.* 2003).

The shoot growth, tree height and spread (Table 2) were recorded significantly higher in trees under the treatment T_{14} (pruning to retain 40 fruiting shoots tree^{-1} + NAA 40 ppm) than all other treatments in both the years of study. Thus, during the course of present study, higher increase in tree height and spread in this treatment seems quite obvious and predictable. Earlier, the increase in shoot growth, tree height and spread with the increase in the severity of pruning has been reported in peach (Hassani and Rezaee, 2007). Further, severe pruning treatments might result in greater availability of photosynthates and nutrients, which in turn enhance cell division and formation of more tissues and consequently vegetative growth (Bussi *et al.,* 2005).

In the year 2014, the maximum flower intensity (72.50%) was however, observed in (Table3) treatment T_1 (pruning to retain 60 fruiting shoots tree^{-1}), which was statistically at par with the treatments T_4, T_5, T_6, T_7, T_8 and T_9. The minimum flower intensity was observed in the treatment T_3 (pruning to retain 40 fruiting shoots tree^{-1}), which was, however statistically at par with all other treatments except T_4,T_5,T_6,T_7,T_8 and T_9.

Table 2. Effect of chemical thinning, gibberellic acid and pruning on shoot growth, tree height and spread of nectarine.

Treatment		Shoot growth (cm)		Tree height (m)		Tree spread (m)	
		2014	2015	2014	2015	2014	2015
T_1	Pruning to retain 60 fruiting shoots tree^{-1} (control)	110.50	120.00	3.00	3.40	2.28	2.80
T_2	Pruning to retain 50 fruiting shoots tree^{-1}	152.50	160.40	3.60	4.15	2.75	3.45
T_3	Pruning to retain 40 fruiting shoots tree^{-1}	156.00	165.70	3.65	4.20	2.78	3.50
T_4	NAA 40 ppm, 2 WAPF	150.00	158.40	3.60	4.00	2.70	3.40
T_5	Ethrel 300 ppm, 2 WAPF	140.00	145.00	3.30	3.70	2.48	3.00
T_6	GA_3 100 ppm, 4 WAPF	130.00	138.00	3.29	3.80	2.51	3.10
T_7	GA_3 200 ppm, 4WAPF	136.20	145.00	3.30	3.90	2.52	3.15
T_8	GA_3 100 ppm, 6 WAPF	134.20	142.60	3.36	3.95	2.50	3.25
T_9	GA_3 200 ppm, 6 WAPF	138.20	148.70	3.38	3.75	2.53	3.20
T_{10}	Pruning to retain 50 fruiting shoots tree^{-1} + NAA 40 ppm (T_4)	154.80	160.00	3.62	4.30	2.76	3.25
T_{11}	Pruning to retain 50 fruiting shoots tree^{-1} + Ethrel 300ppm (T_5)	142.50	145.80	3.50	3.76	2.51	3.00
T_{12}	Pruning to retain 50 fruiting shoots tree^{-1} + $GA_3$100 ppm (T_6)	138.50	150.30	3.39	3.90	2.53	3.10
T_{13}	Pruning to retain 50 fruiting shoots tree^{-1} + GA_3 100 ppm (T_8)	140.30	152.70	3.38	3.95	2.54	3.15
T_{14}	Pruning to retain 40 fruiting shoots tree^{-1} + NAA 40 ppm (T_4)	160.80	170.20	3.70	4.50	2.84	3.60
T_{15}	Pruning to retain 40 fruiting shoots tree^{-1} +Ethrel 300 ppm (T_5)	138.20	155.60	3.35	3.70	2.50	3.10
T_{16}	Pruning to retain 40 fruiting shoots tree^{-1} + GA_3 100 ppm (T_6)	135.20	147.30	3.40	4.00	2.60	3.30
T_{17}	Pruning to retain 40 fruiting shoots tree^{-1} + GA_3 100 ppm(T_8)	138.50	150.00	3.41	4.10	2.62	3.35
$CD_{0.05}$		4.24	1.71	0.28	0.29	0.30	0.20

Table 3. Effect of chemical thinning, gibberellic acid and pruning on flower intensity, leaf area and leaf to fruit ratio in nectarine.

