Effect of shoot pruning severity and plant spacing on leaf nutrient status and yield of guava cv. Pant Prabhat

PANKAJ NAUTIYAL, SHANT LAL and C. P. SINGH

Department of Horticulture, College of Agriculture, G. B. Pant University of Agriculture and Technology, Pantnagar-263145 (U. S Nagar, Uttarakhand)

ABSTRACT : The experiment was conducted at Horticulture Research Centre, Patharchatta, Department of Horticulture, GBPUA&T, Pantnagar, India during the year 2014-15 and 2015-16. Five years old grafted, well trained guava plants planted under high density were selected for the study. The treatments consisted of two plant spacings (i.e. 2.0 m x 1.0 m and 2 m x 2 m spacing) and seven shoot pruning severity viz., One leaf pair shoot pruning (P_1,OLP); Two leaf pairs shoot pruning (P_2,TLP); Three leaf pairs shoot pruning (P_3,THLP); Thinning out of non-fruiting shoots + One leaf pair shoot pruning (P_4,TNFS+OLP); Thinning out of non-fruiting shoots + Two leaf pairs shoot pruning (P_5,TNFS+TLP); Thinning out of non-fruiting shoots + Three leaf pairs shoot pruning (P_6,TNFS+THLP); Thinning out of non-fruiting shoots (P_7,TNFS) and no pruning (P_0) as control. In this way, there were eight treatments with sixteen combinations. The maximum fruit yield was obtained with treatment P_4 (TNFS+OLP) in winter season, while, the unpruned plants (P_O) produced lowest fruit yield. The highest total annual yield (q/ha) was recorded with treatment combination, S_1P_4 (2.0 × 1.0 m plant spacing and TNFS+OLP). Leaf N, P, K contents were significantly influenced by pruning severity during July and October sample and it was lesser in pruned plants than unpruned plants. The low level of leaf nitrogen, phosphorus and potassium contents was recorded in October sample. However, pruning severity did not influence the leaf nitrogen, phosphorus and potassium contents during April sample.

Key words: High density, Guava, , shoot pruning, leaf nutrient status.

Guava (*Psidium guajava* L.) is one of the important members of family Myrtaceae (Hayes, 1974). Its origin is considered from Tropical South America stretching from Mexico to Peru and was introduced in India by the Portuguese during the early 17^{th} century (Bose and Mitra, 2001). Guava contributes 4.61 per cent of the total production of fruits in India, which is around 3.99 million tonnes from an area of 0.25 million hectare and productivity is around 16.21 tonnes per hectare (NHB, 2014-15).

In tropical and subtropical conditions of northern India, guava mainly have two flowering seasons *i.e.,* summer (April-May) and rainy (July- August). The summer (April- May) flowering produces rainy season crop and rainy season (July- August) flowering produces winter season crop. In *tarai* conditions of India, guava trees produce about 90% crop in rainy season, 8-10 % in winter season and very few in spring season. This feature in guava cultivation is a major source of concern. Rainy season fruits are rough, insipid, poor in quality, less nutritive, easily affected by insect pests and have very short shelf life. Due to these characteristics the guava fruits do not fetch remunerative prices. Whereas, the winter season fruits are superior in quality, free from diseases and pests and fetch more prices in the market. Winter season crop have better storage life and thus can be transported to destination offering remunerative prices (Rathore and Singh, 1976; Lal, 1992; Tyagi and Patel, 2004).

Guava is a pruning responsive crop and fruiting occurs in current season growth. Shoot pruning in high density orchards is prerequisite to maintain the desired canopy of this fast growing guava plant. The efficient training and pruning can maintain the proper canopy size of the guava tree, improve fruit quality and provide opportunity to increase the number of trees per unit area (Lal *et al*., 2000). Presently shoot pruning has emerged as eco-friendly alternative method for regulating the guava crop. It is free from all the demerits of existing methods. Shoot pruning may be helpful in reducing the tree size and improving the fruit quality as well (Lal *et al*., 2007). In other hand this is well known fact that increases in productivity of fruit removes large amounts of essential nutrients from the soil. Without proper techniques, continuous fruit production reduces nutrient reserves in the soil. The need exists for some refined shoot pruning method where fruit setting can be regulated to attain winter season fruiting and higher yield especially for high density plantation and find optimum level of nutrients in leaves. The objective of present study was to find out the effect of shoot pruning severity and plant spacing on leaf nutrient status and yield of guava cv. Pant Prabhat.

