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Investigations on Growth Behaviour of 'Kinnow'(Citrus Reticulata) Mother Plants Pruned at Different Intensities

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Abstract: A study was undertaken to investigate the effect of pruning intensity on vegetative growth of 'Kinnow'(*Citrus reticulata*) plants with vigorous and normal growth in mother block reserved for propagation purposes. Pruning improved shoot length and girth in both types of plants with better growth in plants with excellent growth. Similarly, number of leaves and buds per shoot were also recorded significantly higher in pruned plants as compared to un-pruned plants. Significantly higher number of leaves and buds were recorded in severely pruned plants with excellent growth and in lightly pruned plants with normal growth. Minimum number of leaves and buds were noted in unpruned plants. Chlorophyll-a and chlorophyll-b contents was also recorded higher in pruned plants as compared to unpruned plants in both vigorous and normal growth plants.

Key words: Growth · Girth · Leaves · Buds and Chlorophyll

INTRODUCTION

India is the sixth largest citrus producing country in the world. In Punjab, the citrus is a leading fruit crop with more than 64 per cent area of total fruit crops. Among citrus, 'Kinnow', a mandarin hybrid [King (*Citrus nobilis*) X willow leaf (*Citrus deliciosa*)] is the leading cultivar of state.

The major problem in citrus production is non-availability of quality planting material. To raise quality plant material of 'Kinnow', the most important step is to manage mother plants in such a way to get healthy bud wood with maximum number of buds for higher budding success. For this purpose, pruning is the best option for desirable outcome as well as management of plant canopy. Maximum vegetative growth in respect of spread and canopy volume was observed with heavy pruning and minimum being with un-pruned acid lime plants. It is indicated that the plant growth was increased with the increased severity of pruning [1]. Similar results were reported by Tayde and Ingle [2] in Nagpur mandarin. Heavy pruning in kumquat (*Fortunella margarita*) and calamondin (*Citrus microcarpa* Bunge) could induce vegetative growth of the first flush after pruning. The vegetative response of citrus to pruning depends on the date and intensity of pruning [3]. Pruning of vigorous orange trees in fall or winter resulted in less vigorous [4] and less fruitful [5] re-growth than trees pruned in spring. Little difference in vegetative response was found if 'Valencia orange' trees were hedged between spring and early summer [5]. Moore and Nauer [6] suggested that adequate regrowth was obtained by pruning from late winter to late summer. Bacon [5]reported that hedging time did not increase final flush length since the first flush that comes after hedging reaches a certain length independent of hedging time or time interval between hedging and re-growth. However, Fucik [7] reported that large branches pruned in March produced that longest shoots in July. The length of the second and third flushes following pruning was greater for branches pruned from spring to early summer than for branches pruned in fall [8].

Keeping in mind the importance of Kinnow mother plant for healthy bud wood availability, it was logical to study the effect of pruning on Kinnow mother plant growth dynamics and architecture and bud availability.

MATERIALS AND METHODS

Experiment Site and Treatment: The present investigations on were carried out in 'College Orchard', Department of Horticulture, Punjab Agricultural

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University, Ludhiana. The experiment was conducted on four year old plants spaced at 10 feetx10 feet distance. The Mother block of Kinnow was divided in two groups i.e. G_1 (vigorous /excellent growth) and G_2 (normal growth). Five pruning treatments with a viz. pruning of plants at 5 feet, 6 feet, 7 feet and 8 feet from the ground level along with topping of side branches were given to the experimental plants in last week of January to first week of February. Unpruned plants were kept as control. Total 90 experimental trees were selected randomly in this trial and the trial was laid out in the Randomized Block Design with Factorial arrangement. There were three replications with a unit of three plants in each replication.

The experimental plants in the Mother block were divided into two groups.

G_1 - Plants with vigorous /excellent growth
G_2- Plants with normal growth
T_1-Pruning of plants at 5 feet from the ground level along with topping of side branches
T_2- Pruning of plants at 6 feet from the ground level along with topping of side branches
T_3- Pruning of plants at 7 feet from the ground level along with topping of side branches
T_4-Pruning of plants at 8 feet from the ground level along with topping of side branches
T_5 -Control- no pruning

Physical Parameter Determination: Observations on shoot length and girth, number of leaves and buds per shoot were recorded from the experimental plants. For this purpose, shoots were selected randomly on one selected pruned branch in each direction of all the experimental plants. The length of these shoot and girth was measured from lower portion to tip of shoots with measuring tape.The number of leaves were counted in each selected branch. The fully developed green round buds were counted on these shoots, starting from lower portion of newly emerged shoots. All these observations were takenstarting from third week of February to August at monthly interval.

