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Effect of fertilizer application and spacing on quality attributes of taro [*Colocasia esculenta* (L.) Schott.]

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Abstract
An investigation was carried out to effect of fertilizer and spacing on the quality attributes of taro at research field of Department of Horticulture, College of Agriculture, RVSKVV, and Gwalior during two consecutive *kharif* seasons of 2017 and 2018. Three levels of fertilizer dose viz., F_1 = full FYM (10t/ha.) + recommended dose of NPK (80:60:60 kg/ha), F_2 = full FYM (10t/ha.) +75% of recommended dose of NPK (60:45:45 kg/ha), F_3 = full FYM (10t/ha.) +125% of recommended dose of NPK (100:75:75 kg/ha) and three levels of spacing viz., 0.60m x 0.30m, 0.60m x 0.45m and 0.60m x 0.60m were used as treatment variables. The experiments were laid out in factorial randomized block design with three replications. The data revealed that the highest starch content and dry matter content were recorded in F_3 [full FYM (10 t/ha)+125% recommended dose of NPK (100:75:75 kg/ha)] both the respective year and on pooled basis, and highest plant moisture content was recorded in F_1 [full FYM (10 t/ha)+recommended dose of NPK (80:60:60 kg/ha)] for the year of 2017 and on pooled basis) except F_2 in the year of 2018. As respect to highest starch content and dry matter content were recorded in plant spacing S_1 (0.60m x 0.30m) both the respective year and on pooled basis and highest plant moisture content was recorded in plant spacing of S_3 (0.60m x 0.60m) for the year of 2017 and on pooled basis) except F_2 in the year of 2018.

Keywords: Fertilizer application, spacing, quality attributes, taro, *Colocasia esculenta*

Introduction
Taro (*Colocasia esculenta* L. Schott) commonly known as arbi, tarai, dasheen, champadhumpa and eddoe. It is an important staple food crop grown throughout many Pacific island countries, parts of Africa, Asia and the Caribbean and is thought to have originated in North Eastern India and Asia (Kuruvilla and Singh 1981; Ivancic 1992) [4] and gradually spread worldwide by settlers. It is widely grown as a rainfed crop in the valley and *Jhum* area in entire North Eastern States of India. *Colocasia esculenta* is an herbaceous, perennial root crop that has the character of being an underground stem. It is different from yam as it is not a tuber but a corm. Cocoyams belong to the family of the plants called araceae or aroids with two genera – taro (*Colocasia esculenta*) and tannia (*Xanthosoma sagittifolium).* Taro also known as “potato of tropics”, or “elephant ears” is a wetland herbaceous perennial with huge “elephant ear” like leaves. Taro leaves are heart shaped which are 2-3' long and 1-2' across on 3' long petioles that all emanate from an upright tuberous rootstock, called a corm. The petioles are thick and succulent, which attaches near the center of the leaf. The corm is shaped like a top with rough ridges, lumps and spindly roots, and usually weighs around 1-2 pounds, but can weigh eight pounds. The skin of corm and cormels are brown with white or pink color flesh. Colocasia produces smaller tubers or "cormels" which grow off the sides of the main corm. The crop of colocasia has a triple value in that the stem may be used as salads, the tubers provide easily digested starch, with the leaves are used as a green vegetable. The major economic parts are corm and cormels which have a nutritional value comparable to sweet potato, while the young leaves used for food contains about 23% protein on a dry weight basis. It is also rich in calcium, phosphorus, iron, vitamin C, thiamine, riboflavin and niacin, which are important constituents of human diets. Corms and cormels possess a high nutritional value. The corm is a rich source of carbohydrate, the majority being starch, of which 17-28% is amylase and the remainder is amylopectin. Taro corms and cormels have a high economic value in urban markets. Its production provides employment to many people and the crop maintains good ground cover or canopy in the fields.

Nutrient management and spacing are the major regulating factors to get the maximum yield and quality of any crop. Sensible and suitable use of nutrients and spacing are essential to improve yield and quality of produce. Therefore, its merits induce us to advance research especially focused on improving its yield. The present experiment was therefore, carried out to find out suitable plant spacing and optimum fertilizer dose for better quality of taro.