MATERIALS AND METHODS

The study was conducted at Horticulture Research Centre, Patharchatta, Department of Horticulture, G. B. Pant University of Agriculture and Technology, Pantnagar, India during the year 2014-15 and 2015-16. Five years old grafted, well trained guava trees of uniform growth (modified leader system) and planted under high density were selected for the study. The treatments consisted of two plant spacing (i.e. 2.0 m x 1.0 m and 2 m x 2 m spacing) and seven pruning severity [One leaf pair shoot pruning (P_1, OLP:); Two leaf pairs shoot pruning (P_2, TLP); Three leaf pairs shoot pruning (P_3, THLP); Thinning out of non-fruiting shoots + One leaf pair shoot pruning (P_4, TNFS+OLP); Thinning out of non-fruiting shoots + Two leaf pairs shoot pruning ($P_{5,}$ TNFS+TLP); Thinning out of non-fruiting shoots + Three leaf pairs shoot pruning (P_6, TNFS+THLP); Thinning out of non-fruiting shoots (P_7, TNFS). with no pruning (P_0) as control In this way there were eight treatments with sixteen combinations replicated four times each with two plants in one experimental unit. The experiment was laid out in factorial randomized block design. During the month of February, 2014, all the plants were topped to a uniform height of 1.75 m from the ground level. Emergence of new shoot began after 20-25 days of topping. The same procedure was followed in the next year February, 2015. Shoot pruning of current season's growth was done as per treatment, with the help of secateurs, in the last week of April during both the years of study. The observations on yield attributes and mineral composition of leaves were recorded during both the seasons (Rainy and winter season). The data were analyzed according to the procedure of analysis for Factorial Randomized Block Design. The significance of variation among the treatments was observed by applying 'F' test and critical difference at 5 per cent probability was calculated to compare the mean values of treatments for all the characters.

RESULTS AND DISCUSSION

(I) Leaf nutrient status

(A) Nitrogen content

The data presented in Table 1, revealed that pruning severity had no effect on nitrogen content of leaves in April sample, while significantly affected the July and October samples during both the years i.e. 2014-15 and 2015-16. In the month of July, the highest nitrogen content in leaves was observed in treatment P_0 (unpruned plants), while, lowest nitrogen content was found with treatment P_1 (OLP) during both the years of investigation. However, in October sample, the lowest nitrogen content was found with treatment P_4 (TNFS+OLP), while highest

Table 2: Effect of plant spacing and pruning severity on phosphorus (P)content of guava cv. Pant Prabhat.

Treatments	Sym.	Phosphorus (%)					
		2014-15			2015-16		
		April, 2014	July, 2014	October, 2014	April, 2015	July, 2015	October, 2015
Spacing							
2.0 X 1.0 m	S_1	0.235	0.214	0.178	0.238	0.219	0.169
2.0 X 2.0 m	S_2	0.238	0.219	0.182	0.243	0.223	0.172
SEm±		0.001	0.007	0.007	0.001	0.001	0.001
CD at 5%		0.002	0.002	NS	0.004	0.004	0.004
Pruning severity							
Unpruned	P_0	0.237	0.211	0.183	0.231	0.213	0.179
OLP	P_1	0.238	0.215	0.178	0.242	0.230	0.167
TLP	P_2	0.242	0.219	0.180	0.247	0.220	0.171
THLP	P_3	0.237	0.220	0.176	0.236	0.217	0.174
TNFS+OLP	P_4	0.241	0.224	0.175	0.245	0.235	0.154
TNFS+ TLP	P_5	0.235	0.215	0.179	0.242	0.224	0.169
TNFS+ THLP	P_6	0.237	0.209	0.186	0.234	0.216	0.178
TNFS	P_7	0.239	0.220	0.185	0.243	0.212	0.175
SEm±		0.002	0.001	0.001	0.003	0.003	0.002
CD at 5%		NS	0.004	0.004	0.005	0.009	0.008
CV		2.47	1.92	2.31	4.05	4.07	4.65

nitrogen content was recorded with unpruned plants (P_0) during both the years of study. Among plant spacing, nitrogen content of leaves increased non-significantly with increase the plant spacing. The plant spaced at 2.0 x 2.0 m (S_2) gave higher nitrogen content of leaves in all the seasons during both the years.

