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Effect of different levels of fertilizer and plant spacing on yield of taro (*Colocasia esculenta* L.) under Marathwada conditions

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Abstract

The present investigation was carried out during the year 2023-2024 and it was set up in a Factorial Randomized Block Design (FRBD) with three treatments replicated thrice with 09 treatment combinations. Three levels of fertilizer dose viz., F₁ [100% recommended dose of NPK (80:60:60 kg/ha), F₂ [125% of recommended dose of NPK (100:75:75 kg/ha), F₃ [75% of recommended dose of NPK (60:45:45 kg/ha) and three levels of plant spacing viz., S₁ (60 cm x 45 cm), S₂ (60 cm x 60 cm), S₃ (60 cm x 30 cm) were used as treatment variables. The yield and quality attributes of taro viz., Number of corms per plant (2.90), corm length (8.93 cm), corm diameter (6.66 cm), weight of corms per plant (289.55 g), number of cormels plant⁻¹ (41.90), weight of cormels plant⁻¹ (351.59 g), cumulative herbage yield (357.15 g plant⁻¹) was found significantly superior in treatment combination F₂S₂ [125% of RDF (100:75:75 kg/ha at 60 x 60 cm spacing). Whereas cumulative herbage yield (144.31 q ha⁻¹) and total corm and cormel yield (263.22 q ha⁻¹) was found significantly superior in treatment combination F₂S₃ [75% of RDF (60:45:45 kg/ha at 60 x 30 cm spacing) than rest of the treatment combinations under study.

Keywords: Fertilizer, spacing, taro, yield

Introduction

Taro (*Colocasia esculenta* L.) is a highly nutritious crop, particularly valued for its corms, which contain 63-85% water and are rich in essential nutrients. The corms provide 1.3-4.0% protein, 13-29% carbohydrates, 0.6-1.2% fiber and 2.0-4.0% fat with the starch content ranging between 13-30%. Notably, taro has higher protein content than yam, cassava, and sweet potato, making it a valuable protein source despite its relatively low fat content. The quality of taro corms and cormels is influenced by their acidity and fiber content, and the small size of their starch granules contributes to their excellent digestibility, with an estimated digestibility rate of 98.9%. It is also a good source of vitamins A and C with essential amino acids like leucine and phenylalanine.

It is also rich in potassium, calcium, phosphorus, iron, riboflavin, thiamine, niacin. Furthermore; all parts of the taro plant, including the corms, cormels, rhizomes, petioles, leaves, and flowers are edible and contain significant nutritional value. Even after boiling, the tender petioles and leaves remain a rich source of iron and vitamin C, making taro an excellent food for a variety of dietary needs. Two main determining variables for any crop's optimum growth and production are nutrient management and spacing. To increase growth and yield, wise and appropriate application of fertilizers and spacing is necessary. While too high or too low plant spacing can lead to relatively low yield and quality, appropriate plant spacing can produce the best potential production (Akther *et al.*, 2016) ^[1]. In view of this, the present investigation was conducted to find out optimum dose of fertilizer and appropriate spacing for obtaining higher yield in taro.

Methodology

The present investigation was conducted on the instructional cum research farm of College of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (MS), during the year 2023-2024. The experiment was set up in a Factorial Randomized Block Design (FRBD) with three treatments replicated thrice with 09 treatment combinations.

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Twenty-one distinct taro genotypes were evaluated in previous year among which PBNT-1 genotype was found best in respect to quantitative and qualitative parameter under Marathwada conditions hence, the said selected genotype was used in the present investigation for estimation of optimum dose of fertilizer and spacing. Subsequently the uniform sized healthy, disease free corms weighing 30-40 g were used for planting at three different spacings viz., S₁= 60 x 45 cm S₂= 60 x 60 cm S₃= 60 x 30 cm with the application of different levels of fertilizers viz., F₁= 80:60:60 kg NPK/ha (100% RDF) F₂=100:75:75 kg NPK/ha (125% RDF) F₃= 60:45:45 kg NPK/ha (75% RDF). The other cultivation practices were followed as per recommendations and observations of various yield parameters were recorded periodically and data was statistically analyzed as per standard methods.