Materials and Methods

Field experiments were carried out in the research field of Department of Horticulture, College of Agriculture, RVSKVV, and Gwalior during two consecutive *kharif* seasons of 2017 and 2018 on taro [*Colocasia esculenta* (L.) Schott.]. Three levels of fertilizer dose i.e. F_1 = full FYM (10t/ha.) + recommended dose of NPK (80:60:60 kg/ha), F_2 = full FYM (10t/ha.) +75% of recommended dose of NPK (60:45:45 kg/ha), F_3 = full FYM (10t/ha.) +125% of recommended dose of NPK (100:75:75 kg/ha) and three levels of spacing i.e. S_1 = (0.60m x 0.30m), S_2 = (0.60m x 0.45m) and S_3 = (0.60m x 0.60m) were used as treatment variables in the present study. The experiments were conducted in a factorial randomized block design with three replications. The unit plot size was 3.6 m x 3.6 m. The variety used in the experiment was "Narendra Arbi-1". The crop was fertilized with as per treatment. Intercultural operations were done as and when required.

Starch (%)

Extraction of Starch from Tubers

Taro tubers was collected and cleaned properly washed. After washing outer covering layer was peeled. The tuber was than sliced and kept for drying at room temperature. After drying, the dried sliced tuber pieces were crushed in mixer grinder to form the powder. This powder is further used for extraction of starch. Taro powder (50 gm) was taken and dispersed in 100 ml of water; the mixture was homogenized for about 30 mins, by using homogenizer. Resulting solution was kept overnight. On next day the solid and liquid layer gets separated, solid material gets deposited at the bottom of the glass beaker while the liquid floats at upper surface. The liquid layer is decanted and remaining sediment is washed with excess of water. After washing the water is decanted and the starch powder is obtained by filtration through what man filter paper, powder is kept for drying. The obtained powder after drying is starch powder (Ahmed and Khan, 2013) [1]. The starch percentage of tubers was estimated by using following formula:

$$\text{Starch of tubers (\%)} = \frac{\text{Weight of starch powder}}{50} \times 100$$

Moisture (%)

The Moisture content of tubers was estimated by using following formula:

$$\text{Dry matter content of cormels (\%)} = \frac{\text{Total dry weight of cormels (g)}}{\text{Total fresh weight of cormels (g)}} \times 100$$

Dry matter (%)

100 g of cormels was collected from each plot and their fresh weight was recorded and then they were cut into small pieces with a stainless steel knife. The cut pieces were dried in hot air oven by gradually raising the temperature from 65^0C to 85^0C and maintaining at 85^0C until two consecutive weights were constant (Anonymous, 1960) and per cent dry matter was determined by dividing the dry weight of cormels by fresh weight of cormels and then multiplied by 100.

$$\text{Dry matter content of cormels (\%)} = \frac{\text{Total dry weight of cormels (g)}}{\text{Total fresh weight of cormels (g)}} \times 100$$

Results and Discussion

The quality parameters of the samples showed significant (P<0.05) variations among the different fertilizer level and plant spacing (Table 1).

The application of F_3 had highest starch content (19.67%) while application of F_2 recorded the lowest starch content of 11.93%. The plant spacing of S_1 (0.60m x 0.30m) had highest starch content (17.49%) while plant spacing of S_3 (0.60m x 0.60) recorded the lowest starch content of 14.66% which was statistically at par with S_2 (0.60m x 0.45m) (15.61%) in the year of 2017. The application of F_3 had highest starch content (19.78%) while application of F_2 recorded the lowest starch content of 12.09%. The plant spacing of S_1 (0.60m x 0.30m) had highest starch content (17.62%) while plant spacing of S_3 (0.60m x 0.60) recorded the lowest starch content of 14.77% which was statistically at par with S_2 (0.60m x 0.45m) (15.72%) in the year of 2018. The application of F_3 had highest starch content (19.72%) while application of F_2 recorded the lowest starch content of 12.01%. The plant spacing of S_1 (0.60m x 0.30m) had highest starch content (17.56%) while plant spacing of S_3 (0.60m x 0.60) recorded the lowest starch content of 14.71% which was statistically at par with S_2 (0.60m x 0.45m) (15.66%) on the pooled basis.

