UNDER PEER REVIEW

Original Research Article

Effect of different level of NPK and CRF for plant growth and rhizome yield in Arrowroot (*Maranta arundinacae* L.)

ABSTRACT

The present investigation was carried out to Effect of different level of NPK and CRF for plant growth and rhizome yield in Arrowroot (*Maranta arundinacae* L.) was conducted in the horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj (U.P.) during July 2021- April 2022. The experiment was laid out in RBD with 11Treatments with 3 replications. The results revealed thatthe treatment T_{10} 100% CRF(Control Release Fertilizer)performed the best in terms in Plant height (140.22), leaf length (49.06), leaf width (19.10), No. of tillers(14.33), fresh weight per plant (736.33), Number of rhizomes per plant (11.33), yield of rhizomes per plant (11.78), yield of rhizomes per hectare (81.81), Maximum cost benefit (3.50). Therefore, the treatment T_{10} 100% CRF (Control Release Fertilizer) is the best when compared to other treatments. As, the highest benefit cost ratio was observed in T_{10} 100% CRF(Control Release Fertilizer) i.e. (3.50).

Keywords: Arrowroot, NPK, CRF, Growth and Rhizome Yield.

INTRODUCTION

The true arrowroot of commercial importance is the West Indian arrowroot (*Maranta arundinacea* L.) of family Marantaceae (2n-48). It is indigenous to tropical America and constitutes one of the main sources of food starch production in the tropics. In India arrowroot is cultivated in Uttar Pradesh, Bihar, Orissa, West Bengal, Assam and Kerala. Major arrowroot growing countries in the world are USA, Brazil, Philippines, India, Sri Lanka, Indonesia, China and Kenya ***(*Kay *et al.*,1987*)***

The rhizomes are ready for harvest by 10-12 months after planting. Maturity is indicated by yellowing and wilting of leaves. At this time, the stems fall over or lodge. Harvesting is done by digging up the plants and separating rhizomes from the leafy stem. Yields vary enormously and range from 75-37 t/ha Composition of fresh rhizome is moisture-63.4 %; starch-25-30 %; crude protein-1.6%; fat- 0.2%; sugar and dextrin -21%; crude fibre-3.9 % and ash -0.9%.

The most reliable and effective way to make the availability of nutrients coincide with plant requirements is by controlling their release into the soil solution, using controlled or slow release fertilizers. Using slow-release fertilizers instead of WSF for container-grown plant production has been reported to effectively limit the loss of nutrients **(Haver and Schuch, 1996 and Medina *et al.* 2009)**, reduce nutrient runoff, improve nutrient use efficiency and decrease production costs. Also its one application can cover several applications of water soluble fertilizers **(Guertal *et al.*, 2009).** Fertilizers with slow release mechanisms can probably meet the higher nutrient needs of chrysanthemums better than water soluble fertilizers. They also have better impact on the yield, flowering, a higher uptake of major nutrients and higher growth rate compared to water soluble fertilizers (**Voogt *et al*. 2006).**

Nitrogen (N), phosphorus (P) and potassium (K) are primary nutrients required by the plants for

their proper growth and development. Growth and development of plants is negatively affected by the deficiency of any of these nutrients during their life cycle. Nitrogen plays a key role chlorophyll synthesis and subsequently in photosynthesis. Nitrogen plays an important role in vegetative growth of plants; thus, should remain available throughout this stage. The P increases cell division and stimulates root growth and flowering. The P is found in the plant parts having high metabolism and rapid cell division; therefore, plays a role in the storage and transfer of energy released during photosynthesis and its deficiency delays plant maturity.

MATERIALS AND METHODS

The experiment was conducted at Experimental Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (UP) during 2021-22 during Kharif season in India. The rhizomes were collected from CTCRI (Central Tuber Crop Research Institute) Sreekaryam.. The pit was dug with 30×30×30 cm^3 and applied dose of FYM is 10 tonnes/ha and N, P, K is 50 kg, 25kg and 75kg/ha respectively.

Table1. List of different level of NPK and CRF treatment combination

Treatments Notation	Treatment combinations
T_0	100 % RDF (50:25:75 kg/ha)
T_1	90 % RDF +10 % CRF
T_2	80 % RDF +20% CRF
T_3	70 % RDF +30% CRF
T_4	60 % RDF +40% CRF
T_5	50 % RDF +50% CRF
T_6	40 % RDF +60% CRF
T_7	30 % RDF +70% CRF
T_8	20 % RDF +80% CRF
T_9	10 % RDF +90% CRF
T_{10}	100% CRF

RESULTS AND DISCUSSION

Growth Parameters

The data on analysis on days to germination on effect of different level of NPK and CRF for plant growth and rhizome yield in arrow root the earlier germination was seen in the treatment T_{10}. The maximum germination DAS (21.00) was recorded in the treatment T_4 60 % RDF +40% CRF and minimum germination day (17.50) was recorded in T_{10} 100% CRF from Table 2. Earlier germination found in the treatment T_{10} this may be due to the presence of suitable sandy soil, very deep well drained with shallow water table or better permeability to moist. The view was supported by **kamal *et. al.*, (2012), Narayan *et. al.*, (2013)** and **Chandra leela *et. al.*, (2020)** in bottle gourd.

