EFFECT OF PRUNING AND NITROGEN LEVELS ON GROWTH, YIELD AND LEAF NUTRIENTS OF APPLE IN 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 vegetative growth increases as the severity of pruning increases, but the fruit set and yield decreases due to higher vegetative growth. Lower yield recorded during the year 2010 might be partly due to alternate bearing habit of Starking Delicious apple and partly due to the inclement weather conditions. Similarly, 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.

Introduction

The plants are trained according to growth habit and vigour of root- stocks. 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 sun burn and promote early production. Similarly, pruning is also essential to maintain the proper balance between vegetative growth and spur development. Pruning is always started from the top of the tree downward to avoid any breakage of branches kept to fill up the gaps. In pruning of apple trees fast upward growing, crowded branches, diseased and broken branches are removed completely. Similarly, the yearly growth of plants and production of fruit depletes the soil of its macro and micro-nutrient reserves resulting in reduction of native fertility of the soil. Among all other macro-nutrients required by the plants nitrogen is most important major nutrient element for getting optimum growth and production in combination with judicious pruning. Sharma *et al*. (2003) found that increase in the nitrogen levels and pruning intensities increases the vegetative growth of the plants. Similarly, Singh et al. (2009) observed that nitrogen levels increases the fruit yield up to a certain level and in combination with pruning fruit size and quality increases with the intensities of the pruning. In order to keep the balance between vegetative and reproductive growth a regular application of nitrogen and other nutrients are also required to be applied depending upon the growth and yield of a tree. Keeping in view the importance of nitrogen fertilizer and pruning intensities in maintaining balance between vegetative growth and fruit production, the present study was undertaken in a private orchard at Rohru in Shimla district.

Materials and Methods

The experiment was conducted during 2010-11 in a private orchard at Dalgaon in Rohru tehsil on twenty five year old Starking Delicious apple trees, raised on seedling root- stocks in sandy loam soil, spaced at 5 x 5 m apart. A split plot design was followed with three replications. The treatments in main plot were four pruning intensities, as follows: T_1 = No heading back only thinning cuts; T_2 = ¼ heading back and thinning cuts; T_3 = ½ heading back and thinning cuts; and T_4 =¾ heading back and thinning cuts.

Pruning was done in the first week of January every year. Seven levels of nitrogen (300, 400, 500, 600, 700, 800 and 900 g N tree-^{1}) were applied to the sub-plots. All the trees received uniform dose of 700 g K_2O tree-^{1} as muriate of potash and 350 g P_2O_5 tree-^{1} as single super phosphate. Nitrogen was applied as Calcium Ammonium Nitrate in all the trees under treatment. The total dose of P_2O_5 and K_2O were applied annually during January. Nitrogen in different levels was applied in the first fortnight of March. All the fertilizers were applied in the tree basin around 90 cm radius of a tree trunk uniformly and mixed thoroughly. The physical character of the tree growth and yield recorded were: (i) The trunk girth of the tree at 20 cm above the graft union at the beginning and end of growing season; and (ii) Extension shoot growth on ten shoots from current season's growth 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 fruit was done 20 days after petal fall and the following formula was used for the determination of fruit set. For taking fruit yield the crop load removed from the trees during the harvesting season was recorded as Kg $tree^{-1}$ based on 20 Kg standard apple box and later converted in to t/ha.

$$\text{Fruit set} = \frac{\text{Number of fruit set}}{\text{Number of flower cluster}} \times 100$$

For nutrient analysis (N, P and K) leaf samples were taken from the middle of shoots all around the periphery of tree in the second week of July and handling and preparation of sample was 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 and nitrogen levels are presented in Table 1. Data on tree trunk girth shows that pruning intensities and different levels of nitrogen 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 year under study, whereas, in treatment with different levels of nitrogen maximum trunk girth, 48.1 and 48.8 cm was recorded with 900 g N $tree^{-1}$ treatment.

Shoot Length:

The effect of different levels of nitrogen and pruning intensities on extension shoot growth was found to be significant during both the years under study. Maximum shoot growth, 30.4 and 31.8 cm was found in T_4 treatment with ¾ heading back and thinning cuts and maximum, 26.0 and 26.5 cm shoot growth was recorded for 900 g N $tree^{-1}$ during both the years. Maximum extension shoot growth observed under treatment 900 g N $tree^{-1}$ was found to be significantly higher than the lower levels of nitrogen. Similarly, in different pruning intensities shoot growth increases as the severity of pruning increases.