The highest moisture content of 65.09% was found in the fertilizer level of F_1, followed by F_2. The lowest value for moisture content was recorded in fertilizer level of F_3. The highest moisture content of 61.78% was found in the plant spacing of S_3, which was statistically at par with S_2. The lowest value for moisture content was recorded in plant spacing of S_1 in the year of 2017. The highest moisture content of 66.50% was found in the fertilizer level of F_2, followed by F_1. The lowest value for moisture content was recorded in fertilizer level of F_3. The highest moisture content of 66.83% was found in the plant spacing of S_3, followed by S_2. The lowest value for moisture content was recorded in plant spacing of S_1 in the year of 2018. The highest moisture content of 61.70% was found in the fertilizer level of F_1, which was statistically at par with F_2. The lowest value for moisture content was recorded in fertilizer level of F_3. The highest moisture content of 64.31% was found in the plant spacing of S_3, followed by S_2. The lowest value for moisture content was recorded in plant spacing of S_1 on the pooled basis.

The fertilizer level of F_3 exhibited the highest amount of dry matter content (51.84%), whereas, the fertilizer level of F_1 recorded the lowest dry matter content (34.91%). The plant spacing of S_1 exhibited the highest amount of dry matter content (51.51%), whereas, the plant spacing of S_3 recorded the lowest dry matter content (38.22%), which was at par with S_2 in the year of 2017. The fertilizer level of F_3 exhibited the highest amount of dry matter content (51.89%), whereas, the fertilizer level of F_2 recorded the lowest dry matter content (33.50%). The plant spacing of S_1 exhibited the highest amount of dry matter content (53.58%), whereas, the plant spacing of S_3 recorded the lowest dry matter content (33.17%), followed by S_2 in the year of 2018. The fertilizer level of F_3 exhibited the highest amount of dry matter content (51.87%), whereas, the fertilizer level of F_1 recorded the lowest dry matter content (38.30%) which was statistically at par with F_2. The plant spacing of S_1 exhibited the highest amount of dry matter content (52.55%), whereas, the plant spacing of S_3 recorded the lowest dry matter content (35.69%), followed by S_2 on the pooled basis.

Buragohain *et al.* (2013) [3], Sable *et al.* (2007) [6] and Verma *et al.* (2012) [7] reported same result in starch content, moisture and dry matter content in taro.

In conclusion, for quality attributes application of F_3 [full FYM (10t/ha.) +125% of recommended dose of NPK (100:75:75 kg/ha)] has been found suitable. However, for plant spacing use of S_1 (0.60m x 0.30m) for improved quality traits.

Table 1: Effect of fertilizer and plant spacing on starch (%), Moisture (%) and Dry matter (%)

Treatments	Starch (%)			Moisture (%)			Dry matter (%)		
	2017	2018	POOLED	2017	2018	POOLED	2017	2018	POOLED
Fertilizer levels									
F1	16.16	16.25	16.20	65.09	58.30	61.70	34.91	41.70	38.30
F2	11.93	12.09	12.01	53.98	66.50	60.24	46.02	33.50	39.76
F3	19.67	19.78	19.72	48.16	48.11	48.13	51.84	51.89	51.87
S.E.(m)	0.470	0.466	0.468	1.620	1.812	1.719	1.620	1.812	1.719
C.D. (at 5%)	1.409	1.397	1.348	4.858	5.434	4.955	4.858	5.434	4.955
Plant spacing									
S1	17.49	17.62	17.56	48.49	46.42	47.45	51.51	53.58	52.55
S2	15.61	15.72	15.66	56.96	59.66	58.31	43.04	40.34	41.69
S3	14.66	14.77	14.71	61.78	66.83	64.31	38.22	33.17	35.69
S.E.(m)	0.470	0.466	0.468	1.620	1.812	1.719	1.620	1.812	1.719
C.D. (at 5%)	1.409	1.397	1.348	4.858	5.434	4.955	4.858	5.434	4.955

F_1 = full FYM (10 t/ha)+ recommended dose of NPK (80:60:60 kg/ha), F_2 = full FYM (10 t/ha) +75% of recommended dose of NPK (60:45:45 kg/ha), F_3 = Full FYM (10 t/ha)+125% of recommended dose of NPK (100:75:75 kg/ha), S_1 = (0.60m x 0.30m), S_2 = (0.60m x 0.45m), S_3 = (0.60m x 0.60m)

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