Chemical Analysis: For determination of Chlorophyll ‘a’ and ‘b’ content, ten leaves were collected randomly from newly emerged shoots on pruned branches from each direction of all experimental plants in each replication. The collected leaves were washed with distilled water and excess of water was removed by folding them in filter paper layer. Then the leaves were chopped into small pieces and 0.5g of fresh chopped leaves were taken randomly and homogenized thoroughly in 80% (v/v) aqueous acetone using a glass-in- glass homogenizer. The material was centrifuged at 3000 rpm for 10 minutes in dark and clear supernatant was collected in test tube. The pellet was extracted again with 2ml of 80 per cent aqueous acetone and re-centrifuged. The two supernatants were pooled and the final volume was adjusted to 50ml by using 80 per cent aqueous acetone. The absorption was recorded at 645 and 663nm with the help of Spectrophotometer Chlorophyll ‘a’ and Chlorophyll ‘b’ were calculated by using formula given by Starner and Hardley [9].

$$\text{Chlorophyll 'a' (mg/g of fresh weight)} = 12.7\,(\text{O.D at } 663) - \frac{2.69(\text{O.D at } 645) \times V}{1000 \times W}$$

$$\text{Chlorophyll 'b' (mg/g of fresh weight)} = 22.9\,(\text{O.D at } 645) \times \frac{4.68\,(\text{O.D at } 663) \times V}{1000 \times W}$$

where,
V = Final volume made in ml =50ml
W = Weight of tissue in grams = 0.5g
O.D = Absorbance at 645 and 663 nm wave length

RESULT AND DISCUSSION

Shoot Length: Data in Table 1 revealed that the shoot growth increased continuously from the month of February in all experimental plants; however, profuse growth was recorded from June to August in intermediate pruned mother plants with excellent growth. Plants with excellent growth pruned at 6 feet level exhibited maximum (1.26 m) shoot growth followed by 1.08 and 1.2 m in 5 feet and 7 feet level of pruning, respectively. The shoot growth in plants with excellent growth was more than 50% higher than plants with normal growth. Un-pruned plants exhibited significantly less growth under both types of mother plants. Interaction between plant growth types and different pruning levels was found to be significant except during month of July. The results of present findings are in line with that of Dhaliwal and Singh [10], who found that severely pruned (30 cm pruning level) ‘Sardar’ guava trees produced the maximum shoot length during both rainy and winter season crops while minimum in case of unpruned trees. Bajpai *et al*. [11] also found that the severe pruning in Ber produced significantly longest and thicker shoots compared to unpruned trees.

Table 1: Effect of pruning levels on length of shoots

	Shoot length (m)													
	February		March		April		May		June		July		August	
Treatments	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2
T_1	0.03	0.01	0.15	0.10	0.22	0.14	0.34	0.27	0.50	0.33	0.64	0.59	1.08	0.61
T_2	0.03	0.02	0.18	0.13	0.23	0.22	0.35	0.26	0.63	0.39	0.85	0.55	1.26	0.63
T_3	0.04	0.02	0.21	0.11	0.32	0.17	0.39	0.26	0.52	0.46	0.88	0.66	1.02	0.77
T_4	0.03	0.03	0.11	0.08	0.22	0.20	0.37	0.24	0.47	0.37	0.9	0.50	0.93	0.58
T_5	0.02	0.02	0.05	0.07	0.16	0.21	0.27	0.27	0.32	0.38	0.38	0.39	0.40	0.43
Mean	0.03	0.02	0.14	0.10	0.23	0.19	0.34	0.26	0.49	0.38	0.73	0.54	0.94	0.60
%Increase			366.7	400	64.28	90	47.82	36.84	44.11	46.15	48.97	42.1	28.76	11.11
CD (5%) Growth	0.005		0.011		0.015		0.021		0.029		0.102		0.108	
Treatments	0.008		0.017		0.024		0.033		0.039		0.161		0.171	
Interaction	0.011		0.025		0.034		0.047		0.055		NS		0.242	