Table 1: Effect of pruning intensity and nitrogen levels on growth, fruit set and yields of Starking Delicious apple

Pruning intensity	Trunk girth (cm)		Extension growth (cm)		Fruit Set (%)		Yield (t / ha)	
	2010	2011	2010	2011	2010	2011	2010	2011
T_1	42.4	42.9	18.5	19.6	21.5	29.3	19.8	23.5
T_2	43.6	43.8	20.6	20.8	21.8	26.5	19.2	21.2
T_3	43.5	43.9	24.2	26.8	21.3	24.8	18.2	20.8
T_4	44.1	44.3	30.4	31.8	20.5	20.9	17.6	19.6
CD ($P_{0.05}$)	NS	NS	4.3	5.1	1.3	1.7	2.4	2.8
N rates (g/tree)								
300	43.5	44.0	20.5	22.3	21.3	22.7	18.0	25.3
400	44.2	44.5	22.8	23.0	22.3	26.8	17.8	23.5
500	44.6	44.8	23.3	23.9	21.8	24.9	17.9	24.8
600	46.5	47.8	24.6	24.8	22.5	29.6	19.5	27.5
700	46.7	48.2	25.0	25.4	23.1	31.8	19.9	27.8
800	47.8	48.6	25.3	25.9	22.5	30.9	18.2	26.6
900	48.1	48.8	26.0	26.5	22.8	28.2	17.6	23.8
CD ($P_{0.05}$)	NS	NS	3.1	2.9	NS	NS	1.5	2.4

Growth is generally considered to include linear increase, gain in weight, increase in dimension, gain in organic mass and cell multiplication. In general nitrogen application influences the tree growth, which might be due to better root development and nutrient uptake. Growth response as expressed in terms of trunk diameter and shoot growth has been observed in apple tree by Hou *et al.* (2004) and Guak *et al.* (2003). Sharma *et al.* (2003) found that increase in the nitrogen levels and pruning intensities increases the vegetative growth of apple tree. Kanwar (1979) found that higher foliar nitrogen in heavily pruned trees may be due to lower yield and more vegetative growth in peach.

Fruit Set and Yield

Different levels of nitrogen had no significant effect on fruit set. However, maximum fruit set 23.1 and 31.8 percent was observed with 700 g N tree^{-1} during both the year under study. The minimum fruit set 21.3 and 22.7 percent was observed with 300 g N tree-1 in both the years. In different pruning intensities fruit set was found to be significant during both the years (Table 1). With the increase in pruning intensities the level of fruit set decreases, which may be due to more vegetative growth. The effect of pruning intensities and N rates on fruit yield was observed to be significant during both the years under study. The maximum yield 19.9 and 27.8 t ha^{-1} was observed with 700 g N tree^{-1} during both the years, followed by 600 and 800 g N tree^{-1}. Similarly, the effect on fruit yield under different pruning intensities was also found to be significant, but it was observed that with the increase in pruning severity the fruit yield decreases, which may be due to more vegetative growth lesser number of fruiting spurs. Singh *et al.* (2009) observed that nitrogen levels increases the fruit yield up to a certain level. Sharma et al. (2003) earlier demonstrated that N, K and Ca are utilized almost in the same magnitude in the production of flowers and therefore, more yield due to nitrogen levels in the present case may be the cumulative effect of balanced nutrition. Due to the antagonistic effect of nitrogen on potassium uptake, the effect on fruit yield was not significant at higher nitrogen levels. Lower yield recorded during the year 2010 might be attributed partly due to the alternate bearing tendency of the cultivar Starking Delicious and partly to the inclement weather condition such as observed in the present case.

Leaf Nutrient Status:

Nitrogen

The effect of different levels of nitrogen and pruning intensities on the macro-nutrient status of leaves of Starking Delicious apple is given in Table 2. The tree receiving heavy and medium pruning had significantly higher leaf nitrogen than other (Table 2). The results confirm the finding of Kanwar (1979). Higher foliar nitrogen in heavily pruned trees may be due to low yield tree^{-1} and less overall accumulation of dry matter in the leaves. Nitrogen application increased the leaf nitrogen content significantly. The tree receiving 900 g and 300 g tree^{-1} had the maximum and minimum nitrogen content, respectively. Since nitrogen is highly mobile its translocation to the leaves could have aided its accumulation in the apple leaves (Cheng and Raba, 2009).

Pruning intensity	N (%)		P (%)		K (%)		Ca (%)		Mg (%)	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
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
N rates (g tree^{-1})										
300	1.95	1.97	0.29	0.31	2.29	2.32	2.19	2.23	0.23	0.26
400	1.98	1.99	0.28	0.30	2.28	2.30	2.16	2.20	0.25	0.27
500	2.08	2.11	0.27	0.28	2.26	2.27	2.15	2.18	0.26	0.29
600	2.14	2.16	0.23	0.25	2.23	2.25	2.10	2.14	0.28	0.30
700	2.22	2.27	0.21	0.24	2.21	2.22	2.08	2.10	0.32	0.35
800	2.26	2.29	0.20	0.22	2.10	2.14	1.95	2.03	0.35	0.37
900	2.34	2.37	0.18	0.20	2.02	2.06	1.86	1.90	0.38	0.39
$CD_{0.05}$	0.21	0.23	0.03	0.05	0.20	0.22	0.21	0.26	0.08	0.09

Table 2: Effect of pruning intensity and nitrogen levels on leaf nutrient contents of Starking Delicious apple

Phosphorus

The leaf phosphorus content was not influenced by pruning intensities (Table 2). An increase in Nitrogen level decreased the leaf phosphorus content significantly. The higher phosphorus content was observed in trees receiving 300 g nitrogen and lowest in those receiving 900 g nitrogen (Table 2). 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 other treatments. 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 result confirms the finding of Kanwar (1979). An increase in nitrogen level to apple trees decreases the leaf potassium content. The tree receiving low level of nitrogen had the highest potassium content in the leaves. The decrease in the leaf potassium contents with a simultaneous increase in nitrogen was due to antagonistic relationship between them has also been reported by Sadowski *et al*. (1995).