The maximum plant height, leaf length and leaf width at 30, 60, 90 DAS and day before harvest (cm) was recorded in the treatment T_{10} 100% CRF followed by treatment T_9 10 % RDF +90% CRF and minimum plant height was recorded in treatment T_0 100 % RDF (50:25:75 kg/ha). Which might be due to higher

levels of N, P & K, which found suitable for arrowroot which is helpful in cell elongation of leaves use to development of cell and rapid cell division and cell elongation in meristematic region of plant due to production of plant growth substance and this may be due to abundant supply of plant nutrients and water which led in the growth of arrowroot. This finding correlates the findings of **Tumbarc *et. al.*, (2002)** in Chilli**, Sundar *et. al.*, (2019)** in Lettuce. These results are in close conformity with the findings of **Utgikar *et. al.*, (2003), Reddy (2019) and Patel *et. al.*, (2020)** in Isabgol.

The maximum Number of tillers per plant at 30, 60, 90 DAS and day before harvest (cm) was recorded in the treatment T_{10} 100% CRF (2.00), followed by treatment T_9 10 % RDF +90% CRF (1.50) and minimum Number of tillers per plant (**1.25**) was recorded in treatment T_0 100 % RDF (50:25:75 kg/ha). Increase in number of tillers per plant might be due to increased growth of plant in the form of height and number of leaves, which accumulated more photosynthates and thereby increased number of tillers per plant. These findings are in the close conformity with the findings of **Utgikar *et. al.*, (2003) and Saho *et. al.*, (2021)** in isabgol.

Yield parameters

The maximum fresh weight per plant (276.75) was recorded in the treatment T_{10} 100% CRF,followed by treatment T_9 10 % RDF +90% CRF (252.08) and minimum fresh weight per plant (108.92) was recorded in treatment T_0 100 % RDF from Table 3. In Arrowroot, increased vegetative growth results in increased production and storage of photosynthates in rhizomes which accounts for higher yield. In the present study also a significant increase in rhizome yield was observed with increased NPK levels. In general, yield levels increased with an increase in fertilizer levels and highest yield of fresh rhizome. **Muralidharan *et. al.*, (1972), Rao *et. al.*, (1977), Swamy *et. al.*, (1984)** and **Shankaraiah *et. al.*, (1988)** observed increased rhizome yield with increase in level of nutrients in turmeric. **Randhawa *et al.* (1969)** reported significant influence of NPK levels on rhizome yield in ginger.

The maximum Number of rhizomes per plant (11.33) was recorded in the treatment T_{10}100% CRF, followed by treatment T_9 10 % RDF + 90% CRF (11.25) and minimum Number of rhizomes per plant (9.25) was recorded in treatment T_0 100 % RDF. The maximum Rhizome yield per plot (4.43) was recorded in the treatment T_{10} 100% CRF, followed by treatment $T_9$10 % RDF +90% CRF (4.03) and minimum Rhizome yield per plot (1.74) was recorded in treatment T_0 100 % RDF.The application of N and K favoured the metabolic and auxin activities in plant and ultimately resulted in increased fruit size, number of fruits per plant, fruit weight and yield per hectare. These findings are similar of those reported by **Ismail *et. al.*, (2009), Nedunchezhiyan *et. al.*, (2010), Pant *et. al.*, (2010) and Zhang Fu Chun *et. al.*, (2010**) in Taro**.**

The maximum Rhizome yield per hectare (4.43) was recorded in the treatment T_{10} 100% CRF, followed by treatment T_9 10 % RDF +90% CRF (4.03) and minimum Rhizome yield per hectare (1.74) was recorded in treatment T_0 100 %. The application of N and K favoured the metabolic and auxin activities in plant and ultimately resulted in increased yield per hectare. These findings are similar of those reported by **Ismail *et. al.*, (2009), Nedunchezhiyan *et. al.*, (2010), Pant *et. al.*, (2010) and Zhang Fu Chun *et. al.*, (2010), Mohan *et. al.*, (2018**) in Taro.

Table 2.Effect of different level of NPK and CRF on growth related traits of Arrowroot.