Treatment		Flower intensity (%)		Leaf area (cm^2)		Leaf to fruit ratio	
		2014	2015	2014	2015	2014	2015
T_1	Pruning to retain 60 fruiting shoots $tree^{-1}$ (control)	72.50(58.38)	64.20(53.27)	30.62	28.60	25.50	23.73
T_2	Pruning to retain 50 fruiting shoots $tree^{-1}$	65.07(53.81)	58.72(50.04)	38.20	36.29	36.34	33.20
T_3	Pruning to retain 40 fruiting shoots $tree^{-1}$	63.09(52.62)	52.39(46.38)	40.10	38.78	38.41	35.70
T_4	NAA 40 ppm, 2 WAPF	72.18(58.19)	65.75(54.22)	38.50	36.50	42.60	37.62
T_5	Ethrel 300 ppm, 2 WAPF	72.30(57.03)	64.40(53.39)	35.70	33.52	37.60	34.72
T_6	GA_3 100 ppm, 4 WAPF	72.40(58.37)	62.69(52.38)	30.70	32.71	26.78	31.62
T_7	GA_3 200 ppm, 4WAPF	71.69(57.89)	60.32(50.98)	31.72	33.62	26.70	31.38
T_8	GA_3 100 ppm, 6 WAPF	72.39(58.43)	62.42(52.22)	32.60	34.51	27.68	32.33
T_9	GA_3 200 ppm, 6 WAPF	72.45(58.82)	60.10(50.85)	33.00	35.21	28.62	34.32
T_{10}	Pruning to retain 50 fruiting shoots $tree^{-1}$ + NAA 40 ppm (T_4)	64.10(53.21)	64.48(53.44)	40.19	39.18	38.63	35.82
T_{11}	Pruning to retain 50 fruiting shoots $tree^{-1}$ + Ethrel 300ppm (T_5)	65.21(53.89)	63.72(52.98)	36.79	34.71	37.60	35.70
T_{12}	Pruning to retain 50 fruiting shoots $tree^{-1}$ + $GA_3$100 ppm (T_6)	65.45(54.04)	52.48(46.43)	36.57	34.54	34.68	33.62
T_{13}	Pruning to retain 50 fruiting shoots $tree^{-1}$ + GA_3 100 ppm (T_8)	66.29(54.53)	50.82(45.47)	39.50	35.40	35.66	32.61
T_{14}	Pruning to retain 40 fruiting shoots $tree^{-1}$ + NAA 40 ppm (T_4)	62.11(52.04)	55.62(48.24)	42.71	40.63	38.41	36.80
T_{15}	Pruning to retain 40 fruiting shoots $tree^{-1}$ +Ethrel 300 ppm (T_5)	62.42(52.60)	54.72(47.72)	38.74	34.02	38.52	35.62
T_{16}	Pruning to retain 40 fruiting shoots $tree^{-1}$ + GA_3 100 ppm (T_6)	62.44(52.21)	50.72(45.42)	37.52	35.29	36.61	33.63
T_{17}	Pruning to retain 40 fruiting shoots $tree^{-1}$ + GA_3 100 ppm(T_8)	63.10(52.61)	49.72(44.84)	38.06	35.32	37.52	34.61
$CD_{0.05}$		2.83	0.43	2.03	5.27	3.60	4.71

In next year, the maximum flower intensity was observed significantly higher in the treatmentT_4 (65.75%) in comparison to all the other treatments. The flowering intensity was however, recorded significantly least (49.72%) in the treatment T_{17} (pruning to retain 40 fruiting shoot/tree + GA_3 100 ppm, shoots $tree^{-1}$). The treatments T_{13} (pruning to retain 50 fruiting shoots $tree^{-1}$+ GA_3 100 ppm, applied 4 WAPF) and T_{16} (pruning to retain 40 fruiting shoots $tree^{-1}$+ GA_3 100 ppm, applied 4 WAPF) also decreased the flower intensity over the control, which were however, statistically at par with each other, in respect of this attribute. Gibberellin has an inhibitory role in flowering in fruit crops. Treatment with gibberellic acid can significantly reduce bloom in the following year and the reduction in the number of flower buds (Autio and Krupa, 2012).

