The Bioscan 10(1): 411-415, 2015 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

EFFECT OF TERTIARY SHOOT PRUNING AND FOLIAR SPRAY OF NUTRIENTS ON FLOWERING AND YIELD OF CASHEW (*ANACARDIUM OCCIDENTALE* L.) UNDER HIGH DENSITY PLANTING SYSTEM

K. MURALI*[1], P. PRASANNA KUMAR[1] AND M. S. ANEESA RANI[2]
[1]Department of Spices and Plantation Crops, Tamil Nadu Agricultural University, Coimbatore -3, INDIA
[2]Regional Research Station, Vriddhachalam - 606 001, INDIA
e-mail: muralihort@yahoo.com

KEYWORDS
Tertiary shoots pruning
Foliar spray
Flowering

Received on :
16.12.2014

Accepted on :
18.02.2015

***Corresponding author**

ABSTRACT
A field experiment was conducted during 2011-2012 at Regional Research Station, TNAU, Vriddhachalam. The experiment was laid out in split plot design with main plot consisted of tertiary shoot pruning (M_1) and control (M_2). The sub plot consisted of foliar spray of NPK 19:19:19 (1%) was given at new flush stage uniformly in all the treatments except the control in M_1S_9 and absolute control in M_2S_9 (August). A second spray of NPK 19:19:19 (1%), boron (0.1%), sulphate of potash (SOP) (2 %), mono ammonium phosphate (MAP) (1%) alone or in different combinations were given at flowering stage (December). The results also revealed that the treatment (M_1S_8) consisting of tertiary shoot pruning along with two foliar sprays *viz.*, NPK 19:19:19 @ one per cent at new flush stage (August) followed by a second spray of boron 0.1% + SOP 2% + MAP 1% at flowering stage (December) was found to be the best in increasing number of current season's shoot (3.25 Numbers), number of panicles (16.3 Numbers per m^2), percentage of bisexual flowers (31.9%), percentage of fruit set (11.5%) and yield (4.43 kg/ tree) in cashew grown under high density planting system.

INTRODUCTION

Cashew, *Anacardium occidentale* L. (Anacardiaceae), is a nut crop of world importance. It is a predominantly cross pollinated tree with entomophilous pollination (Nambiar and Pillai 1985). In India, Kerala, Karnataka, Goa, Maharashtra on West Coast and Tamil Nadu, Andhra Pradesh, Orissa, West Bengal on East coast are the major cashew growing states. Maharashtra leads in area, production and productivity with 1.64 lakh hectares, 1.97 lakh MT and 1.5 MT ha^{-1} respectively. Tamil Nadu records a poor productivity of (700 kg ha^{-1}) despite its large area under cashew (1.23 lakh ha^{-1}). Large area of old senile seedling orchards, low plant population, poor canopy management and non-adoption of improved package of practices are considered as the major limiting factors in cashew production (Kumar *et al.,* 2012). Development, popularization and area increase under improved varieties / hybrids, development of high density planting system and good agricultural practices to double the yield per unit area are the ways to improve the cashew productivity in the state. In Tamil Nadu, high density planting system with spacing of 5 x 4 m to accommodate 500 plants ha^{-1} was standardized and released for adoption during 2011 (Anon, 2011). In HDP method, pruning is an important tree management practice to regulate vegetative growth, flowering and yield in many fruit crops including mango (Srilatha *et al.,* 2015).

One of the major reasons for low productivity of cashew in Tamil Nadu as compared with other states like Andhra Pradesh and Maharashtra is poor nutrient management practices in orchards. However, studies proved that the cashew responds very well to fertilizer and irrigation, wherein, the individual trees are capable of yielding 23-36 kg per tree (Chacko, 1994).

There is a great scope for improving the fruit set, number of nuts and nut yield per tree through fertilization, foliar spray with nutrients and plant growth regulators as evidenced in many other horticultural crops (Albert and Krishnasamy, 2004). Tertiary shoot pruning along with nutrient foliar spray has been standardized to manage the canopy and increase the yield of cashew orchards under normal density (Aneesa Rani *et al.*, 2011). However, it becomes necessary to study the effect of such pruning combined with various nutrient foliar spray schedules for canopy management and to double the nut yield per unit area under high density planting system. Keeping this in view, the study was conducted in cashew with an objective of increasing the flowering, fruit set and yield in cashew under high density planting system.

