

# INFLUENCE OF SETT SIZE, PLANT POPULATION AND ORGANIC MANURES ON YIELD COMPONENTS, YIELD AND QUALITATIVE CHARACTERS OF ARROWROOT GROWN AS INTERCROP IN COCONUT GARDEN<sup>1</sup>

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## ABSTRACT

Field experiment was conducted for two consecutive seasons to study the influence of sett size, plant population and organic manures on arrowroot yield components, yield and qualitative characters grown as intercrop in coconut garden. Sett sizes (15-20 g and 25-30 g) did not show significant effect on yield components, quality characters, whereas, they were significantly superior under lower plant density of 111 thousands per hectare (30 x 30 cm) compared to higher plant density of 166 thousands per hectare (30 x 20 cm). Among organic manures, Farm yard Manure or Vermicompost applied alone and FYM+NPK combination showed significantly higher number and length of rhizomes and higher starch and crude protein content. Fresh rhizome yield did not differ significantly due to sizes of planting material and plant population levels. FYM+NPK combination recorded significantly higher fresh rhizome yield. The starch and crude protein contents were significantly higher under FYM, VC, FYM+NPK and NPK alone treatments.

## INTRODUCTION

Arrowroot, a mainor tuber crop is an erect, perennial herb belonging to the family Marantaceae and found to grow well under shaded conditions. It is indigenous to tropical America and widely distributed throughout the tropical countries like India, Sri Lanka, Indonesia, Philippines, Australia and West Indies. The economic part rhizome, is used for the production of starch, which in turn is used in the preparation of biscuits, cakes, puddings and jellies. It possesses demulcent properties and given in bowel complaints. It

is employed as a suspending agent in the preparation of barium meals and the starch is preferred as base material for making tablets, since it produces rapid disintegration. Starch is also used as a base for face powders and in the preparation of special glues. As there is dearth of information on the agrotechniques of this important crop, a study was conducted at CPCRI, Kasaragod. to findout the effect of sizes, plant population and organic manures on yield components, yield and quality characters of arrowroot grown as intercrop in coconut garden.

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## MATERIALS AND METHODS

Field experiments were conducted during 1995-96 and 1996-97 at Central Plantation Crops Research Institute, Kasaragod which is situated at 12° 30'N latitude and 75° 00' longitude at an elevation of 10.7 m above mean sea level. The soil of the experimental site was red sandy loam with the field capacity of 7.40 and 8.95% at 0-25 and 25-50 cm, respectively. The soil was low in available N, and K and was high in available P. The field experiment was laid out in a split plot design with three replications. Sizes of planting materials and plant population levels formed main plot treatments viz., 15-20 g with 111 thousands population ha<sup>-1</sup> (S<sub>1</sub>P<sub>1</sub>), and 166 thousands population ha<sup>-1</sup> (S<sub>1</sub>P<sub>2</sub>) and 25-30g with 111 thousands population ha<sup>-1</sup> (S<sub>2</sub>P<sub>1</sub>) and 166 thousand population ha<sup>-1</sup> (S<sub>2</sub>P<sub>2</sub>). Organic manures like Fam Yard Manure (FYM): 26 t ha<sup>-1</sup> (F<sub>1</sub>), FYM : 34 t ha<sup>-1</sup> (F<sub>2</sub>), Composted Coir Pith (CCP) : 32 t ha<sup>-1</sup> (F<sub>3</sub>), CCP : 42 t ha<sup>-1</sup> (F<sub>4</sub>), Vermicompost (VC) : 22 t ha<sup>-1</sup> (F<sub>5</sub>) VC: 30 t ha<sup>-1</sup> (F<sub>6</sub>), FYM (20 t ha<sup>-1</sup>) + NPK (75:50:50 kg ha<sup>-1</sup>) (F<sub>7</sub>), NPK alone (75:50:50 kg ha<sup>-1</sup>) (F<sub>8</sub>) and Control (F<sub>9</sub>) formed the subplot treatments. The same treatments were superimposed in the same plot during second year.

Yield components like number of rhizomes, rhizome length (cm) and rhizome girth (cm) were measured from five plants and average was worked out. The harvest index was calculated by using the formula;

$$\text{Harvest Index (HI)} = \frac{\text{Economic yield}}{\text{Biological yield}}$$

The starch and crude protein contents were estimated by the following methods;

### Starch

Starch content was estimated by Anthrone reagent method (Sadasivam and Manikam, 1992). The sample was treated

with 80% alcohol to remove sugars and the starch was extracted with perchloric acid. Then it was hydrolysed to glucose and dehydrated to hydroxymethyl furfural in hot acidic medium, which, with anthrone forms a green colour product. The starch content was expressed on dry weight basis.

### Crude protein:

The crude protein was calculated by multiplying the Nitrogen percentage of rhizome by the factor 6.25 (Jackson, 1973).

## RESULTS AND DISCUSSION

### Yield components:

Yield components like number of rhizomes per plant, length of the rhizomes and girth of the rhizomes did not differ significantly due to sizes of planting material. This is mainly because the growth under these treatments was similar as reflected in growth components.