Treatment	plant height					Leaf length					Leaf width					No. of tillers				
	30 DAS	60 DAS	90 DAS	120 DAS	DBH	30 DAS	60 DAS	90 DAS	120 DAS	DBH	30 DAS	60 DAS	90 DAS	120 DAS	DBH	30 DAS	60 DAS	90 DAS	120 DAS	DBH
T_0	21.08	37.50	63.63	86.03	105.89	15.61	21.28	26.49	38.26	46.96	4.01	7.55	11.08	13.35	17.84	1.25	3.25	6.50	9.50	13.08
T_1	21.40	37.83	63.63	86.08	106.13	15.83	21.28	26.88	38.34	47.00	4.19	7.68	11.12	13.45	17.93	1.25	3.25	6.58	9.58	13.17
T_2	21.98	37.86	63.82	86.17	106.25	15.82	21.36	26.93	38.63	47.37	4.34	7.76	11.13	13.86	18.04	1.33	3.50	6.58	9.67	13.33
T_3	22.08	37.89	63.78	86.15	106.59	16.57	21.97	27.68	38.66	47.11	4.52	7.80	11.18	13.62	17.92	1.42	3.33	6.67	9.83	13.67
T_4	22.08	38.06	63.93	86.27	106.28	16.50	21.34	27.33	38.98	47.08	4.42	7.78	11.19	13.53	18.03	1.33	3.50	6.75	9.75	13.33
T_5	22.03	38.36	64.30	86.83	106.31	16.01	21.31	27.23	38.86	47.23	4.43	7.72	11.19	13.48	17.94	1.42	3.50	6.58	9.75	13.50
T_6	22.17	38.24	64.72	86.14	106.25	16.09	21.48	27.27	38.57	47.43	4.41	7.72	11.20	13.55	18.06	1.25	3.58	6.67	9.67	13.17
T_7	22.22	38.03	63.87	86.63	106.40	16.23	21.67	27.54	38.66	47.51	4.43	7.78	11.18	13.46	17.98	1.33	3.33	6.58	9.92	13.33
T_8	22.43	38.32	63.97	86.71	106.45	16.42	22.17	28.11	39.16	47.77	4.53	7.86	11.18	13.73	18.05	1.33	3.42	6.67	9.67	13.42
T_9	22.68	38.92	64.43	87.45	106.59	16.59	22.19	28.24	39.48	47.79	4.56	7.86	11.28	13.88	18.18	1.50	3.58	6.92	10.00	13.92
T_{10}	27.26	44.37	71.48	90.47	110.44	18.25	25.58	30.02	40.13	49.06	5.00	8.28	11.48	14.65	19.10	2.00	4.25	7.58	10.67	14.33
S.Ed (±)	**0.71**	**0.57**	**0.67**	**0.58**	**0.70**	**0.52**	**0.47**	**0.49**	**0.39**	**0.44**	**0.18**	**0.14**	**0.08**	**0.22**	**0.18**	**0.09**	**0.14**	**0.21**	**0.21**	**0.32**
C.D.(0.05)	**1.49**	**1.19**	**1.40**	**1.21**	**1.46**	**1.08**	**0.98**	**1.01**	**0.82**	**0.92**	**0.37**	**0.29**	**0.17**	**0.47**	**0.38**	**0.19**	**0.28**	**0.45**	**0.43**	**0.67**
C.V.	**3.88**	**1.81**	**1.27**	**0.82**	**0.82**	**3.89**	**2.63**	**2.15**	**1.23**	**1.13**	**4.96**	**2.21**	**0.88**	**2.00**	**1.22**	**7.92**	**4.73**	**3.89**	**2.60**	**2.90**

Table 3.Effect of different level of NPK and CRF on yield traits of Arrowroot

Treatment	Fresh weight per plant	Number of rhizomes per plant	Rhizome yield per plot(kg)	Rhizome yield per hectare(t/ha)
T_0	108.92	9.25	1.74	12.10
T_1	138.92	9.25	2.22	15.43
T_2	164.92	9.42	2.63	18.32
T_3	173.08	9.50	2.77	19.23
T_4	184.83	9.58	2.95	20.53
T_5	194.17	9.58	3.10	21.57
T_6	200.42	9.67	3.20	22.26
T_7	207.50	9.67	3.32	23.05
T_8	228.83	11.08	3.66	25.42
T_9	252.08	11.25	4.03	28.00
T_{10}	276.75	11.33	4.43	30.75
S. Ed (±)	**0.60**	**0.36**	**0.01**	**0.07**
C.D.(0.05)	**1.26**	**0.76**	**0.02**	**0.14**
C.V.	**0.38**	**4.45**	**0.43**	**0.38**

CONCLUSION

The present investigation was concluded that the different levels of NPK and CRF treatments rendered their significant effect on almost all the growth and yield characters of arrowroot that the treatment **T_{10}** i.e. application of 100 % CRF was found superior in terms of days to germination, plant height (cm), leaf length (cm), leaf width (cm), number of tillers per plant, fresh weight per plant (gm), yield of rhizome per plot (kg) and yield of rhizome per hectare (t/ha) was found suitable for application in kharif season arrowroot cultivation for better growth and yield.