It is evident from different treatments had a significant effect on the leaf to fruit ratio in comparison to control (T_1). In the year 2014, leaf to fruit ratio was recorded significantly higher in the treatment T_4 (42.60:1) than all the other treatments. The least leaf to fruit ratio (25.50:1) was observed in control (T_1) which was however, statistically at par with the treatments T_6, T_7, T_8 and T_9. The average leaf area (Table 3) was significantly affected by different thinning treatments. The largest value pertained to the trees subjected to the treatment T_{14} (pruning to retain 40 fruiting shoots $tree^{-1}$ + NAA 40 ppm) and the minimum leaf area was found in the treatment T_1 (pruning to retain 60 fruiting shoots $tree^{-1}$) during both the years.

Present results revealed that average leaf area was increased greatly by pruning to retain 40 fruiting shoots $tree^{-1}$ (T_3) and NAA treatments. Heavy pruning severity reduces the number of vegetative buds that are likely to develop into new shoots, thereby, reducing the competition for carbohydrates and other metabolites and consequently might favour leaf growth (Hassani and Rezaee, 2007).

In the year 2015, highest leaf to fruit ratio (37.62:1) was recorded in the treatment T_4 (Table 3) which was however, statistically at par with all the other treatments, except T_1,T_6,T_7,T_8 and T_{13}. However, the leaf to fruit ratio was observed significantly least (23.73:1) in the treatment T_1 (control).

The present study revealed that different treatments significantly influenced the leaf to fruit ratio in nectarine. The results on increased the leaf to fruit ratio under NAA and Ethrel treatments have been discussed in Experiment I. In this study, the resultant positive effect on this attribute with the decrease in fruiting shoot in T_4 seems clearly understandable and are in accordance with the earlier findings (Sharma *et al.,* 2003) that reduction in the number of fruiting shoots increased the leaf/fruit ratio in peach.

However, the minimum fruit drop (2.30, 4.20% in 2014 and 2015, respectively) was recorded in the treatment T_4 (NAA 40 ppm applied 2 WAPF), which was however, statistically at par with the treatments T_5 (Ethrel 300 ppm) in both the years (Table 4). The remaining treatments also decreased the fruit drop significantly when compared with T_1 (control). As discussed in Experiment I, post petal fall application of NAA though caused abscission of young fruitlets, but decreased the drop of the remaining fruits until harvest. In recent studies, Ethrel when applied as fruit let thinner decreased the fruit drop in nectarine cultivars May Fire (Rimpika *et al*., 2014).

In the year 2014, the production of “A” grade fruits was significantly (Table 5) higher in the treatment T_4 (38.73%), in comparison to all other treatments. Treatments with Ethrel at 300 ppm (T_5), heavier pruning alone (T_2 & T_3) or in combination with NAA and Ethrel also recorded appreciable increase in the proportion of “A” grade fruits over the control. The production of “A” grade fruits was significantly lower in control (15.00%) in comparison to all the remaining

Table 4. Effect of chemical thinning, gibberellic acid and pruning on fruit drop, A grade fruits, B grade fruits and C grade fruits in nectarine cv. May fire.

