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Effect of different pruning intensities on growth, yield and leaf nutrients status of starking delicious apple in hilly region of Himachal Pradesh

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ABSTRACT

A field experiment on the effect of different pruning intensities on apple cultivar Starking Delicious was conducted in a private orchard at Rohru in Shimla district. Four pruning intensities were used as treatments. The results revealed that in different pruning intensities the plant growth increased as the severity of pruning increased, but the fruit set and yield decreased due to more vegetative growth. Lower yield recorded during the year 2007 might be partly due to alternate bearing habit of Starking Delicious apple and partly due to the inclement weather conditions. The leaf nutrient status was also affected by the different pruning intensities. Leaf nitrogen and potassium contents increased with the increase in severity of pruning, whereas, leaf calcium content was found to decrease.

Keywords : Pruning, intensities, Starking Delicious, plant growth.

INTRODUCTION

The plants are trained according to growth habit and vigour of rootstocks. Training helps to establish a strong framework of scaffold limbs capable of supporting heavy yield and quality fruits, regular annual succession of crops, expose maximum leaf surface to the sun, direct the growth of trees so that various cultural operation like spraying and harvesting become economical, protect the tree from sunburn and promote early production. Pruning is also essential to maintain the proper balance between vegetative growths and spur development. More severity of pruning in apple plants leads to higher vegetative growth, thereby, adversely affecting the fruit production. For old trees, severity of pruning half to three fourth is required to rejuvenate the growth in addition to spur maintenance, whereas, in younger trees the severity of pruning is different. Keeping in view the importance of severity of pruning in maintaining balance between vegetative growth and fruit production, the present study was undertaken in a private orchard at Rohru in Shimla district of Himachal Pradesh.

MATERIAL AND METHODS

The experiment was conducted during 2007- 08 in a private orchard at Dalgaon in Rohru tehsil on twenty five year old Starking Delicious apple trees, raised on seedling rootstocks in sandy loam soil, spaced at 5 x 5 m apart. A randomized block design was followed with five replications. The treatments consisted of four pruning intensities, as given below:

T_1 No heading back, only thinning cuts
T_2 ¼ heading back and thinning cuts
T_3 ½ heading back and thinning cuts
T_4 ¾ heading back and thinning cuts

Pruning was done in the first week of January every year. Chaubatia paste was applied immediately after pruning to avoid any infection to the pruning cuts. The data on tree growth, fruit yield and leaf nutrient status to study the effect of different pruning intensities were recorded. The trunk girth of the tree was measured at 20 cm above the graft union with the help of a measuring tape at the beginning and at the end of growing season. For extension shoot growth, ten shoots from current season's growth were randomly selected from the periphery of the tree and their lengths were measured to find out an average increase in extension shoot growth.

Procedure suggested by Westwood (1978) was adopted for fruit set estimation. Count of all fruits was done 20 days after petal fall and the following formula was used for the determination of fruit set:

$$\text{Fruit set} = \frac{\text{Number of fruits set}}{\text{Number of flower clusters}} \times 100$$

For taking fruit yield the crop load removed from the trees during the harvesting season was recorded as kg/tree based on 20 kg standard apple box and later converted in to ton/ha.

For plant analysis, leaf samples were taken from the middle of the shoots all around the periphery of the tree in the second week of July and handling and preparation of samples were done in accordance with procedure given by Chapman (1964). The digestion of plant material for various nutrient elements was done in diacid mixture (nitric acid: perchloric acid in the ratio of 4:1). Separate digestion was carried out for nitrogen estimation using concentrated sulphuric acid and digestion mixture as suggested by Jackson 1967. Analysis for various nutrient elements was done as per procedure given by Jackson 1973.

RESULTS AND DISCUSSION

The data on trunk girth, shoot growth, fruit set and yield of Starking Delicious apple as influenced by pruning intensities are presented in Table 1.

Table 1. Effect of different pruning intensities on growth, fruit set and yield of Starking Delicious apple

Pruning intensity	Trunk girth (cm)		Extension growth (cm)		Fruit Set (%)		yield (ton / ha)	
	2007	2008	2007	2008	2007	2008	2007	2008
T_1	42.4	42.9	17.5	19.3	21.6	28.4	9.6	24.5
T_2	43.6	43.8	19.6	20.2	21.2	27.5	9.0	23.6
T_3	43.5	43.9	24.5	26.2	20.3	24.6	8.5	21.8
T_4	44.1	44.3	29.4	31.9	19.5	20.8	7.6	20.5
$CD_{0.05}$	NS	NS	4.7	5.3	1.2	1.8	1.4	2.9

Trunk girth

The data presented in Table 1 show that different pruning intensities had no significant effect on trunk girth during both the years under study. However, maximum trunk girth 44.1 and 44.3 cm was recorded in T_4 treatment with ¾ heading back and thinning cuts during both the years under study, whereas, in treatment T_1 minimum trunk girth of 42.4 and 42.9 cm was recorded.

Shoot length

The effect of different levels of pruning intensities on extension shoot growth was found to be significant during both the years under study. Maximum shoot growth 29.4 and 31.9 cm was found in T_4 treatment with ¾ heading back and thinning cuts and minimum 17.5 and 19.3 cm shoot growth was recorded in T_1 treatments with ¼ heading back and thinning cuts during both the years. Maximum extension shoot growth observed under treatment T_4 was found to be statistically at par with T_3 treatment, which was found to be significantly higher than the T_1 and T_2 treatments, thus indicating that shoot growth increases with the severity of pruning.