MATERIALS AND METHODS

A field experiment was conducted during 2011-12 at Regional Research Station, TNAU, Vriddhachalam. The experiment was laid out in a split plot design with 2 main plot and 9 sub plot treatments with 2 replications. The variety used for the study was VRI 3 with hundred uniform sized trees spaced at 5 x 4m. Trees were about 3 years old and each treatment consists of 4 trees. Each replication has two trees. Tertiary shoot pruning was done on July 15th. Tertiary shoot pruning was done upto half of the length of the shoot removed. It is also called as

lateral shoot pruning. First foliar spray of NPK 19:19:19 was given on August 15th (New flush stage). Second foliar spray based on treatments was given on December 15th (Flowering stage). Observation on plant morphological characteristics was taken 30 days after foliar spray of NPK 19:19:19 given as per the treatments and at harvest stage.

The treatments comprised of main plot M_1 - Tertiary shoot Pruning and M_2 - No pruning. Sub plots consisted of foliar spray of different nutrients and interaction consisted tertiary shoot pruning and foliar spray of different nutrients, M_1S_1 - NPK 19:19:19 mixture 1% foliar spray during at new flush stage (August), M_1S_2 - M_1S_1 + Boron 0.1% foliar spray at flowering stage (December), M_1S_3 - M_1S_1 + Sulphate of Potash (SOP) 2% at flowering stage (December), M_1S_4 - M_1S_1 + Mono Ammonium Phosphate 1% at flowering stage (December), M_1S_5 - M_1S_1 + Boron 0.1% and SOP 2% at flowering stage (December), M_1S_6 - M_1S_1 + Boron 0.1% and MAP 1% at flowering stage (December), M_1S_7 - M_1S_1 + NPK 19:19:19 mixture 1% at flowering stage (December), M_1S_8 - M_1S_1 + Boron 0.1% + SOP 2% + MAP 1% at flowering stage (December), M_1S_9 - No spray, M_2S_1 - NPK 19:19:19 mixture 1% foliar spray during at new flush stage (August), M_2S_2 - M_2S_1 + Boron 0.1% foliar spray at flowering stage (December), M_2S_3 - M_2S_1 + Sulphate of Potash (SOP) 2% at flowering stage (December), M_2S_4 – M_2S_1 + Mono Ammonium Phosphate 1% at flowering stage (December), M_2S_5 - M_2S_1 + Boron 0.1% and SOP 2% at flowering stage (December), M_2S_6 - M_2S_1 + Boron 0.1% and MAP 1% at flowering stage (December), M_2S_7 - M_2S_1 + NPK 19:19:19 mixture 1% at flowering stage (December), M_2S_8 - M_2S_1 + Boron 0.1% + SOP 2% + MAP 1% at flowering stage (December), M_2S_9 - No spray + No Pruning (Control).

RESULTS AND DISCUSSION

Effect of tertiary shoot pruning and foliar spray on number of current season's shoot

M_1 with pruning recorded the highest value of 3.10 numbers, when compared to M_2 (2.08 number of current season's shoot). Consequent to pruning of branches, new shoots are expected to grow as a result of removal of apical dominance. In the present study also, it was observed that pruned shoots gave more number of laterals per branch, highlighting the suppressive effect of apical dominance as expected in any other plants. More number of lateral productions in the pruned shoot was also observed in cashew by Mohan and Singh (1991). Satapathy (1988) suggested that pruning of terminal shoots after harvest induced the early emergence of shoots which resulted in better fruiting in the next year in mango.