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 light pruned trees also favored greater calcium accumulation. Similarly, the calcium content in the leaves decreased significantly with the increasing level of nitrogen. The failure of nitrogen to raise the calcium level in leaves may be related to the slow mobility of calcium in plant tissues. Application of 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 and nitrogen level from 300 g to 900 g N $tree^{-1}$. Maximum magnesium level 0.36% and 0.37% was recorded at T4 treatment with ¾ heading back and thinning cuts and 0.38% and 0.39% at 900 g N $tree^{-1}$, which was significantly higher to the lower levels of nitrogen. The high uptake of magnesium with the increase in nitrogen level was due to more accumulation of magnesium under increased percentage of nitrogen (Guak *et al*. 2003).

This study highlight that training and pruning helps to establish a strong framework of branches capable of supporting heavy yield and quality fruits, 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 sun burn and promote early production. Pruning also helps in maintaining the proper balance between vegetative growth and spur development. Keeping in view the importance of pruning and nitrogen the present study was undertaken in the commercial apple orchard in Rohru on different pruning intensities and nitrogen levels which shows that these treatments affect the plant growth, fruit yield and leaf nutrient contents significantly. With the increase in severity of pruning the fruit set and fruit yield decreases, which was due to more vegetative growth and less spur formation. Similarly, with the increase in nitrogen levels plant growth and fruit yield increases up to 700 g nitrogen tree-1 and decrease after that was due to antagonistic effect of nitrogen on other essential nutrients.

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NGOs AS THE GUARDIANS OF ENVIRONMENT

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Introduction

As early as 1896, the Swedish Scientist Svante Arrhenius had predicted that human activities would interfere with the way the sun interacts with the earth, resulting in global warming and climate change. Another Scientist Peter Vitousek and his co-authors stated in a 1997 article in Science: "We are changing earth more rapidly than we understanding it. *We live on a human-dominated planet and the momentum of human population growth, together with the imperative for further economic development in most of the world, ensures that our dominance will increase…Humanity's dominance of Earth means that we cannot escape responsibility for managing the planet.*"

The intactness and purity of the environment and its natural resources is of utmost importance, not only by itself, but also because it holds a great value to humans by providing the ecosystem services. Thus, the conservation of natural environment is a major concern worldwide, because directly air, water and land pollution or degradation does not recognize borders, and indirectly poor soil conditions of one nation may reduce the availability of food to another country.

In the present scenario, the world governments, viz., UN and other development organizations, and the third sector or voluntary sector, comprising of a large number of NGOs from all over the world, are actively involved in raising concern about the environmental impacts of the development processes and in providing solutions for sustainable development.

To put it in the words of environmentalist journalist *Mark Hertsgaard* (1998): 'In fact, if humans are smart, repairing the environment could become one of the biggest businesses of the coming century, a huge source of profits, job, and general well-being.'

Discussion

Non-governmental organizations are also emerging as an important element of contemporary Indian society and alike between in the grassroots and civil society. The great expansion of the network of NGOs in India has also strengthened the rise and growth of environmental movements. The field experiences and understanding of the NGOs highlight the fact that the best way to safeguard the environment, to restore ecological balance and to promote sustainable and environment friendly is through people participation. Putting the common or indigenous people at the centre stage and making them active partners and managers of resources not only raises their awareness about environment related issues but also bring to the forefront the ultimate tool of local knowledge and traditional wisdom that has for ages worked well in nurturing and conserving the life sustaining ecosystems on earth.

Kerala Sastra Sahitya Parishad (KSSP), an NGO, undertook the challenging task of preserving the rich bio-diversity and gene pool of the valley from the dangers of the proposed dam construction on the River Kuntipuzha and the ruthless deforestation. Thus, the Silent Valley Campaign became a landmark in India's Environmental Movement, where community participated in protest against the destruction of the environment and convinced the decision making authorities that alternatives with less impact on the environment existed, that have good economic and social outputs. It played a significant role in creating favourable public opinion by associating the young people, college students in major cities of Kerala, by imparting environmental education and awareness at various levels in an informal manner to make the general public understand the linkages that the nature and its conservation have with the various dimensions of their lives- social, cultural, economic, etc. Several other scientific bodies also lent their support to the movement. The Bombay Natural History Society, the oldest environmental NGO of India, also supported the campaign. The campaign led to the declaring of the Silent Valley as a National Park in 1985.

The joint action and struggle of Tarun Bhagat Sangh, a voluntary organization and the villagers over a long period of 15 years led to an economic and ecological miracle creating another success story in the twin villages of Bhaonta-Koyalala, nestled in the Aravalli hill ranges in the Alwar district of Rajasthan. Their remarkable work led to the reviving of the traditional water