(B) Phosphorus content

A critical examination of data presented in Table 2, unveil that pruning severity had no effect on phosphorus content of leaves in April sample, while significantly affected the July and October samples during both the years i.e. 2014-15 and 2015-16.The highest phosphorus content of leaves was observed with treatment P_4 (TNFS+OLP) in the month of July during both the years of experiment. However, in October sample, the highest phosphorus content was found with treatment P_0 (unpruned plants) during both the years of study. Among plant spacing, phosphorus content of leaves increased significantly with decrease the plant density. The plant spaced at 2.0 x 2.0 m (S_2) gave higher phosphorus content of leaves in all the seasons during both the years.

(C) Potassium content

The data presented in Table 3, show that pruning severity had no effect on potassium content of leaves in April sample, while significantly affected the July and October samples during both the years (2014-15 and 2015-16). The highest potassium content was observed with treatment P_5 (TNFS+TLP) and treatment P_2 (TLP) in the month of July, during first year and second year, respectively. However, in October sample, the lowest potassium content was found with treatment P_4 (TNFS+OLP) during both the years of study. The plant spacing had non- significant effect on potassium content of leaves.

The observations on mineral composition of guava leaves are in close conformity with the earlier findings of Tassar *et al*. (1989) Kotour *et al.* (1997) and Goswami *et al.* (2012). Sah (2013) observed that nitrogen, phosphorus and potassium content of guava leaves were not affected significantly by any time of shoot pruning treatments. He also reported that all the time of shoot pruning treatments gave higher level of N, P and K contents in guava leaf than un-pruned plant during October. This is due to the fact that there were three timings for leaf sampling. Firstly, in the month of April *i.e.* before treatment application when the vegetative growth at the peak for flowering of rainy season crop. Secondly, after harvesting of rainy season crop. Thirdly, during winter season crop. In these three conditions, plant always had under a situation of utilization of nutrients whether in the form of vegetative growth, in the form of reproductive growth or exhausted after crop removal.

Pruning severity did not influence the leaf nitrogen, phosphorus and potassium contents during April because N, P and K contents were taken before imposing the

Table 1: Effect of plant spacing and pruning severity on nitrogen (N) content of guava cv. Pant Prabhat.

Treatments	Sym.	Nitrogen (%)					
		2014-15			2015-16		
		April, 2014	July, 2014	October, 2014	April, 2015	July, 2015	October, 2015
Spacing							
2.0 X 1.0 m	S_1	1.740	1.577	1.458	1.710	1.562	1.458
2.0 X 2.0 m	S_2	1.766	1.638	1.505	1.751	1.638	1.517
SEm±		0.004	0.005	0.002	0.011	0.013	0.007
CD at 5%		NS	NS	NS	0.03	NS	NS
Pruning severity							
Unpruned	P_0	1.722	1.681	1.533	1.779	1.701	1.519
OLP	P_1	1.730	1.553	1.469	1.669	1.456	1.452
TLP	P_2	1.738	1.627	1.500	1.753	1.601	1.500
THLP	P_3	1.732	1.652	1.502	1.733	1.677	1.501
TNFS+OLP	P_4	1.754	1.552	1.455	1.690	1.468	1.415
TNFS+ TLP	P_5	1.729	1.577	1.463	1.731	1.571	1.473
TNFS+ THLP	P_6	1.737	1.596	1.481	1.720	1.642	1.513
TNFS	P_7	1.775	1.624	1.487	1.749	1.653	1.528
SEm±		0.008	0.007	0.004	0.022	0.026	0.015
CD at 5%		NS	0.023	0.012	NS	0.074	0.043
CV		1.369	1.506	0.838	3.732	4.618	2.928

Table 3: Effect of plant spacing and pruning severity and on potassium (K) content of guava cv. Pant Prabhat.