Growth is generally considered to include linear increase, gain in weight, increase in dimension, gain in organic mass and cell multiplication. In general, pruning intensities influenced the tree growth, which might be due to removal of apical dominance of a bud. Growth response as expressed in term of trunk diameter and shoot growth

has been observed by Guak et al (2003). Sharma et al (2003) found that increase in the nitrogen levels and pruning intensities increases the vegetative growth of the plants. Kanwar (1979) found that higher shoot growth in heavily pruned trees may be due to lower yield and conversion of nutrient elements for use in vegetative growth.

Fruit set and yield

In different pruning intensities, fruit set was found to be significant during both the years under study. With the increase in pruning intensities the level of fruit set decreased and minimum fruit set of 19.5 and 20.8 per cent was observed at T_4 level of pruning intensity, which was significantly lower than the lower levels of pruning intensities, which might be due to more vegetative growth in lower level of pruning intensities. The effect of pruning intensities on fruit yield was observed to be significant during both the years under study. The maximum yield 9.6 and 24.5 ton/ ha was observed with T_1 pruning intensity during both the years, followed by T_2 and T_3 treatments. The decrease in the fruit yield with the increase in pruning severity may be due to more vegetative growth and lesser number of fruiting spurs. Singh et al (2009) observed that nitrogen levels in combination with pruning intensities increased the fruit yield up to a certain level. Lower yield recorded during the year 2007 might be attributed partly due to the alternate bearing tendency of the cultivar Starking Delicious and partly to the inclement weather conditions.

Leaf nutrient status

The effect of different levels of pruning intensities on the macronutrient status of leaves of Starking Delicious apple are given in Table 2.

Nitrogen

The trees receiving heavy and medium pruning had significantly higher leaf nitrogen than others. The highest nitrogen content 2.24 per cent and 2.29 per cent found in treatment T_4 during both the years was significantly higher to the lower level of pruning intensities. In treatment T_1 only 2.01 per cent and 2.04 per cent nitrogen content was found. The results confirm the findings of Kanwar (1979). Higher foliar nitrogen in heavily pruned trees may be due to low yield/tree and less overall accumulation of dry matter in the leaves. Since nitrogen is mobile, its translocation to the leaves could have aided its accumulation in the apple leaves (Cheng and Raba 2009).

Phosphorus

The leaf phosphorus content was not influenced by pruning intensities (Table 2). The higher phosphorus content was observed in treatments T_3 and T_4 but no systematic trend was found in the level of

Table 2. Effect of different pruning intensities on leaf nutrient contents of Starking Delicious apple

Pruning intensity	N (%)		P (%)		K (%)		Ca (%)		Mg (%)	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
T_1	2.01	2.04	0.30	0.31	2.12	2.14	2.21	2.24	0.30	0.33
T_2	2.06	2.08	0.28	0.32	2.20	2.25	2.18	2.20	0.34	0.36
T_3	2.13	2.16	0.33	0.30	2.26	2.29	2.13	2.16	0.32	0.35
T_4	2.24	2.29	0.31	0.34	2.30	2.34	2.06	2.12	0.36	0.37
$CD_{0.05}$	0.20	0.22	0.01	0.03	0.12	0.14	0.09	0.10	0.03	0.02

phosphorus. This could possibly be due to the antagonism between phosphate and nitrate anions at the absorption sites. Similar results were found by Sharma and Singh (1982).

Potassium

The leaf potassium content increased significantly with the increase in severity of pruning (Table 2). Heavily pruned trees had significantly higher leaf potassium content than others and maximum potassium content (2.30% and 2.34%) was found in treatment T_4 and minimum (2.12% and 2.14%) in treatment T_1. Higher foliar potassium content in heavily pruned trees was due to less accumulation of dry matter and vigorous growth, which caused increased uptake of this element. The results confirm the findings of Kanwar (1979).

Calcium

The calcium concentration in leaves decreased with an increase in the pruning intensity. Light pruned trees accumulated the highest calcium in leaves, which differed significantly from other pruning intensities. The decrease in leaf calcium content with pruning intensity could be attributed to higher potassium level in heavily pruned trees. The higher amount of dry matter in the lightly pruned trees also favored greater calcium accumulation. The failure of calcium level in leaves may be related to the slow mobility of calcium in plant tissues. Nitrogen releases ammonia, which affects the calcium level in various ways (Shear 1975).

Magnesium

Leaf magnesium content increased significantly with the increase in pruning

intensity .Maximum magnesium level (0.36% and 0.37%) was recorded in T_4 treatment with ¾ heading back and thinning cuts and minimum (0.30% and 0.33%) in treatment T_1. The high uptake of magnesium with the increase in pruning intensities was due to more accumulation of magnesium (Guak et al 2003).

The present study shows that different pruning intensities affect the plant growth, fruit yield and leaf nutrient contents significantly. With the increase in severity of pruning the fruit set and fruit yield decreased, which was probably due to more vegetative growth and less spur formation. However, the levels of nitrogen, potassium and magnesium increased with the increase in pruning intensities.

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