Results and Discussion

The data pertaining to number of corms per plant, corm length, corm diameter and weight of corms per plant under various treatments have been statistically analyzed and presented in Table 1. The maximum number of corms per plant (2.03) was recorded in treatment F₂ [125% of the recommended NPK dose (100:75:75 kg/ha)] whereas, the minimum (1.48) was observed in treatment F₃ [75% of the recommended NPK dose (60:45:45 kg/ha)]. The results in respect to number of corms might be due to the higher fertilizer levels generally increase the number of corms per plant by providing essential nutrients that promote growth and development. Das *et al.* (2018) [4] reported similar result in number of corms per plant in taro. The plant spacing plant spacing S₂ (60 cm x 60 cm) produced maximum number of corms per plant (1.92) while the minimum number of corms per plant (1.56) was obtained in S₃ (60 cm x 30 cm). The greater number of corms per plant produced at wider spacing likely due to less competition among the plants for nutrients, water and space. These results are in accordance with Dhar (1989) [5]. The highest number of corms per plant was recorded in the F₂S₂ combination [125% RDF (100:75:75 kg/ha) with 60 cm x 60 cm]. The lowest number of corms per plant (1.31) was recorded in F₃S₃ combination [75% of RDF (60:45:45 kg/ha) with 60 cm x 30 cm]. Akther *et al.* (2016) [1] and Bhatt *et al.* (2019) [2] reported similar result in number of corms per plant of taro.

The highest corm length (8.20 cm) was recorded in F₂ [125% of recommended dose of NPK (100:75:75 kg/ha)] followed by F₁ [100% recommended dose of NPK (80:60:60 kg/ha)], (7.34 cm) while lowest (7.26 cm) was recorded in F₃ [75% of recommended dose of NPK (60:45:45 kg/ha)] and the highest corm length (8.00 cm) was obtained in the plant spacing of S₂ (60 cm x 60 cm) followed by plant spacing of (S₁- 60 cm x 45 cm) i.e. 7.43 cm. The S₃ (60 cm x 30 cm) recorded lowest corm length (7.37 cm). Adequate fertilization provides essential nutrients that support robust growth and development. Proper levels of nitrogen, phosphorus and potassium promote healthy corm development leading to longer corms. Similarly increase in corm length might be due to proper spacing reduces competition for resources such as light, water and nutrients. When plants are closely spaced, they compete for these resources which can limit corm growth and result in shorter corms. Similar results were reported by Mannan *et al.* (1988) [6] and Dhar (1989) [5]. The highest corm length was observed in the F₂S₂ combination [125% of RDF

(100:75:75 kg/ha) with 60 cm x 60 cm] averaging (8.93 cm). The lowest (6.62 cm) was obtained from F₃S₃ combination [75% RDF (60:45:45 kg/ha) with 60 cm x 30 cm]. These are in accordance with the findings of Akther *et al.* (2016) [1] and Bhatt *et al.* (2019) [2].

The maximum corm diameter (6.17 cm) recorded in F₂ [125% of recommended dose of NPK (100:75:75 kg/ha)] followed by F₁ [100% recommended dose of NPK (80:60:60 kg/ha)] i.e. 4.75 cm and the minimum corm diameter (4.69 cm) was recorded in F₃ [75% of recommended dose of NPK (60:45:45 kg/ha)]. This increment in diameter might be due to the application of higher dose of fertilizer, the similar findings are in line of Verma *et al.* (2012) [8] and Das *et al.* (2018) [4]. In respect to the plant spacing treatment S₂ (60 cm x 60 cm) recorded maximum corm diameter (5.64 cm) which was followed by S₁ (60 x 45 cm) i.e. 5.09 cm whereas, minimum corm diameter (4.88 cm) was observed in treatment S₃ (60 cm x 30 cm). The increase in corm diameter with wider spacing was also reported by Dhar (1989) [5] and Akther *et al.* (2016) [1]. Wider plant spacing usually results in larger corm diameter as it reduces competition for resources and allows more favorable condition for corm development. The interaction of plant spacing and fertility levels had a significant effect on corm diameter. The highest corm diameter (6.66 cm) was observed in the F₂S₂ combination [125% of RDF (100:75:75 kg/ha) with 60 cm x 60 cm], the lowest (4.04 cm) was recorded in F₃S₃ combination [75% of RDF (60:45:45 kg/ha) with 60 cm x 30 cm]. Akther *et al.* (2016) [1] and Bhatt *et al.* (2019) [2] reported similar result about corm diameter in taro.

The highest average corm weight (228.95 g) was recorded in F₂ [125% of recommended dose of NPK (100:75:75 kg/ha)] which was followed by F₁ [100% recommended dose of NPK (80:60:60 kg/ha)], (219.44 g) while the lowest (188.39 g) was noticed in F₃ [75% of recommended dose of NPK (60:45:45 kg/ha)] which was significantly inferior to rest of other treatments. Increased fertilizer levels typically lead to greater corm weight per plant by supplying more nutrients that support robust growth. Similarly, the maximum corm weight (236.73 g) was obtained in treatment S₂ (60 cm x 60 cm) which was followed by S₁ (60 cm x 45 cm) i.e. 200.54 g and minimum (199.51 g) was observed in S₃ (60 cm x 30 cm). Wider plant spacing typically enhances corm weight per plant by minimizing competition for nutrients and light (Akther *et al.* 2016) [1]. The interaction of plant spacing and fertility levels had significant effect on the weight of corms per plant at the final stage. The highest weight of corms per plant was observed in the F₂S₂ combination [125% of RDF (100:75:75 kg/ha) with 60 cm x 60 cm] averaging (289.55 g). The lowest weight of corms per plant (175.17 g) was obtained in F₃S₂ [75% of RDF (60:45:45 kg/ha) with 60 cm x 60 cm]. Bhatt *et al.* (2019) [2] reported similar results in weight of corm per plant in taro. The data pertaining to number of corms plant⁻¹ revealed that the maximum number of corms per plant (32.89) was found in F₂ [125% RDF (100:75:75 kg/ha)] followed by F₁ [100% of RDF (80:60:60 kg/ha)] i.e. 30.53 whereas, the minimum (21.10) was recorded in F₃ [75% of RDF NPK (60:45:45 kg/ha)]. Higher levels of fertilizer generally increase the number of corms per plant by providing essential nutrients that support additional growth.