Treatments	Sym.	Potassium (%)					
		2014-15			2015-16		
		April, 2014	July, 2014	October, 2014	April, 2015	July, 2015	October, 2015
Spacing							
2.0 X 1.0 m	S_1	1.273	1.151	1.002	1.258	1.170	1.061
2.0 X 2.0 m	S_2	1.291	1.188	0.963	1.284	1.154	1.006
SEm±		0.002	0.011	0.007	0.002	0.009	0.008
CD at 5%		NS	0.033	NS	NS	0.002	NS
Pruning severity							
Unpruned	P_0	1.265	1.110	1.068	1.260	1.126	1.100
OLP	P_1	1.254	1.159	0.942	1.253	1.152	1.008
TLP	P_2	1.286	1.161	0.993	1.278	1.212	1.030
THLP	P_3	1.261	1.148	1.013	1.261	1.154	1.070
TNFS+OLP	P_4	1.286	1.166	0.890	1.284	1.170	0.956
TNFS+ TLP	P_5	1.293	1.343	0.929	1.276	1.168	0.989
TNFS+ THLP	P_6	1.304	1.147	1.009	1.274	1.165	1.033
TNFS	P_7	1.308	1.121	1.020	1.283	1.148	1.079
SEm±		0.004	0.023	0.014	0.005	0.019	0.048
CD at 5%		0.013	0.067	0.040	0.016	0.055	0.017
CV		1.025	5.720	4.077	1.320	4.772	4.684

pruning treatments. Leaf nitrogen content was significantly influenced by pruning severity during July and October sample. This might be due to the utilization of nitrogen by the regrowth of vegetative parts of pruned plants. Leaf phosphorous content was significantly influenced by shoot pruning severity during July and it was higher in pruned plants than unpruned plants. This might be due to the less utilization of phosphorus by the lesser crop load after pruning while unpruned plants utilized more phosphorus due to more crop load of rainy season crop. On other hand lesser potassium content might be due to the utilization of more potassium by the pruned plants for fruit development of rainy season crop and regrowth for winter season crop.

The severity of pruning gave low leaf nitrogen, phosphorus and potassium contents than unpruned plants during October. Decreased nitrogen, phosphorus and potassium contents of the plants have also been reported by Olszewski and Mika (1990) and Sah (2013). Lower levels of leaf N, P and K pruned plants might be due to the heavy crop load during winter season crop causing more utilization of N, P and K. Unpruned plants contained higher amount of leaf N, P and K than the pruned plants. It was probably due to light crop load on unpruned plants and more crop load on pruned plants during winter season while unpruned plants got sufficient time to make up the nutrient status which was exhausted by heavy crop load in rainy season.

Yield (kg) per plant

The effect of interaction between plant spacing and pruning severity was found significant on fruit yield per plant (Table 4 and Fig. 1). The highest fruit yield (kg) per plant (6.60 and 6.14 kg/plant) was obtained with treatment combination S_2P_O (2.0 × 2.0 m plant spacing and unpruned plant), while the lowest (0.93 and 0.88 kg/plant) was found with treatment combination S_1P_4 (2.0 × 1.0 m plant spacing and TNFS+OLP) in rainy season during both the years of investigation. However, in winter season, the highest fruit yield (kg) per plant (6.53 and 6.23 kg/plant) was recorded with the treatment combination S_2P_4 (2.0 × 2.0 m plant spacing and TNFS+OLP). The lowest fruit yield per plant was recorded with treatment combination S_1P_O (2.0 × 1.0 m plant spacing and unpruned plants) during both the years of experiment.