Table 2: Effect of pruning levels on shoot girth

	Shoot girth (cm)													
	February		March		April		May		June		July		August	
Treatments	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2
T_1	0.60	0.46	0.95	0.76	1.20	0.83	1.30	0.96	1.30	1.06	1.46	1.16	2.23	1.33
T_2	0.56	0.46	1.10	0.83	1.20	1.03	1.33	1.16	1.46	1.26	1.53	1.33	1.76	1.46
T_3	0.63	0.50	1.40	0.83	1.50	0.93	1.56	1.03	1.56	1.16	1.66	1.23	2.43	1.43
T_4	0.50	0.46	0.73	0.95	0.80	0.96	0.90	1.06	0.96	1.10	1.63	1.20	2.60	1.30
T_5	0.26	0.30	0.70	0.40	0.70	0.50	0.83	0.60	0.93	0.76	1.13	0.93	1.43	1.40
Mean	0.51	0.44	0.97	0.75	1.08	0.85	1.18	0.96	1.24	1.07	1.48	1.17	2.09	1.38
%Increase			90.19	70.45	11.34	13.33	9.25	12.94	5.08	11.45	19.35	9.34	41.21	17.94
CD (5%) Growth	0.071		0.078		0.087		0.064		0.051		0.080		0.150	
Treatments	0.112		0.124		0.138		0.101		0.081		0.127		0.237	
InteractionNS	0.176		0.195		0.143		0.115		NS		0.336			

G_1 - Plants with vigorous /excellent growth G_2- Plants with normal growth

Shoot Girth: It is evident from the data in Table 2 that shoot girth increased significantly in both type of plants, but, maximum increment in girth was noted during the period of July-August. The maximum shoot girth (2.60cm) was recorded in plants pruned at 8 feet level followed by 2.43cm in 7 feet pruning level of plants with excellent growth. However, in case of plants with normal growth, shoot girth was maximum in plants pruned at 6 feet (1.46cm) and 7 feet (1.43 level. Interaction between plant growth types and different levels of pruning was found to be significant except during month of February and July. These results are in line with that of Bisla *et al*. [12], who reported that girth of new shoots more in case of pruned trees as compared to unpruned trees in ber. It might be because light pruned trees stored more reserved food compare to severe pruned trees which provide more vegetative growth. In severe pruned trees, a part of the energy is always lost for healing of wounds and bearing the pruning setback. Awasthi and Mishra [13] also recorded that maximum diameter of shoots on light and medium pruned trees as compared to unpruned trees in Ber.

Number of Leaves: Significant increase in number of leaves in both types of plants was observed from the month of February to August (Table 3). Data shows that number of leaves (39.6) was maximum in plants with excellent growth pruned at 6 feet level followed by 37.3 in 5 feet pruned plants However, the number of leaves were maximum (32.6) in plants with normal growth pruned at 7 feet level followed by 29.6 in 5 feet pruning level. In control plants, the number of leaves were only 24.6 and 22 in plants with excellent growth and normal growth, respectively. The results of present findings are in agreement with that of Jadhao *et al*. [14], who recorded the maximum average number of leaves per branch in pruned 'Sardar' guava trees and minimum in unpruned trees. Bajpai *et al*. [11] also recorded the maximum number of leaves per shoot in severely pruned guava trees and minimum in unpruned trees.

Table 3: Effect of pruning intensity on number of leaves per shoot

	Number of leaves per shoot													
	February		March		April		May		June		July		August	
Treatments	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2
T_1	4.3	3.3	10.0	7.0	14.6	11.0	20.3	16.0	24.6	21.6	29.0	27.3	37.3	29.6
T_2	3.3	3.0	10.0	10.6	15.6	12.0	20.6	16.0	26.0	21.3	33.0	24.6	39.6	27.3
T_3	4.6	3.6	8.3	10.6	08.3	10.6	15.0	14.3	23.6	22.6	29.3	28.3	30.6	32.6
T_4	3.3	2.6	6.6	9.0	14.6	12.3	20.0	16.6	24.3	18.0	28.6	18.3	37.0	25.6
T_5	1.6	1.3	3.0	6.0	11.6	9.0	15.3	13.3	21.3	20.0	21.3	20.6	24.6	22.0
Mean	3.4	2.8	7.6	8.6	13.0	11.0	18.2	15.2	24.0	20.7	28.2	23.8	33.8	27.4
%Increase			119.7	209.3	71.0	27.0	40.4	38.7	31.4	35.8	17.7	15.1	19.8	15.1
CD (5%) Growth	NS		0.64		1.25		1.31		1.03		0.74		2.25	
Treatments	1.36		1.01		1.98		2.07		1.64		1.18		3.55	
Interaction	NS		1.43		1.80		NS		2.32		1.67		5.03	

