Plant Archives Vol. 18 No. 1, 2018 pp. 1000-1004 ***ISSN 0972-5210***

EFFECT OF NUTRITIONAL SUBSTITUTION ON GROWTH, FLOWERING& FRUIT YIELD OF PAPAYA cv. ARKA PRABHAT

V. N. P Sivarama Krishna*, M. L. N.Reddy, A.V.D. Dorajee Rao, K.T. Venkataramana and P. Sudhakar

*College of Horticulture, Dr.YSR Horticultural University, Anantharajupeta-516 105 (A.P.) India

Abstract

A study was conducted on the effect of substitution of nutritional source on growth, yield and quality aspects of papaya cultivar Arka Prabhat at College of Horticulture, Dr.Y.S.R. Horticultural University, Anantharajupeta (Andhra Pradesh), India during 2013-14 and 2014-15. Farm yard manure and vermicompost were used to replace the nutritional source at 25% recommended dose of nitrogen (RDN) and 50% RDN level. These levels of substitution were tried with and without addition of Biofertilizers. The experiment was laid out in Randomized Block Design with 10 treatments replicated thrice. The result revealed that vegetative characters like stem circumference, leaf area plant^{-1} and canopy spread were at maximum by the application of 50% RDF + 50% RDN through vermicompost + biofertilizers and the nutritional substitution with FYM and vermicompost produced dwarf plants compared to 100% RDF . Initiation of flowering and reaching to 50% flowering stage were also at the earliest by the application of 50% RDF + 50% RDN through vermicompost + biofertilizers. The lower level of nutritional substitution *i.e.* 25% RDN though vermicompost and FYM in other treatments had to wait for more period of time to initiate flowers. Further, the earliest fruit harvest as well as highest fruit yield per plant and per hectare were also recorded by the application of inorganic + organic source combination wherein 50 per cent RDN was replaced through vermicompost along with biofertilizers.

Key words: papaya, growth, biofertilizers, vermicompost, yield.

Introduction

Papaya (*Carica papaya* L.) is an evergreen herbaceous commercial fruit crop belongs to the family Caricaceae. It has occupied a unique place in the diet of people worldwide because of striking nutritional, health benefits and medicinal value of fruits which are rich sources of carbohydrates, minerals and vitamins (Carotene, riboflavin, vitamin A and C). India ranks fourth among papaya producing countries in the world after Brazil, Thailand and Mexico. Research work on papaya has been done on various aspects such as evolution of new varieties, spacing, irrigation, weed management, nutrient management, fertigation, mulching, other agro techniques and post harvest management for improving the productivity, quality and managing the incidence of pest and diseases. Papaya is considered as an exhaustive crop demanding large quantity of nutrients in a limited time. A number of studies pointed out to the fact that organic approaches offered the most sustainable way of crop production besides contributing to environmental protection, minimizing soil degradation.

Use of organic manures alone cannot fulfill the crops' nutritional requirement. Hence, combined use of organic manures, bio-inoculants along with chemical fertilizers plays an important role in ensuing productivity and maintenance of soil health in a balanced way. The substitution of chemical fertilizers with organic manures and bio-inoculants has been shown to produce higher crop yields and quality, than their individual application.

Material and Methods

The study was carried out for two consecutive years *i.e.* 2013-14 and 2014-15 on papaya at College of Horticulture, Anantharajupeta, YSR District, Andhra Pradesh. The treatments adopted were aimed to minimize the quantity of chemical fertilizers by substituting the N with organic manures and biofertilisers to maximize the yield and quality by way of enhancing nutrient use

****Author for correspondence :*** E-mail : vnpsrk@gmail.com

efficiency. The experiment was laid out in Randomized Block Design with 10 treatments replicated thrice *viz.*, **T_1**: 100% RDF (250 g N + 250 g P_2O_5 + 500 g K) (Control), **T_2**: 100% RDF + Biofertilisers, **T_3**: 75% RDF + 25% RDN through FYM, **T_4**: 75% RDF + 25% RDN through FYM + Biofertilisers, **T_5**: 50% RDF + 50% RDN through FYM, **T_6**: 50% RDF + 50% RDN through FYM + Biofertilisers, **T_7**: 75% RDF + 25% RDN through Vermicompost, **T_8**: 75% RDF+ 25% RD Nthrough Vermicompost + Biofertilisers, **T_9**: 50% RDF + 50% RDN through Vermicompost and **T_{10}**: 50% RDF + 50% RDN through Vermicompost + Biofertilisers. The biofertilisers *Azospirillum lipoferium, Bacillus megathurium*, *Frateuria aurantia*,and *Glomus intraradicis* were applied at the rate of 5 g plant^{-1} mixed with 2 kg of FYM and were applied to the plants at the time of planting. Inorganic fertilizers were applied in the form of urea, single super phosphate and muriate of potash, in six splits at 2 month interval after transplanting. Organic fertilizers were applied along with other fertilizers in split doses. Need based cultural and plant protection operations were taken up till harvest. In a plot of 20 plants, central 6 plants were selected to record the data on morphological, flowering and yield characters to avoid border effect. The experimental data was analysed statistically by the method of analysis of variance as out lined by Panse and Sukhatme (1995).