The interaction between the plant spacing and pruning severity had also significant effect on total annual yield per plant during both the years of experiment (Table 4). The highest total annual yield per plant (8.13 kg/plant and 7.72 kg/plant) was obtained with treatment combination of S_2P_4 (2.0 × 2.0 m plant spacing and TNFS+OLP) followed by treatment combination S_2P_O (2.0 × 2.0 m plant spacing and unpruned plants) during both the years. The minimum total annual yield per plant (4.17 kg/plant and 4.28 kg/plant) was recorded with treatment combination S_1P_6 (2.0 × 1.0 m plant spacing and

Table 4: Interaction effect of plant spacing and pruning severity on total yield (kg) per plant of guava cv. Pant Prabhat.

Treatments	Sym.	Total yield (kg/plant)											
		2014-15						2015-16					
		2.0 X 1.0 m (S_1)			2.0 X 2.0 m (S_2)			2.0 X 1.0 m (S_1)			2.0 X 2.0 m (S_2)		
		R*	W*	T*	R	W	T	R	W	T	R	W	T
Unpruned	P_0	4.90	0.94	5.84	6.60	1.41	8.01	4.42	0.82	5.24	6.14	1.28	7.42
OLP	P_1	1.10	3.98	5.08	1.94	5.78	7.72	1.01	3.71	4.72	1.50	4.52	6.02
TLP	P_2	1.56	2.73	4.29	2.30	4.34	6.64	1.49	2.79	4.28	2.09	3.53	5.62
THLP	P_3	2.00	2.30	4.30	3.15	3.61	6.76	2.19	2.28	4.47	2.99	2.98	5.97
TNFS+OLP	P_4	0.93	5.04	5.98	1.60	6.53	8.13	0.88	4.46	5.34	1.48	6.23	7.72
TNFS+ TLP	P_5	1.32	3.59	4.91	1.61	5.11	6.72	1.31	3.34	4.65	1.97	4.77	6.74
TNFS+ THLP	P_6	1.48	2.69	4.17	1.95	4.09	6.04	1.51	2.98	4.49	2.12	3.97	6.08
TNFS	P_7	2.69	1.68	4.37	4.31	2.29	6.59	2.72	1.62	4.34	4.48	2.12	6.60
SEm±		0.16	0.20	0.28	0.16	0.20	0.28	0.16	0.17	0.25	0.16	0.17	0.25
CD at 5%		0.47	0.57	0.79	0.47	0.57	0.79	0.45	0.48	0.71	0.45	0.48	0.71
CV		13.42	11.49	9.36	13.42	11.49	9.36	13.39	10.61	8.92	13.39	10.61	8.92