In this study pruning and foliar spray produced higher number of current season shoot compared to control. Among the sub plot, S_8 recorded the highest mean value for current season's shoot (2.76 numbers) followed the lowest number of current season's shoot S_9 with 2.33 numbers. M_1S_1, M_1S_2 showed the highest value of 3.25 numbers followed by M_1S_7 with 3.23 numbers (Table.1). In this study pruning and foliar spray produced higher number of current season shoot compared to control. Ram (1999) also opined that shoot decapitation in the last week of June and first week of July followed by 1% urea spray after harvesting increased new shoot production in mango. Cashew is a current season shoot bearer and hence reduction in canopy size could no way have deleterious effect on current season's shoot production. This is highly beneficial in increasing the number of flowering shoots and thus nut yield.

Effect of tertiary shoot pruning and foliar spray on number of number of panicles per m^2

Number of panicles after 30 days of second foliar spray, M_1 with pruning recorded the highest value of (14.42 numbers), when compared to M_2 (12.52 numbers). In an evergreen tree like cashew, proper canopy management is essential to encourage sufficient number of panicles per square meter and number of panicles per tree so that the higher productivity could be achieved. Results of pruning on 28 year old trees revealed that trees with three branches pruned recorded the highest number of panicles / sq. m. in cashew (Panda, 1990). Number of panicles emerged from current season's shoot per tree was also significantly influenced by pruning and foliar spray of nutrient in the present investigation. The highest number of panicles was observed in pruned trees. Among the sub plot mean also significant difference was observed. M_1S_8 (M_1S_1 + Boron 0.1% + SOP 2% + MAP 1% at flower initiation stage (November) showed the highest value (16.3 Numbers) followed by M_1S_5 (M_1S_1 + Boron 0.1% and SOP 2% at flower initiation stage) (15.5 Numbers) (Table.1) . This revealed that boron and phosphorous had significant effect on improving flowering characterstics. The enhanced number of panicle production is attributed to nitrogen, phosphorous, potash in foliar sprayed treatments in mango (Kanwar *et al.*, 1987). Aneesa rani *et al.* (2011) reported that tertiary pruning along with foliar spray of mono ammonium phosphate induced more number of panicles per sq. m in cashew, which is an accordance with the present study.

Effect of tertiary shoot pruning and foliar spray on percentage of bisexual flowers

Percentage of bisexual flowers per panicle has direct relationship with fruit set and yield. The pruning intensities significantly improved the percentage of bisexual flowers per panicle. Waghmare and Joshi (2008) reported that the low percentage of bisexual flowers is due to the development of low temperature regime in denser canopies. Removal of excess shoots, which leads to more light interception and movement of assimilates to fewer growing points. Among the main plot treatment, M_1 with pruning recorded the highest mean value of 28.74 per cent when compared to M_2 with 26.81 per cent. The increase in bisexual flower production in the pruned shoots might be due to reduction of gibberellin output which consequently brought about an optimum cytokinin/ gibberellin balance to promote flowering (Rao and Khader, 1979). In this study, the higher percentage of bisexual flowers per panicle was found in pruned treatments. Among the sub plot treatment also significant difference was observed. This indicated that foliar spray of different nutrients enhanced the percentage of bisexual flowers per panicle. The treatment M_1S_8 (M_1S_1 + Boron 0.1% + SOP 2% + MAP 1% at flowering stage) recorded the highest number of bisexual flowers (31.9 per cent) revealing the effects of foliar spray of nutrients on induction of female/ bisexual flowers in cashew(Table.1). Aneesa Rani *et al.* (2011) reported that foliar spray of NPK

Table 1: Effect of tertiary shoot pruning and foliar spray on number of current season's shoot percentage of bisexual flowers (%), percentage of fruit set (%) in cashew