Result and Discussion

Morphological characters

The two years pooled data revealed that plant height was maximum 178.84c m in case of the plants that received 100% RDF whereas, the plants fed by organic nutritional sources and biofertilizers produced comparatively dwarf plants. The lowest height (119.26cm) was observed with application of 50% RDF + 50% RDN through Vermicompost + Biofertilizers. This indicates that substitution of nutritional source with organics in place of inorganic led to the equitable distribution of growth rate over both the growing periods. Plant height was found to decrease as the proportion of organic manures was on increase. It is evident from the data given in Table 1 that the 25% substitution was found to have comparatively higher plant height than 50% substitution of inorganic fertilizers. A higher plant height by 100% RDF could be due to readily available primary nutrients. The findings of Soorianathasundaram *et al.* (200l), Naresh and Anamika (2002) and Nalina *et al.* (2002) also were in support that the increased doses of RDF increased the availability of primary nutrients rapidly and vertical growth could be higher in such cases as compared to reduced RDF levels and substituting the nutrient source.

On the contrary, the maximum gain in stem circumference (35.58cm) and number of leaves (46.98) were recorded by the application of 50% RDF + 50% RDN through vermicompost + biofertilisers as against the application of 100% RDF (table 1). Similar highest gain was also observed in respect of leaf area (11.05m^2) with the application of 50% RDN through vermicompost + biofertilisers (table 2). Leaf area was also found to be positively influenced by the number of leaves because a larger number of expanded leaves could have been produced by the organically substituted nutritional applications rather than simply enhancing the number of leaves. Leaf area index is the measure of leaf area per unit of ground area. This value denotes coverage of green surface and helps us to know about the degree of light harvest out of the total light incident on the ground. The value of Leaf area index was found to increase at maximum by the application of 50% RDF + 50% RDN through vermicompost + biofertilisers as compared to 100% RDF. The increase in stem circumference, number of leaves, leaf area and leaf area index in the higher levels of organic manure application might be due to slow and continuous availability of nutrients by the application of organic manures that improved soil nutrient status and the biological environment in the rhizosphere. Similar increase in leaf number with application of organic manure was reported by Mustaffa *et al.* (2002) Ram and Nagar (2004) and Kannan *et al.* (2006).

At harvest the highest canopy spread (199.55 cm EW and 191.08cm NS) was observed with application of 50% RDF + 50% RDN through Vermicompost + Biofertilizers which was on par with 50% RDF + 50% RDN through Vermicompost (192.73 cm) and the least canopy spread (152.72 cm EW and153.59cm NS) was observed in control : 100% RDF. The canopy spread in both East West and North South directions indicated the canopy volume. The volume of canopy showed steeper expansion in case of organically substituted nutritional treatments as compared to 100% RDF alone. The increase in canopy spread and canopy volume with application of organic manures might be due to the fact that the application of organic manures along with Biofertilizers might have stimulated biological activity in the soil. Nitrogen is known to increase protein synthesis of chloroplast leading to leaf expansion and production of new leaves that in turn reflected as wider canopy with increased canopy volume (Rao and Krishnamohan, 1999). In the present investigation the improvement of canopy spread and canopy volume of papaya plants might be correlated with these factors.

Table 1: Plant height (cm), stem circumference (cm) and number of leaves per plant as influenced by nutritional substitution in papaya cv Arka Prabhat.