Table 4: Effect of pruning intensity on number of buds per shoot

	Number of buds per shoot													
	February		March		April		May		June		July		August	
Treatments	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2	G_1	G_2
T_1	3.00	3.00	7.00	7.00	17.33	12.66	21.66	19.33	26.66	22.33	38.00	25.00	47.66	28.00
T_2	2.66	1.66	7.00	7.00	25.00	11.00	29.00	15.33	40.66	22.33	47.66	22.33	57.00	24.33
T_3	1.66	2.33	9.00	8.66	20.00	12.33	27.00	20.33	34.33	24.00	42.00	29.33	49.00	33.33
T_4	2.00	1.66	6.00	7.33	18.00	12.66	24.00	14.66	30.00	21.00	39.33	25.00	47.33	32.66
T_5	2.33	2.33	3.00	3.00	7.33	06.33	10.33	10.33	14.00	12.00	17.33	14.66	22.66	20.00
Mean	2.33	2.2	6.40	6.60	17.53	11.00	22.40	16.00	29.13	20.33	36.86	23.26	44.73	27.66
%Increase			174.7	200	173.9	66.66	27.78	45.45	30.04	27.06	26.53	14.41	21.35	18.91
CD (5%) Growth	NS		NS		1.07		1.41		1.10		1.15		1.83	
Treatments	NS		1.45		1.69		2.23		1.74		1.82		2.90	
Interaction	NS		NS		2.39		3.15		2.46		2.58		4.90	

G_1 - Plants with vigorous /excellent growth G_2- Plants with normal growth

Number of Buds: Highest number of buds (57) was counted in plants pruned at 6 feet pruning level in plants with excellent growth followed by 49 in 7 feet pruning level. However, in plants with normal growth the number of bud per shoot were quite less than plants with excellent growth (Table 4). Least number of bud i.e. 22.66 and 20 buds were recorded in control plants in both excellent and normal growth plants, respectively. Interaction between plant growth types and different levels of pruning treatments was found to be significant except during month of February and March. The present findings are in line with that of Braswell *et al*. [15], who found that spring pruning in 'Climax blue berry' plants enhanced vegetative bud initiation. Lord *et al*. [16] also found that summer pruning and heading back in apple, induced flower bud initiation on shoots as compared to unpruned trees. Similar results were recorded by George and Nissen [17], who found that summer pruning of custard apple enhanced the number of sub-petiolar buds as compared to unpruned trees.

Chlorophyll 'A' and 'B' Content: Maximum mean chlorophyll-b (0.68mg/g) content was recorded in plant pruning at 8 feet level in both types of plants. Similarly, the chlorophyll-a content was maximum (0.85mg/g) in plants pruned at 6 feet and 8 feet level in case of plants with excellent growth and 0.83mg/g in plant pruned at 5 feet followed by 0.80mg/g at 7 feet pruned plants with normal growth. The chlorophyll-a and chlorophyll-b content was recorded minimum in unpruned plants.

Interaction between plant growth types and different levels of pruning treatments were found non-significant for both chlorophyll a and chlorophyll b. These findings are in agreement with that of Sharma and Chauhan [18], who reported that higher chlorophyll content in leaves of pruned peach trees leaves as compared to unpruned trees. Hussain *et al*. [19] also found that summer pruning of peach trees enhance chlorophyll content in leaves as compared to unpruned trees. Yamada *et al*. [20] also recorded similar results in peach and found that summer pruning produced more chlorophyll content in leaf as compared to winter pruned and unpruned trees.

From the study it may be concluded that the mother plants should be of excellent growth and the pruning of plants at higher intensity levels encourage the formation of more buds required for propagation of 'kinnow' plants.

CONCLUSION

Although the length of shoot, shoot girth, number of leaves and number of buds were improved significantly in plants with intermediate pruning and excellent vigor but it was also improved in weak and medium growth. It was being observed that maximum improvement in growth dynamic recorded from June to August because of favorable weather conditions. Similarly, the content of chlorophyll 'a' and 'b' was being improved with intermediate pruning in plants with excellent growth.

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