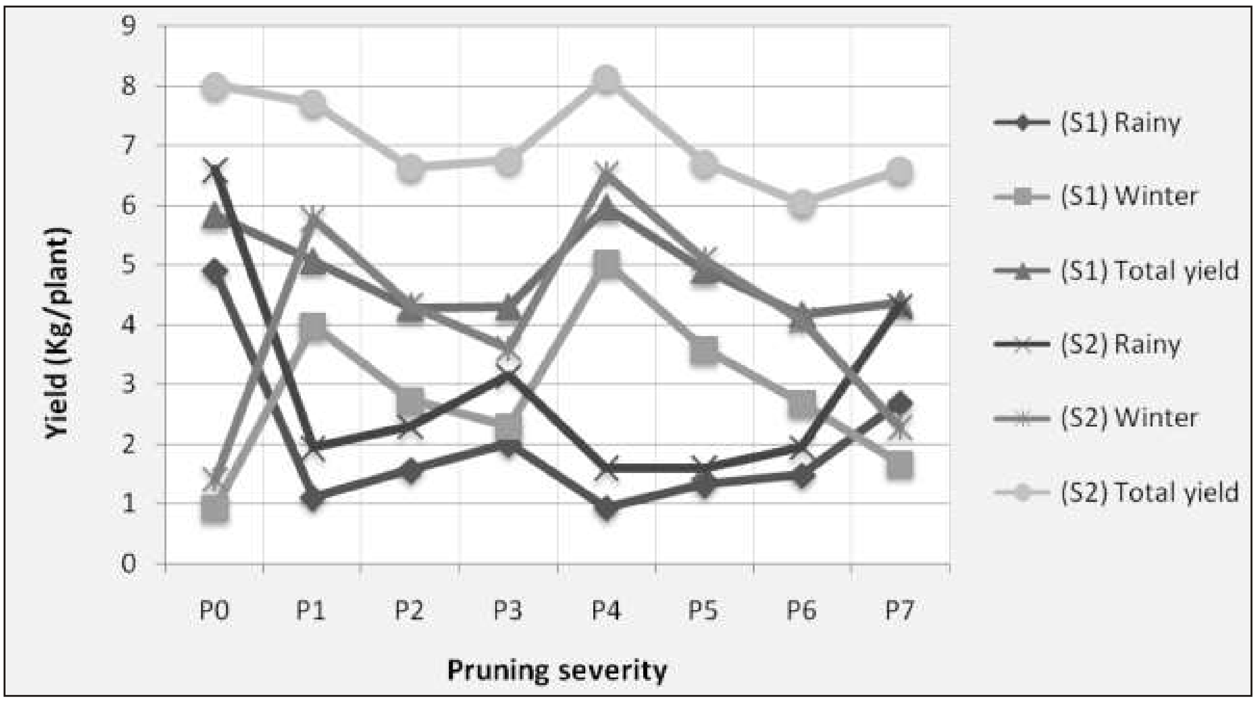

Fig. 1: Interaction effect of plant spacing and pruning severity on yield (kg/plant) of guava cv. Pant Prabhat during the years 2014-15.

TNFS+THLP) in first year and S_1P_2 (2.0 × 1.0 m plant spacing and TLP) in second year, respectively.

Yield (q) per plant

The interaction among plant spacing and pruning severity significantly affected the total annual fruit yield (q) per hectare during both the years of investigation (Table 5). The highest total annual yield (298.93 q/ha and 267.22 q/ha) was recorded with treatment combination of 2.0 × 1.0 m plant spacing and TNFS with OLP (S_1 P_4) followed by combination S1PO i.e. plant spaced at 2.0 × 1.0 m and unpruned plants during both the years of experiment. The lowest total annual yield (151.03 q/ha and 140.54 q/ha) was obtained with treatment combination S_2P_6 (2.0 × 2.0 m plant spacing and TNFS+THLP) in first year and S_2P_2 (2.0 × 2.0 m plant spacing and TLP) in second year, respectively. Several

Table 5: Interaction effect of plant spacing and pruning severity on total yield (q/ha) of guava cv. Pant Prabhat.

Treatments		Total yield (q/ha)											
		2014-15						2015-16					
		2.0 X 1.0 m (S_1)			2.0 X 2.0 m (S_2)			2.0 X 1.0 m (S_1)			2.0 X 2.0 m (S_2)		
		R*	W*	T*	R	W	T	R	W	T	R	W	T
unpruned	P_0	244.90	47.23	292.13	165.04	35.16	200.21	221.18	40.75	261.93	153.56	31.89	185.44
OLP	P_1	55.21	198.84	254.05	48.55	144.53	193.08	50.53	185.59	236.12	37.41	112.96	150.36
TLP	P_2	77.90	136.54	214.44	57.49	108.61	166.11	74.55	139.33	213.88	52.19	88.36	140.54
THLP	P_3	100.14	114.90	215.04	78.66	90.37	169.03	109.68	114.00	223.68	74.71	74.60	149.31
TNFS+OLP	P_4	46.69	252.24	298.93	40.02	163.19	203.21	43.97	223.24	267.22	37.12	155.76	192.88
TNFS+TLP	P_5	66.14	179.56	245.70	40.19	127.86	168.05	65.65	167.03	232.68	49.24	119.21	168.44
TNFS+THLP	P_6	74.10	134.30	208.40	48.82	102.21	151.03	75.53	148.86	224.39	52.88	99.16	152.04
TNFS	P_7	134.49	84.05	218.54	107.63	57.18	164.81	135.98	81.1	217.04	111.99	53.05	165.04
SEm±		5.60	6.59	9.16	5.60	6.59	9.16	5.51	5.74	8.01	5.51	5.74	8.01
CD at 5%		15.97	18.77	26.11	15.97	18.77	26.11	15.72	16.35	NS	15.72	16.35	NS
CV (%)		12.94	10.67	8.72	12.94	10.67	8.72	13.12	10.01	8.06	13.12	10.01	8.06