Main plot mean										
Treatment	Number of current season's shoot		Number of panicle per sq.m		Percentage of bisexual flowers		Percentage of fruit set		Yield (kg)	
M_1	3.10		14.52		28.74		10.28		3.97	
M_2	2.08		12.52		26.81		8.650		3.67	
Mean	2.59		13.52		27.78		9.465		3.82	
	SEd	CD 0.05	SEd	CD 0.05	SEd	CD 0.05	SEd	CD 0.05	SEd	CD 0.05
M	0.04	0.56*	0.05	0.70*	0.11	1.41 *	0.22	NS	0.01	0.18*
Sub plot mean										
S_1	2.72		13.70		27.4		8.75		3.57	
S_2	2.72		14.55		29.3		9.96		4.10	
S_3	2.55		14.25		28.1		9.60		3.71	
S_4	2.66		13.35		27.6		9.27		3.85	
S_5	2.38		14.45		28.5		9.24		4.02	
S_6	2.50		13.25		29.2		10.1		4.00	
S_7	2.70		13.90		27.7		9.01		3.99	
S_8	2.76		14.60		30.9		10.5		4.29	
S_9	2.33		9.650		21.4		8.82		2.87	
Mean	2.59		13.52		27.8		9.47		2.87	
	SEd	CD 0.05	SEd	CD 0.05	SEd	CD 0.05	SEd	CD 0.05	SEd	CD 0.05
S	0.12	0.26*	0.21	0.45*	0.55	1.17 *	0.27	0.58 *	0.08	0.18*
Interaction effect										
M_1S_1	3.25		14.7		28.2		9.57		3.70	
M_1S_2	3.25		15.4		30.7		11.2		4.25	
M_1S_3	3.03		15.0		27.8		10.6		3.91	
M_1S_4	3.15		13.6		28.4		9.96		3.91	
M_1S_5	3.15		15.5		28.8		9.77		4.10	
M_1S_6	2.97		13.4		30.1		11.4		4.05	
M_1S_7	3.23		15.2		29.2		9.82		4.08	
M_1S_8	3.03		16.3		31.9		11.5		4.43	
M_1S_9	3.08		11.6		23.6		8.88		3.30	
M_2S_1	2.20		12.7		26.6		7.93		3.45	
M_2S_2	2.10		13.7		27.8		8.76		3.95	
M_2S_3	2.08		13.5		28.3		8.66		3.51	
M_2S_4	2.18		13.1		26.7		8.59		3.80	
M_2S_5	2.08		13.4		28.2		8.71		3.95	
M_2S_6	2.15		13.1		28.3		8.83		3.95	
M_2S_7	2.03		12.6		26.3		8.21		3.90	
M_2S_8	2.00		12.9		30.0		9.44		4.15	
M_2S_9	1.86		7.70		19.2		8.76		2.45	
Mean	2.60		13.5		27.8		9.48		3.82	
	SEd	CD 0.05	SEd	CD 0.05	SEd	CD 0.05	SEd	CD 0.05	SEd	CD 0.05
MXS	0.17	0.48*	0.29	0.72*	0.74	1.75 *	0.42	2.10 *	0.11	0.26*
SXM	0.17	0.37*	0.30	0.64*	0.78	1.65 *	0.39	0.82 *	0.12	0.25*

19:19:19 (1%) and MAP (1%) at flushing and flowering stage respectively enhanced the bisexual flowers in VRI 3 cashew.

Effect of tertiary shoot pruning and foliar spray on percentage of fruit set

There was no significant difference among the main plot treatments with respect to percentage of fruit set. In the present investigation, the maximum percent of fruit set was noticed in treatment with pruning (M_1). Yeshitela *et al.* (2005) observed that panicle pruning at the time of full bloom induced synchronized re-flowering and early fruit set in mango cv. Tommy Atkins. Cashew generally produces more number of flowers in the panicles but the per cent of fruit set is relatively low. Hence, knowledge on the fruit setting ability is highly essential under any crop management practices.

S_8 recorded the highest percentage of fruit set (10.5%) followed by S_6 with 10.1 per cent. M_1S_8 recorded the highest percentage of fruit set (11.5%) followed by M_1S_6 with 11.4 per cent (Table.1). In this study, the foliar spray with pruning in M_1S_8 (M_1S_1 + Boron 0.1% + SOP 2% + MAP 1% at flowering stage) recorded the highest percentage of fruit set. Boron has been found to play a key role in reproductive processes affecting another development, pollen germination, pollen tube growth and enhancing the fruit set which is evident from results showing higher fruit set in boron sprayed treatments (Ganie *et al.,* 2014). Foliar spray of boron increased the fruit set percentage in almond (Nyomora *et al.,* 1997) and hazelnut (Silva *et al.,* 2003). However, the NPK with boron, SOP and MAP treatment has revealed the role of boron and sulphate of potash in enhancing the accumulation of carbohydrate in the flowering shoots. The carbohydrate was then utilized for the fruit set. Issarangkool and Ayutthaya (2000) showed that application of boron during flowering increased the carbohydrate content in shoots and fruit set in mango. Similar

results were obtained in VRI 3 cashew which showed tertiary pruning along with nutrient foliar spray increased the growth and production of number of nuts per sq m. (Aneesa Rani *et al.,* 2011).