REFERENCES

Guertal, E.A. (2009). Slow-release fertilizers in vegetable production: a review. Hort Technology, 19: 16–19. Google Scholar.

Kamal N, Verma S, Agrawal S, Rao SS (2012). Genetic variability and correlation studies in bottle gourd grown as intercrop in coconut garden. *Plant Arch.*,12(1):85-8.

Kay, D. E., Gooding, E. G. B., (1987). Root crops, London, UK: Tropical Products Institute.

Medina, L.C.,J.B. Sartain, and T.A. Obreza. (2009). Estimation of release properties of slow-release fertilizer materials. *Hort Technology* 19:13–15

Mohan E, Guruprasad TR. Herle PS, Seetharamu GK. Murthy 2004) . Studies on biomass production,harvest index. concentration and uptake of NPK in different turmeric cultivars. *Indian Journal of Arecanut, Spices and Medicinal Plant.* 6(4):122126.

Mohan kumar, C.R., Sadanandan, N. and Saraswathy, P. (1989). Effect of levels of NPK and time of application of N and K on the yield of taro (*Colocasia esculenta* L.). *Journal of Root Crops*. 16 (1): 33 38.

Muralidharan A & Balakrishnan S (1972). Studies on the performance of some varieties of turmeric and its fertilizer requirement. *Agric. Res. J. Kerala* 10: 112-115

Narayan K. (**2013).** Genetic diversity and correlation studies in bottle gourd germplasm under Baster condition. *J. Agri. Sci.* Chhattisgarh Young Sci Congress.;XI:1.5: 15

Nedunchezhiyan, M., Byju, G., Naskar, S.K. and Mukherjee, A. (2010). Effect of mulching and graded doses of fertilizer on yield and nutrient uptake of greateryam + maize intercropping system. *Indian Journal of Horticulture.* 67: 283-287

Pant, K.S., Mishra, V.K., Sanwal, C.S. and Dinssa, K.U. (2010). Effect of nitrogen and popular spacing on yield & nutrient content of taro (*Colocasia esculenta* L.) *Indian Journal of Agroforestry*.12(1): 18-22

Patel, D.M., M.R. Patel, H.K. Patel, R.B. Prajapati and S.A. Chauhan, (2015). Response of different levels of nitrogen, phosphorus and potassium on yield and quality of Isabgol (*Plantago Ovata* Forsk.). *J. Pure and Appl. Microb*., 9: 1665-1669.

Randhawa KS & Nandpuri K S (1969). Response of ginger (Zingiber officinale Rosc.) to nitrogen, phosphorus and potash fertilization. *J. Res. Punjab. Agric. Univ.,* Ludhiana 6 212-214.

Rao M R & Reddy V R (1977) Effect of different levels of nitrogen, phosphorus and potassium on yield of turmeric (*Curcuma longa* L.) *J. Plant. Crops* 5: 60-63.

Reddy, G.S. (2014). Effect of date of sowing and nitrogen on growth and yield of Isabgol (Plantago ovata). Intl. Conf. Agric. Horti. Sci., Hyderabad, February 03-05, 2014, Omics Group Conferences. Hyderabad, p. 46.

Sahu, P. & Naruka, Inder & Shaktawat, R P S & Haldar, A.. (2020). Effect of levels of NPK on growth and yield of Isabgol (*Plantago ovata* Forsk). *Journal of Applied Horticulture.* 23. 50-53. 10.37855/jah.2021.v23i01.10.

Shankaraiah V & Prabhaker Reddy J (1988). Studies on effect of different manorial and spacing levels with local and high yielding turmeric varieties. *Indian Cocoa, Arecanut & Spices J*. 11: 94-95.

Sundar S, Sanjib S, Liu Zhiming (2019). Effects of Nutrient Composition and Lettuce Cultivar on Crop Production in Hydroponic Culture., Horticulture 5(72) 10.3390/horticulture 5040072.

Utgikar, V.P., Harmon, S.M., Chaudhary, N., Tabak, H.H., Govind, R. and Haines, J.R., (2002). Inhibition of sulfate-reducing bacteria by metal sulfide formation in bioremediation of acid mine drainage. Environmental Toxicology: An International Journal, 17(1), pp.40-48.

Voogt W., van Winkel A., Steinbuch F. (2006): Evaluation of the 'fertigation model', a decision support system for water and nutrient supply for soil grown greenhouse crops. ISHS Acta Horticulturae, 718: 531–538.

Zhang Fu Chun (2010). Optimum NPK application for Colocasia esculenta cv. Liuyuehong in Yongding County of China. *Fujian Journal of Agricultural Sciences*. Vol.25 No.3 pp.332-335.