*(R: Rainy season, W: Winter season, T: Total yield) # Treatment abbreviations - P_1, OLP: One leaf pair shoot pruning; P_2 TLP: Two leaf pairs pruning; P_3, THLP: Three leaf pairs shoot pruning; P_4, TNFS + TOLP: Thining out of non-fruiting shoots + one leaf pair shoot pruning; P_5, TNFS + TPLP; Thining out of non fruiting shoots + Two leaf pairs shoot pruning; P_6 TNFS+THLP Thiningout of non-fruiting shoots + Three leaf pairs shoot pruning; P_7 TNFS : Thining out of non-fruiting shoots.

researchers also observed the similar results in guava crop and reported that as increased the severity of pruning decreased the fruit yield in rainy season and subsequently increased in the winter season crop. These results are in accordance Tiwari and Lal (2007), Pratibha *et al.* (2013), Joshi *et al.* (2014), Kumawat *et al.* (2014), Thakre *et al.* (2016) and Joshi *et al.* (2016).

Pruning severity with complete removal of non fruiting shoots significantly decreased the yield in rainy season crop and subsequently increased the yield in winter season crop. This type of trend might be due to response of plant hormones, stored carbohydrates and available nutrients in soil. Shoot pruning overcomes the apical dominance and increases the activity of cytokinin and gibberellins, which promotes emergence of new shoots. Cytokinin content and its activity is very high in all growing shoots of pruned plants (Murray, 2010). Elevated growth of new vegetation occurs after pruning. It strongly reduces nutrient reserves, in particular of carbohydrates, from unpruned plant parts (Marini, 2014). Shoot pruning, thus, affects the physiological processes of photosynthesis and non-structural carbohydrate synthesis. Non-structural carbohydrate reserves, mainly starch provide the energy to drive re-growth of pruned plants for rainy season flowering (i.e. winter season fruiting).The stored carbohydrates in plants and available nutrients in soil, which might have been used for further growth of non-fruiting shoots, have been utilized for emergence of new shoots and subsequently for impressive morphometric growth and enhanced fruit quality of winter season crop (Bagachi *et al.*, 2008).

CONCLUSION

On the basis of above observations, it can be concluded that leaf nitrogen and phosphorous content were significantly influenced by pruning severity during July and October sample and it was lesser in pruned plants than unpruned plants. The plant spaced at 2.0 x 2.0 m gave higher nitrogen and phosphorus content of leaves in both the seasons during both the years. Fruit yield of guava can be influenced by pruning severity and plant spacing. Maximum fruit yield per hectare can be achieved with 2.0 X 1.0 m plant spacing. Therefore, for obtaining higher winter season crop and maintaining leaf nutrient status under high density plantation (2.0 x 1.0 m plant spacing) of guava, complete removal of non fruiting shoots followed by one leaf pair shoot pruning of current season growth (i.e. retaining one leaf pair at the base of the newly emerged shoots) should be done during first week of May.

REFERENCES

Bagachi, T.B., Sukul, P. and Ghosh, B. (2008). Biochemical changes during off-season flowering in guava (*Psidium guajava* L.) induced by bending and pruning. *J. of Tropical Agri.,* 46(1-2): 64-66.

Bose, T.K. and Mitra, S.K. (2001). Guava In: Fruits: Tropical and Subtropical. Bose, T.K and Mitra, S.K. (eds.). Naya Prakashan Kolkata, 280-303.

Goswami, A.K., Lal, S., and Misra, K.K. (2012). Integrated nutrient management improves growth and leaf nutrient status of guava cv. Pant Prabhat. *Indian Journal of Horticulture*, 69(2): 168-172.

Hays, W.B. (1974). Fruit Growing in India. Kitabistan, Allahabad.