Treatment		Fruit drop (%)		A grade fruits (%)		B grade fruits (%)		C grade fruits (%)	
		2014	2015	2014	2015	2014	2015	2014	2015
T_1	Pruning to retain 60 fruiting shoots $tree^{-1}$ (control)	5.20	7.40	15.00 (18.88)	8.00 (2.98)	25.00 (28.56)	15.00 (18.00)	60.20 (65.30)	77.00 (65.42)
T_2	Pruning to retain 50 fruiting shoots $tree^{-1}$	2.70	4.60	32.11 (34.89)	21.83 (4.87)	37.34 (38.87)	34.77 (35.92)	30.55 (32.31)	43.40 (41.51)
T_3	Pruning to retain 40 fruiting shoots $tree^{-1}$	2.60	4.50	34.84 (36.17)	25.28 (5.16)	38.73 (39.71)	36.00 (36.27)	26.38 (27.87)	37.33 (37.95)
T_4	NAA 40 ppm, 2 WAPF	2.30	4.20	38.73 (39.71)	28.88 (5.37)	41.50 (40.11)	38.38 (39.45)	19.77 (20.71)	32.74 (34.94)
T_5	Ethrel 300 ppm, 2 WAPF	2.40	4.30	34.18 (35.78)	26.69 (5.31)	40.82 (39.71)	35.78 (36.74)	25.00 (27.09)	37.53 (38.77)
T_6	GA_3 100 ppm, 4 WAPF	3.70	4.90	15.77 (18.90)	18.00 (4.87)	25.48 (28.34)	28.42 (30.45)	58.75 (55.75)	53.58 (50.17)
T_7	GA_3 200 ppm, 4WAPF	3.60	4.80	16.20 (17.23)	18.16 (4.37)	25.39 (28.90)	27.52 (28.21)	58.41 (55.51)	54.32 (52.09)
T_8	GA_3 100 ppm, 6 WAPF	4.80	4.85	15.64 (17.60)	18.09 (4.25)	25.55 (28.60)	28.34 (30.67)	58.81 (56.89)	53.57 (51.65)
T_9	GA_3 200 ppm, 6 WAPF	4.65	4.75	16.45 (18.48)	18.22 (4.26)	25.37 (28.68)	29.22 (30.95)	58.18 (55.90)	52.56 (50.53)
T_{10}	Pruning to retain 50 fruiting shoots $tree^{-1}$ + NAA 40 ppm (T_4)	2.50	4.35	37.55 (38.40)	27.22 (5.80)	38.74 (38.49)	37.44 (38.81)	23.71 (25.74)	35.34 (36.06)
T_{11}	Pruning to retain 50 fruiting shoots $tree^{-1}$ + Ethrel 300ppm (T_5)	2.55	4.50	34.70 (36.09)	23.33 (4.82)	37.26 (37.62)	36.66 (37.20)	28.04 (31.97)	40.01 (39.07)
T_{12}	Pruning to retain 50 fruiting shoots $tree^{-1}$ + $GA_3$100 ppm (T_6)	3.65	4.45	31.32 (27.03)	22.88 (4.78)	35.35 (36.48)	24.66 (25.20)	39.33 (40.65)	57.56 (54.02)
T_{13}	Pruning to retain 50 fruiting shoots $tree^{-1}$ + GA_3 100 ppm (T_8)	3.50	4.50	30.53 (28.28)	23.85 (4.77)	36.63 (37.44)	25.16 (26.76)	36.84 (38.95)	55.00 (53.84)
T_{14}	Pruning to retain 40 fruiting shoots $tree^{-1}$ + NAA 40 ppm (T_4)	2.45	4.35	37.86 (38.43)	27.35 (5.93)	38.94 (39.71)	37.00 (38.00)	23.20 (25.71)	35.00 (37.67)
T_{15}	Pruning to retain 40 fruiting shoots $tree^{-1}$ +Ethrel 300 ppm (T_5)	2.60	4.45	32.36 (35.06)	23.33 (4.82)	37.26 (37.62)	36.88 (37.58)	30.38 (33.43)	40.79 (39.92)
T_{16}	Pruning to retain 40 fruiting shoots $tree^{-1}$ + GA_3 100 ppm (T_6)	3.30	4.70	33.08 (29.05)	26.50 (4.18)	35.50 (37.11)	26.95 (27.55)	37.41 (38.31)	54.15 (50.92)
T_{17}	Pruning to retain 40 fruiting shoots $tree^{-1}$ + GA_3 100 ppm(T_8)	3.40	4.75	34.18 (29.78)	27.85 (4.56)	37.18 (38.78)	27.82 (28.76)	34.64 (35.22)	51.30 (50.06)
$CD_{0.05}$		0.10	0.11	1.25	0.19	0.93	1.33	0.82	0.69

treatments except, T_6, T_7, T_8 and T_9.