Table 1: Effect of fertilizer, plant spacing levels and their interaction on yield characteristics of taro under Marathwada conditions.

Treatments	Number of corms plant ⁻¹	Corm length (cm)	Corm diameter (cm)	Weight of corms (g plant ⁻¹)	Number of cormels plant ⁻¹	Weight of cormels (g plant ⁻¹)	Herbage yield (q ha ⁻¹)	Total corm + cormel yield (q ha ⁻¹)
Fertilizer levels								
F ₁	1.63	7.34	4.75	219.44	30.53	294.80	103.68	205.26
F ₂	2.03	8.20	6.17	228.95	32.89	323.53	120.88	233.10
F ₃	1.48	7.26	4.69	188.39	21.10	227.08	93.48	127.47
S.E.(m)±	0.128	0.077	0.102	1.512	0.584	2.002	7.667	101.04
C.D. (at 5%)	0.382	0.231	0.305	4.532	1.750	6.001	22.977	205.26
Spacing levels								
S ₁	1.66	7.43	5.09	200.54	27.10	271.62	108.41	188.99
S ₂	1.92	8.00	5.64	236.73	31.20	306.06	83.67	184.58
S ₃	1.56	7.37	4.88	199.51	26.22	267.73	125.36	192.26
S.E.(m)±	0.128	0.077	0.102	1.512	0.584	2.002	7.667	33.70
C.D. (at 5%)	0.382	0.231	0.305	4.532	1.750	6.001	22.977	101.04
Interaction (F x S)								
F ₁ S ₁	1.69	7.63	4.93	201.21	32.52	299.85	107.68	185.90
F ₁ S ₂	1.54	7.13	5.05	245.47	31.67	325.43	75.28	144.00
F ₁ S ₃	1.65	7.27	4.27	211.63	27.40	259.12	128.06	285.89
F ₂ S ₁	1.68	7.45	5.51	202.01	29.48	301.49	120.46	191.08
F ₂ S ₂	2.90	8.93	6.66	289.55	41.90	351.59	98.03	245.00
F ₂ S ₃	1.51	8.23	6.33	195.29	27.30	317.50	144.31	263.22
F ₃ S ₁	1.60	7.22	4.83	198.39	19.31	226.55	97.09	190.00
F ₃ S ₂	1.52	7.95	5.20	191.60	23.98	241.15	79.64	164.73
F ₃ S ₃	1.31	6.62	4.04	175.17	20.03	213.53	122.98	234.67
S.E.(m)±	0.221	0.133	0.176	2.619	1.011	3.467	13.28	58.38
C.D. (at 5%)	0.662	0.399	0.529	7.849	3.031	10.394	39.81	175.00

Conversely, lower fertilizer levels often result in fewer cormels due to limited nutrient availability. The maximum number of cormels plant⁻¹ (31.20) was obtained in plant spacing of S₂ (60 cm x 60 cm) which was followed by plant spacing S₁ (60 cm x 45 cm) *i.e.* 27.10 whereas, minimum number of cormels plant⁻¹ (26.22) was observed in the plant spacing of S₃ (60 cm x 30 cm). An increase in plant spacing the corresponding increase in number of cormels plant⁻¹ was also reported by Mannan *et al.* (1988) [6] and Dhar (1989) [5]. Different levels of fertilizer in combination with spacing had a significant effect on the number of cormels plant⁻¹ at the final stage. The highest number of cormels plant⁻¹ (41.90) was recorded in the F₂S₂ combination [125% of RDF (100:75:75 kg/ha) with 60 cm x 60 cm] which was significantly higher than the other treatments. The lowest number of cormels plant⁻¹ (19.31) was obtained from the F₃S₁ [75% RDF (60:45:45 kg/ha) with 60 cm x 45 cm]. These results are in accordance with the findings of Mannan *et al.* (1988) [6] and Dhar (1989) [5].