Joshi, P., Lal, S., Nautiyal, P. and Pal, M. (2014). Response of plant spacing and pruning intensity on yield contributing characteristics of guava cv. Pant Prabhat. *J Hill Agr*., 5(2): 163-167.

Joshi, P., Lal, S., Nautiyal, P. and Pal, M. (2016). Effect of plant spacing and pruning intensity on flowering, fruiting, and yield of guava (*Psidium guajava* L.) cv. Pant Prabhat, *International Journal of Agriculture Sciences*, 8(7):1064-1068.

Kotur, S.C., Kumar, R. and Singh, H.P. (1997). Influence of nitrogen, phosphorus and potassium on composition of leaf and its relationship with fruit yield in Allahabad Safeda guava (*Psidium guajava* L.) on an Alfisol. *Indian J Agri. Sci*., 67:568-570.

Kumawat, K.L., Sarolia, D.K., Kaushik, R.A. and Jodha, A.S. (2014). Effect of different spacing on newly planted guava cv l-49 under ultra high density planting system. *African Journal of Agricultural Research*. 9(51): 3729-3735.

Lal, S. (1992). Response of guava (*Psidium guajava* L.) cv Sardar to spacing and pruning intensities. Thesis, Doctor of Philosophy (Horticulture), G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, India. 129 p.

Lal, S. Tiwari, J. P. and Misra K.K. (2000). Effect of plant spacing and pruning intensity on fruit yield and quality of guava. *Progressive Horticulture*, 32(3-4): 20-25.

Lal, S., Tiwari, J.P. Awasthi P. and Mahajan A.R. (2007). Studies on planting systems in guava (*Psidium guajava* L.) cv. Sardar. *Acta Horticulturae*, 735: 263-266.

Marini, R. (2014). Physiology of pruning fruit trees, Virginia cooperative Ext. Publication, 422-025:1-8.

Murray, J. (2010). Tree hormones and why they matter, *Arnoldia Arboretum*, 67(4): 15-19.

N.H.B. (2015). *Indian Horticulture database*. N.H.B., Gurgaon, Haryana.

Olszewski, T. and Mika, A. (1990). Influence of orchard cultural practices on mineral composition of apple leaves and fruits (ii) influence of apple trees planting density of mineral compostion of fruit. *Fruit Science Reports*, 17(3):121-128.

Pratibha, Lal, S. and Goswami, A.K. (2013). Effect of pruning and planting systems on growth, flowering, fruiting and yield of guava cv. Sardar. *Indian Journal of Horticulture,* 70(4): 496-500.

Rathore, D.S. and Singh, R.N. (1976). Yield pattern in three cropping patterns of guava (*Psidium guajava* L.). *Indian Journal of Horticulture*, 33(1):7-13.

Sah, H. (2013). Response of time of shoot pruning in meadow orchard of guava (*Psidium guajava* L.) cv. Pant Prabhat. Thesis, Doctor of Philosophy (Horticulture), G. B. Pant University of Agriculture and Technology, Pantnagar, U. S. Nagar, India. 138p

Tassar, K., Tiwari, J.P. and Lal, S. (1989). Effect of different levels of leaf nitrogen on growth, yield and quality of guava (*Psidium guajava* L) cv. Sardar. *Progressive Horticulture*, 20(3-4):213-217.

Thakre, M., Lal S., Uniyal, S., Goswami A.K. and Prkash, P. (2016). Pruning for crop regulation in high density guava (*Psidium guajava* L.) plantation. *Spanish Journal of Agricultural Research,* 14(2):e0905 http://dx.doi.org/10.5424/sjar/2016142-7846

Tiwari, J. P. and Lal, S. (2007). Effect of NAA, flower bud thinning and pruning on crop regulation in guava (*Psidium guajava* L.) cv. Sardar. *Acta Horticulturae*, 735: 311-314.

Tyagi, S.K. and Patel, R.M. (2004). Effect of growth regulators on rooting of air layering of guava *(Psidium guajava L.). Orissa journal of Horticulture*, **4**:23-27.

Received: July 31, 2016
Accepted: August 17, 2016