Treatments	Plant height (cm)			Stem circumference (cm)			Number of leaves plant^{-1}		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
T_1: 100% RDF (CONTROL)	170.33	187.36	178.84	27.10	29.27	28.19	35.52	39.08	37.30
T_2: 100% RDF + Biofertilizers	159.01	171.73	165.37	26.90	29.59	28.25	36.83	39.78	38.30
T_3: 75% RDF + 25% RDN through FYM	148.97	159.39	154.18	27.88	29.83	28.85	37.55	40.18	38.87
T_4: 75% RDF + 25% RDN through FYM + Biofertilizers	128.22	135.91	132.06	28.28	29.41	28.85	39.89	41.49	40.69
T_5: 50% RDF + 50% RDN through FYM	132.97	140.94	136.96	31.75	33.66	32.71	43.18	45.77	44.47
T_6: 50% RDF + 50% RDN through FYM + Biofertilizers	122.31	128.43	125.37	33.33	35.33	34.33	44.29	46.95	45.62
T_7: 75% RDF + 25% RDN through Vermicompost	146.70	152.57	149.64	29.72	30.61	30.16	40.22	41.43	40.83
T_8: 75% RDF + 25% RDN through Vermicompost + Biofertilizers	144.48	148.81	146.65	30.84	31.45	31.14	41.00	41.82	41.41
T_9: 50% RDF + 50% RDN through Vermicompost	133.27	135.93	134.60	34.25	35.96	35.11	46.33	46.79	46.56
T_{10}: 50% RDF + 50% RDN through Vermicompost + Biofertilizers	118.67	119.85	119.26	35.40	35.75	35.58	45.83	48.13	46.98
Mean	140.49	148.09	144.29	30.55	32.09	31.32	41.06	42.59	41.83
S.Em (±)	3.65	4.55	4.10	0.68	0.62	0.65	0.84	0.75	0.80
C.D. at 5%	3.49	4.28	3.89	2.03	1.85	1.94	2.49	2.24	2.37

Table 2: Leaf area per plant (m^2), Canopy spread (EW) and (NS) (cm)as influenced by nutritional substitution in papaya cv Arka Prabhat

Treatments	Leaf area per plant (m^2)			Canopy spread (EW) (cm)			(NS) (cm)		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
T_1: 100% RDF (CONTROL)	8.36	9.19	8.78	151.21	154.23	152.72	146.28	160.90	153.59
T_2: 100% RDF + Biofertilizers	8.67	9.36	9.01	155.25	158.35	156.80	149.22	161.16	155.19
T_3: 75% RDF + 25% RDN through FYM	8.84	9.45	9.15	153.66	156.74	155.20	154.61	165.43	160.02
T_4: 75% RDF + 25% RDN through FYM + Biofertilizers	9.39	9.76	9.57	154.50	157.59	156.05	165.83	172.47	169.15
T_5: 50% RDF + 50% RDN through FYM	10.16	10.77	10.46	176.02	179.54	177.78	179.00	189.74	184.37
T_6: 50% RDF + 50% RDN through FYM + Biofertilizers	10.42	11.05	10.73	181.99	185.64	183.82	182.47	193.41	187.94
T_7: 75% RDF + 25% RDN through Vermicompost	9.46	9.75	9.61	168.09	171.45	169.77	169.18	174.25	171.71
T_8: 75% RDF + 25% RDN through Vermicompost + Biofertilizers	9.65	9.84	9.74	171.31	174.73	173.02	176.28	179.80	178.04
T_9: 50% RDF + 50% RDN through Vermicompost	10.90	11.01	10.95	190.82	194.64	192.73	189.99	191.89	190.94
T_{10}: 50% RDF + 50% RDN through Vermicompost + Biofertilizers	10.78	11.32	11.05	197.57	201.52	199.55	186.42	195.74	191.08
Mean	9.66	10.15	9.91	170.04	173.44	171.74	169.93	178.48	174.20
S.Em (±)	0.20	0.18	0.19	2.6665	2.9065	2.7865	3.47	3.02	3.25
C.D. at 5%	0.59	0.53	0.56	7.8929	8.6033	8.2481	10.31	8.97	9.64

Table 3: Days taken to first flowering and 50% flowering as influenced by nutritional substitution in papaya cv Arka Prabhat.