The treatment F₂ [125% of RDF (100:75:75 kg/ha)] recorded highest cormel weight (323.53 g) and it was followed by F₁ [100% of RDF (80:60:60 kg/ha)] *i.e.* 294.80 g while treatment F₃ [75% of RDF (60:45:45 kg/ha)] recorded lowest cormel weight (227.08 g plant⁻¹). The similar results were also reported by Verma *et al.* (2012) [8] and Akther *et al.* (2016) [11]. The maximum average cormel weight (306.06 g plant⁻¹) was obtained in the plant spacing of S₂ (60 cm x 60 cm) followed by S₁ (60 cm x 45 cm) *i.e.* 271.62 g and minimum average cormel weight (267.73 g plant⁻¹) was observed in treatment S₃ (60 cm x 30 cm) which was significantly inferior to rest of other treatments. Wider plant spacing typically leads to greater cormel weight per plant by reducing competition for resources and allowing for more extensive growth (Dhar 1989) [5]. The highest weight of cormels plant⁻¹ 351.59 g was recorded in F₂S₂ [125% of RDF (100:75:75 kg/ha) with 60 cm x 60 cm] followed by

F₁S₂ (325.43 g plant⁻¹), (F₂S₃ 317.50 g plant⁻¹) whereas, the lowest weight of cormels plant⁻¹ 213.53 g was observed in F₃S₃ combination [75% of RDF (60:45:45 kg/ha) with 60 cm x 30 cm]. This is in agreement with the results of Mannan *et al.* (1988) [6] and Dhar (1989) [5].

The maximum cumulative herbage yield 120.88 q/ha was recorded in treatment F₂ [125% of RDF (100:75:75 kg/ha)]. However, the minimum 93.48 q/ha herbage yield was recorded in treatment F₃ [75% of RDF (60:45:45 kg/ha)]. The highest herbage yield 125.36 q/ha was obtained in plant spacing of S₃ (60 cm x 30 cm) which was significantly higher than rest of all other treatments. The lowest cumulative herbage yield 83.67 q/ha noticed in plant spacing of S₂ (60 cm x 60 cm). The interaction effect of different levels of fertilizer and plant spacing had significant effect on cumulative herbage yield at 120 days. The highest herbage yield 144.31 q/ha was recorded in F₂S₃ combination [125% of RDF (100:75:75 kg/ha) with 60 cm x 30 cm] which was significantly higher than other treatments. This was at par with F₁S₃ [100% of RDF (80:60:60 kg/ha) with 60 cm x 30 cm] (128.06 q/ha). The lowest herbage yield 75.28 q/ha was recorded in F₁S₂ combination [100% RDF (80:60:60 kg/ha) with 60 cm x 60 cm]. Shellikeri *et al.* (2019) [7] documented similar data on herbage yield. Interaction effect of fertilizer levels and plant spacing on herbage yield (g/plant) in taro significantly influences overall productivity.

In respect to the total corm + cormel yield, the maximum (233.10 q/ha) was recorded in treatment F₂ [125% of RDF (100:75:75 kg/ha)]. However, the minimum corm + cormel yield was recorded (127.47 q/ha) in treatment F₃ [75% of RDF (60:45:45 kg/ha)]. The influence of plant spacing on the total corm + cormel yield was also noticed as the highest corm + cormel yield (192.26 q/ha) was obtained in plant spacing of S₃ (60 cm x 30 cm) which was significantly higher than rest of all other treatments. The lowest total

yield (184.58 q/ha) was obtained in S₂ (60 cm x 60 cm). High fertilizer levels combined with closer plant spacing generally result in the more corm + cormel yield as plants receive optimum nutrients and more plant population per unit area. The interaction of plant spacing and fertility levels showed a significant effect on corm + cormel yield (q ha⁻¹). The highest corm + cormel yield (263.22 q/ha) was observed in the F₂S₃ combination [125 of% RDF (100:75:75 kg/ha) with 60 cm x 30 cm] while the lowest corm (144 q/ha) was recorded in the F₁S₂ combination [100% RDF (80:60:60 kg/ha) with 60 cm x 60 cm]. Several researchers, including Choudhary *et al.* (2013) ^[3], Shellikeri *et al.* (2019) ^[7] and Bhatt *et al.* (2019) ^[2] reported similar findings.

Conclusion

In view of the findings and results presented above, it may be concluded that the treatments F₂ [125% of RDF *i.e.* 100:75:75 kg/ha] and plant spacing S₂ [60x60 cm] found significantly superior over all other treatments which was found to be statistically at par with treatments F₁ [100% of RDF *i.e.* 80:60:60 kg/ha] and S₁ (60x45 cm). In relation to the combined effect, treatment F₂S₃ [125 of% RDF (100:75:75 kg/ha) with 60 cm x 30 cm] found to be the best combination for highest herbage and corm yield under Marathwada conditions.

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