Effect of tertiary shoot pruning and foliar spray on nut yield per tree

Among the main plot treatments, M_1 with pruning recorded the highest value (3.97 kg) of yield per tree. M_2 without pruning recorded the lowest value (3.67 kg) of yield per tree. S_8 recorded the highest value (4.29 kg) of yield per tree. Nut yield in cashew is mainly influenced by number of current season's shoot, flowering clusters and fruit set percentage (Aneesa Rani *et al.,* 2011). The rise in nut production might be ascribed to the increase in fruit setting. To support this result, Pruning of cashew tree influenced the production of flowering laterals, number of bisexual flowers per panicle and the number of fruits per panicle (Ghosh,1988). Kumar and Rattanpal (2010) studied that in guava, the total fruit yield and yield per hectare were the highest in pruning treatment of half removal of vegetative growth.

In the present study, the nut yield per tree during the period of experiment was generally higher in pruning combined with foliar spray treatments. Foliar spray of nutrients had positive effect on plants. M_1S_8 (M_1S_1 + Boron 0.1% +SOP 2% + MAP 1% at flowering stage) recorded (4.43 kg) the highest nut yield followed by M_1S_2 with 4.25 kg (Table.1). This is attributed to the fact that the treatment had the highest current season's shoot, number of panicles, carbohydrate content, C: N ratio and percentage of fruit set in cashew. Foliar spray of boron, SOP, MAP at different concentration increased the yield. Similar results obtained by Silva *et al.* (2003) stated that the foliar application of 600 and 900 mg l^{-1} of boron increased the pollen germination, fruit set and nut yield of hazelnut. Kumar *et al.* (2009) reported in mango cv. Alphonso that foliar application of sulphate of potash 2 per cent was effective in improving the number of fruits and fruit yield per tree. Mono ammonium phosphate treatments increased vigour of trees, the number of flower clusters per tree, flower intensity, the number of fruits per tree in apple (Wojcik and Klamkowski, 2005). Aneesa Rani *et al.* (2011) reported that tertiary shoot pruning along with foliar spray increased yield by about 30 per cent in cashew.

REFERENCES

Albert, V. and Krishnasamy, V. 2004. Evaluation of organic sources of nutrients on growth and yield parameters of tomato, Master thesis, Department of soil science and agricultural chemistry, TNAU, Coimbatore-3.

Aneesa rani, M. S., Jeeva, S. and Vaidyanathan, R. 2011. Effect of pruning and foliar spray on growth and yield of cashew variety VRI 3. In: 1st International symposium on cashew nut, held at AC & RI , TNAU, Madurai, 09 -12 December 2011.

Anonyomus 2011. High density planting system in cashew. **In:** New crop implements and management technologies, Ed: Directorate of Research, Tamil Nadu Agricultural University, Coimbatore, 641 003

Babhulkar, P. S., Badole, W. P. and Balpande, S. S. 2000. Effect of sulphur and zinc on yield and quality and nutrient uptake by safflower in vertisol. *J. Ind. Soc. Soil Sci.* **48(3):** 541-543.

Chacko, E. K. 1994. Cashew hybridization during 1988 - 92 (CSH - 36 H) and evaluation of progenies planted at four test sites in Northern Australia. Working papers of the seventh Annual cashew research and development workshop, May 17, 1994, Cairns, North Queensland. pp.1-10.

Ganie, M. A., Akhter, F., Bhat, M. A. and Najar, G. R. 2014. Growth, yield and quality of French bean (*Phaseolus vulgaris L.*) as influenced by sulphur and boron application on inceptisols of Kashmir. *The Bioscan.* **9(2):** 513-518.