Treatments	Days taken to first flowering			Days taken to 50% flowering		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
T_1 : 100% RDF (CONTROL)	71.65	78.81	75.23	96.16	105.78	100.97
T_2 : 100% RDF + Biofertilizers	69.81	75.39	72.60	93.26	100.72	96.99
T_3 : 75% RDF + 25% RDN through FYM	68.23	73.01	70.62	90.52	96.86	93.69
T_4 : 75% RDF + 25% RDN through FYM + Biofertilizers	64.43	67.00	65.72	87.03	90.51	88.77
T_5 : 50% RDF + 50% RDN through FYM	54.27	57.53	55.90	72.67	77.03	74.85
T_6 : 50% RDF + 50% RDN through FYM + Biofertilizers	52.11	55.23	53.67	69.22	73.38	71.30
T_7 : 75% RDF + 25% RDN through Vermicompost	62.35	64.22	63.29	84.63	87.17	85.90
T_8 : 75% RDF + 25% RDN through Vermicompost + Biofertilizers	57.42	58.57	57.99	75.01	76.51	75.76
T_9 : 50% RDF + 50% RDN through Vermicompost	48.41	50.83	49.62	67.70	71.09	69.39
T_{10}: 50% RDF + 50% RDN through Vermicompost + Biofertilizers	49.66	50.16	49.91	66.42	67.08	66.75
Mean	59.83	63.08	61.45	80.26	84.61	82.44
S.Em (±)	1.91	2.28	2.10	2.51	3.00	2.75
C.D. at 5%	5.69	6.76	6.22	7.46	8.91	8.18

Table 4: Days to first harvest, fruit yield per plant (kg) and fruit yield per hectare (tonnes) as influenced by nutritional substitution in papaya cv Arka Prabhat

Treatments	Days to first harvest			Fruit yield plant^{-1}			Fruit yield ha^{-1}		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
T_1: 100% RDF (CONTROL)	225.61	230.12	227.86	15.86	17.44	16.65	39.64	43.61	41.62
T_2: 100% RDF + Biofertilizers	220.29	226.90	223.60	16.82	18.16	17.49	42.04	45.41	43.72
T_3 : 75% RDF + 25% RDN through FYM	214.69	223.28	218.98	17.38	18.60	17.99	43.45	46.49	44.97
T_4 : 75% RDF + 25% RDN through FYM + Biofertilizers	199.01	201.00	200.00	18.88	19.64	19.26	47.21	49.10	48.15
T_5 : 50% RDF + 50% RDN through FYM	199.28	213.23	206.25	21.56	22.85	22.20	53.89	57.13	55.51
T_6 : 50% RDF + 50% RDN through FYM + Biofertilizers	197.82	207.71	202.76	21.76	23.07	22.42	55.78	56.33	56.05
T_7: 75% RDF + 25% RDN through Vermicompost	206.40	227.04	216.72	19.87	20.47	20.17	49.68	51.17	50.43
T_8: 75% RDF + 25% RDN through Vermicompost + Biofertilizers	206.09	222.57	214.33	20.82	21.24	21.03	52.05	53.09	52.57
T_9: 50% RDF + 50% RDN through Vermicompost	203.28	215.48	209.38	22.31	22.53	22.42	54.41	57.67	56.04
T_{10}: 50% RDF + 50% RDN through Vermicompost + Biofertilizers	196.38	208.17	202.27	22.17	23.28	22.73	55.43	58.21	56.82
Mean	206.88	217.55	212.22	19.74	20.73	20.24	49.36	51.82	50.59
S.Em (±)	2.24	2.19	2.22	0.53	0.49	0.51	1.32	1.22	1.27
C.D. at 5%	6.67	6.51	6.59	1.57	1.45	1.51	3.93	3.62	3.77

Flowering Parameters

The early flowering (49.62) and least number of days to 50% flowering (49.91) (table 4) was observed in nutritional substitution by vermicompost without biofertilizer and with biofertilizer. Earliness in flowering at 50% RDF coupled with 50% RDN through organics might be due to the higher net assimilation rate on account of slow and horizontal vegetative growth in conjunction with higher leaf area per plant leading to the production of endogenous metabolites earlier in optimum level enabling early flowering in papaya (Yadav *et al*, 2011). These results are in conformity with the findings reported by Shivakumar (2011) and Suresh *et al*. (2010) in papaya.