During the year 2015, higher "A" grade fruit production (28.88%) was observed in the treatment T_4 (NAA 40 ppm), which was however, statistically at par with the treatments T_5, T_{10} and T_{14}. The minimum percentage of "A" grade fruits (8.00%) was observed in control trees, which was significantly lower than all other treatments. During the year 2014, the proportion of the "B" grade fruits (Table 4) was observed highest (41.50%) in the treatment T_4 (NAA 40 ppm), which was however, statistically at par with the treatments T_3, T_5 and T_{14}.

The lowest proportion of "B" grade fruits (25.00%) was found in the treatment T_1 (pruning to retain 60 fruiting shoots $tree^{-1}$), which was statistically at par with the treatments T_6, T_7, T_8 and T_9. In the year 2015, the highest "B" grade fruit yield was observed in the treatment T_4 (38.38%), which was however, statistically at par with the treatment T_{10}. The yield of "B" grade fruits (15.00%) was found significantly lower in the treatment T_1 (control) than all the other treatments.

In the year 2014, the yield of "C" grade fruit (Table 4) was noticed significantly highest (60.20%) in control. However, the proportion of "C" grade fruit was recorded significantly lowest (19.77%) in trees treated with NAA at 40 ppm (T_4). The remaining treatments also decreased the production of "C" grade fruit significantly over the control. During the year 2015, significantly highest (77.00%) "C" grade fruit yield was observed in the treatment T_1. However, the percentage of "C" grade fruits was observed significantly lowest (32.74%) in trees treated with NAA at 40 ppm (T_6).

Average fruit yield decreased significantly under different treatments when compared with control. However, when yield of graded fruits was taken into account in this study, the production of superior grade fruits was found to be significantly higher under different treatments in comparison to control. Trees under chemical thinning with NAA at 40 ppm produced appreciably higher proportion of "A'' and "B'' grade fruits, whereas, trees under control produced negligible amount of superior grade fruits. Exogenous application of NAA might stimulate ethylene evolution, causing abscission of young fruit-lets (Krishnamoorthy, 1981). The detachment of fruits encompasses the formation of anatomically distinct separation layer which facilitate abscission by cell wall changes due to hydrolysis or dissolution of middle lamella which causes the loss of cementing effectiveness between adjacent cell wall (Ouma *et al*., 2010). Subsequently there is dissolution of lamella and break down of all or parts of the cellulose cell wall and mechanically breakage of nonliving elements. The results are in conformity with the earlier findings that fruit thinning with NAA lead to a decrease in average yield and increase in the production of marketable fruits in peach (Sharma *et al.,* 2003) and nectarine (Rimpika *et al*., 2014). Robinson *et al.* (2006) also reported that lightly pruned trees recorded greater yield as compared to heavily pruned peach trees. In the present study, the reduction in the fruit yield following reduction in fruiting area in severely pruning treatments is clearly predictable. The production of three layer and four layer grade fruits was higher in the most heavily pruned trees whereas the trees with lighter pruning intensity produced higher proportion of loose grade fruits (Hua *et al*., 2006).

Conclusion

1) Treatments with NAA at 40 ppm when applied two weeks after petal fall reduced the crop load to the greatest extent and improve the yield of superior grade fruits and increase the leaf to fruit ratio and decrease the fruit drop.

2) Pruning to retain 40 fruiting shoots tree^{-1} + NAA 40 ppm, 2WAPF increased the shoot growth, tree height, tree spread, leaf area. However, effect of chemical were less pronounced on trees subjected to severe pruning.

3) May Fire cultivar of nectarine mature first week of may when no other fresh stone fruits are available in the market hence fetches high remunerative price to the growers. Keeping in view its earliness farmers of mid hills of Himachal Pradesh are increasing the plantations of this variety year after year.

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