Ghosh, S. N. 1988. Effect of nitrogen, phosphorus and potassium on flowering duration, yield and shelling percentage of cashew (*Anacardium occidentale* L.). *Ind. Cashew J.* **19:** 19-23.

Issarangkool, N. and Ayutthaya, S. 2000. Influence of calcium – boron on carbohydrate reserve, protein and fruit set of mango cv. Nam Dok Mai Tawai. *Master thesis, Kasetsart Univ.* Thailand.

Kanwar, J. S., Nijjar, G. S. and Kahlon, G. S. 1987. Effect of nitrogen, phosphorus and potassium fertilizers on growth and productivity of Dashehari mango (*Mangifera indica* L.). *J. Res. Punjab Agricul. Univ.,* **24:** 411-422.

Kumar, N., Ponnuswami, V., Jeeva, S., Ravindran, C. and Kalaivanan, D. 2012. Cashew industry in India - An overview. *Chronica Horticulturae.* **52(1):** 23-29.

Kumar, N., Selvi., Suresh, R. J., Balakrishnan, S. and George, E. 2009. Foliar application of sulphate of potash on the yield and quality of fruits in mango (*Mangiferaindica* L.) cv. Alphonso **In:** National seminar on production, post harvest technology and marketing of mango, held at HC & RI, TNAU, Periyakulam, 23 - 25 September 2009. pp. 118 - 120.

Kumar, Y and Rattanpal, H.S. 2010. Effect of pruning in guava planted at different spacing's under Punjab conditions. *Indian J. Hort.,* **67:**115-119.

Mohan, E. and Singh, R.1991. Effect of time and severity of pruning in cashew. *J. Plantation Crops.* **18:** 7-10.

Nambiar, M.C. and Pillai, P.K.T. 1985. Cashew. **In:** Fruits of India: tropical and subtropical. *Edited by* T.K.Bose. Naya Prokash, Calcutta, India. pp.409–438.

Nyomora, A. M., Nyomora, S. and Brown, P. H. 1997. Fall foliar application boron increases tissue boron concentration and nut set of almond. *J. Amer. Soc. Hort. Sci.* **122:** 405-415.

Panda, J. M. 1990. Effect of pruning severity on yield of cashewnut. *Cashew bull.* **27:** 15-17.

Ram, S. 1999. Hormonal physiology of flowering in Dasheri mango. *J. Appl. Hort.* **1(2):** 84-88.

Rao, V. N. M. and Khader, J. B. M. A. 1979. More about mango pruning. *Indian Hort.* **23(4):** 2-5.

Satapathy, B. 1988. Thinning, training and pruning of cashew to increase production and and productivity of cashewnut. *The Cashew.* **2:** 6-8.

Silva, A. P., Rosa, E. and Haneklaus, S. H. 2003. Influence of foliar boron application on fruit set and yield of hazelnut. *J. Plant Nutr.* **26:** 561-569.

Srilatha, V., Reddy, Y. T. N., Upreti, K. K. and Jagannath, S. 2015. Pruning and paclobutrazol induced vigour, flowering and hormonal changes in mango (*Mangifera indica L.*). *The Bioscan.* **10(1):** 161-166.

Stephenson, R. A. and Gallagher, E. C. 1987. Effects of foliar boron sprays on yield and quality of macadamia. *Scientia Hort.* **32:** 97-103.

Waghmare, G. M. and Joshi, G. D. 2008. Response of mango (*Mangifera indica* L.) to light pruning for vegetative and flowering flushes. *Indian J. Agri. Sci.* **78:** 651-654.

Wojcik, P. and Klamkowski, K. 2005. Response of Jona gold apple

trees in the first three years after planting to mono ammonium phosphate fertilization under replant problem conditions. *J. plant Nutr.* **28:** 1397-1411.

Yeshitela, T., Robbertse, P. J. and Stassen, P. J. C. 2005. Effect of pruning on flowering, yield and fruit quality in mango (*Mangifera indica* L.). *Australian J. Expt. Agri.* **45:** 1325-1330.