Yield attributes

Fruits attained early harvesting stage (200 days) when the plants were fed with 75% RDF + 25% RDN through FYM + Biofertilizers which was on par with application of 50% RDF + 50% RDN through Vermicompost + Biofertilizers (202.27). The pooled data showed that the highest fruit yield per plant (22.73 kg) and fruit yield per ha (56.82 ton ha^{-1}) was noticed in 50% RDF + 50% RDN through Vermicompost + Biofertilizers. Among the organics, Vermicompost could record higher yield but it was statistically on par with the fruit yield obtained in FYM treatment. Similar results were also reported by Shivakumar *et al.* (2012). Higher fruit yield in papaya may be realized due to increase in fruit number and fruit weight per plant and this was attributed to application of organic manures. Substitution of nutrient source through organics could favour the desired growth parameters in an appropriate manner by supplying the nutrients in a befitting manner as and how it might be required by the plants. On the contrary, inorganic source of nutrients might have resulted in a high but short period availability of nutrients most of which might have lost through various ways rather than being absorbed by the plants. The results of the present investigation are in conformity with findings of Ram and Nagar (2004), Naik and Sriharibabu (2005) and Sable *et al*. (2007) in different crops.

Conclusion

The results obtained from the present investigation to substitute the inorganic nutritional sources with organic nutritional sources *viz.,* farm yard manure and vermicompost is encouraging in papaya cv Arka prabhat. The response of papaya to the application of organic manures especially in the form of Vermicompost along with Biofertilizers was clearly exhibited with better morphological growth, early flowering and highest yield.

References

Kannan, P., A. Saravanan and T. Balaji (2006). Organic farming on tomato yield and quality. *Crop Research*, **32(2)**:196-200.

Mustaffa, M.M, V. Kumar, B. Tanujapriya, K.C. Sivakumar and S. Sathimoorthy (2002). Organic farming of Karpuravalli. *Global Conference on Banana and Plantain,* October, 28-31, Bangalore. 130

Naik and B. Sriharibabu (2005). Feasibility of organic farming in guava (*Psidium guajava*). In: *First International guava symposium*, ISH, Lucknow, December, 2005. 156.

Nalina, L., B. Kumar and P. Jeyakumar (2002). Effect of different fertilizer treatment on growth, yield and fertilizer quality of tissue cultured banana Robusta (AAA). *Global Conference on Banana and Plantain.* October, 28th -31st 2001. Bangalore. 127.

Naresh, B., and K. Anamika (2002). Effect of integrated nutrient management on production of Banana and soil. *Global Conference on Banana and Plantain.* October, 28-31 Bangalore. 126.

Panse, V.G. and P.V. Sukhatme (1995). *Statistical Methods for Agricultural Workers*. 4th Edition, I C A R, New Delhi. 1-347.

Ram, R.A. and A.K. Nagar (2004). Effect of different organic manures on yield and quality of guava cv. Allahabad safeda. Proceedings of National Symposium on Organic farming in Horticulture Sustainable Production, CISH, Lucknow. 306-10

Rao, L.M and K. Krishnamohan (1999). Effect of Bradyhizobium japonicum strains and nitrogen on growth, N2-fixation and yield of soybean genotypes during monsoon and post monsoon season. In: (Srivastava *et al.* eds.). Plant Physiology for sustainable Agriculture. Pointer Publishers: Jaipur, India. 122-28.

Sable, C.R, T.D. Ghuge, S.B. Jadhav and A.K. Gore (2007). Impact of organic sources on uptake, quality and availability of nutrients after harvest of tomato. *Journal of Soils and Crops,* **17(2)**: 284-87.306-10

Shivakumar, B.S. (2011). Integrated nutrient management studies in papaya (*Carica papaya* L.) cv. Surya. *Ph.D. Thesis* University of Agricultural Science, Dharwad, Karnataka, (India).

Shiva Kumar, B.S, P.R. Dharmatti and H.T. Channal (2012). Effect of Organic cultivation of Papaya on Yield, Economics, and Soil nutrient status. *Karnataka Journal of Agricultural Science,* **25(4)**: 488-92.

Soorinathasundaram, K., N. Kumar and A. Shanthi (2001). Influence of organic nutrition on the productivity of banana *cv.* Nendran (French plantain - AAB). *South Indian Horticulture.* **49**: 109-14.

Suresh, C.P., S. Nath, M. Poduval and S.K.Sen (2010). Studies on the efficacy of phosphate solubilizing microbes and VAM fungi with graded levels of phosphorus on growth, yield and nutrient uptake of papaya (*Carica papaya* L). *Acta Horticulture,* **851**: 401-06.

Yadav, P.K, A.L. Yadav, A.S. Yadav and H.C. Yadav (2011). Effect of integrated nutrient nourishment on vegetative growth and physico-chemical attributes of papaya *(Carica papaya* L.) fruit *cv.* Pusa Dwarf. *Plant Archives,* **11(1)**: 327-29.