Plant population level of 111 thousands ha<sup>-1</sup> produced more number of rhizomes (Table 1) compared to 166 thousands ha<sup>-1</sup> population. Increase in number of rhizomes was attributed to production of more number of tillers and more number of leaves. Ramakrishnan Nayar and Sadanandan (1990) reported, decrease in number of tubers per plant with increase in plant population in cassava. Length and breadth of tubers was also not influenced by the plant population levels.

Among organic manures, FYM+NPK resulted in more number of rhizomes compared to other treatments. The length and girth of rhizomes were significantly superior in FYM+NPK, FYM, VC and NPK treatments compared to CCP and control. This is mainly attributed to better growth of the crop as reflected in growth components resulted in more uptake of nutrients which favoured the efficient bulking of rhizomes. Ramesan (1991) reported more number of

Table 1. Yield components of arrowroot as influenced by different treatments.

Treatments	No. of rhizomes plant <sup>-1</sup>			Length of rhizomes (cm)			Girth of rhizomes (cm)		
	a	b	c	a	b	c	a	b	c
<b>A. sizes of planting material</b>									
S <sub>1</sub> : 15-20 g	7.3	7.5	7.4	17.0	17.1	17.0	4.9	4.9	4.9
S <sub>2</sub> : 25-30 g	7.3	7.5	7.4	16.9	17.0	16.9	4.9	4.9	4.9
'F' test	NS	NS	NS	NS	NS	NS	NS	NS	NS
SEm±	0.05	0.04	0.04	0.04	0.04	0.04	0.01	0.01	0.01
CF (P=0.05)	-	-	-	-	-	-	-	-	-
<b>B. Plant population levels</b>									
P <sub>1</sub> : 111 Thousands ha <sup>-1</sup>	7.6	7.9	7.7	17.0	17.0	17.0	4.9	4.9	4.9
P <sub>2</sub> : 166 Thousands ha <sup>-1</sup>	7.0	7.1	7.0	17.0	17.0	17.0	4.9	4.9	4.9
'F' test	*	*	*	NS	NS	NS	NS	NS	NS
SEm±	0.05	0.04	0.04	0.04	0.04	0.04	0.01	0.01	0.01
CD (P=0.05)	0.18	0.15	0.16	-	-	-	-	-	-
<b>C. Organic manures &amp; levels</b>									
F <sub>1</sub> : FYM : 26 t ha <sup>-1</sup>	9.2	9.8	9.5	18.7	18.7	18.7	5.4	5.4	5.4
F <sub>2</sub> : FYM : 34 t ha <sup>-1</sup>	9.4	9.9	9.6	18.8	18.8	18.8	5.4	5.4	5.4
F <sub>3</sub> : CCP : 32 t ha <sup>-1</sup>	3.3	3.3	3.3	13.5	13.5	13.5	4.0	4.0	4.0
F <sub>4</sub> : CCP : 42 t ha <sup>-1</sup>	3.5	3.5	3.5	13.6	13.5	13.6	4.1	4.1	4.1
F <sub>5</sub> : VC : 22 t ha <sup>-1</sup>	9.4	9.4	9.4	18.8	18.8	18.8	5.4	5.4	5.4
F <sub>6</sub> : VC : 30 t ha <sup>-1</sup>	9.5	9.7	9.6	18.9	18.9	18.9	5.4	5.4	5.4
F <sub>7</sub> : FYM (20t/ha)+NPK (75:50:50kg/ha)	10.9	11.1	11.0	18.9	18.9	18.9	5.3	5.4	5.4
F <sub>8</sub> : NPK(75:50:50 kg/ha)	8.0	8.1	8.0	18.7	18.7	18.7	5.4	5.4	5.4
F <sub>9</sub> : Control	2.7	2.7	2.7	13.1	13.2	13.2	4.0	4.0	4.0
'F' test	*	*	*	*	*	*	*	*	*
SEmt	0.10	0.10	0.09	0.09	0.08	0.08	0.03	0.03	0.03
CD (P=0.05)	0.28	0.29	0.26	0.24	0.21	0.22	0.08	0.07	0.07

a: 1995-96, b: 1996-97:c:Pooled NS: Non Significant

rhizomes at 150:75:150 kg PK Ha<sup>-1</sup> compared to lower levels in arrowroot.

#### YIELD:

Sizes of planting material and plant population levels did not influence the rhizome yield significantly during both the seasons. This is mainly attributed to non-significant difference in growth parameters and yield components under both the sizes of planting material. Among the plant population levels, AGR during 180-240 DAP was statistically on par at both the population levels. The number of rhizomes produced per plant with 111 thousands ha<sup>-1</sup> was significantly superior (7.7), as compared to 166 thousands plants ha<sup>-1</sup> (7.0) resulting in higher yield. Rajagopalan *et al.* (1992) also reported the maximum fresh rhizome yield of arrowroot with 30cm x 30 cm spacing when grown as intercrop in coconut garden. Cock *et al.* (1977) reported the higher yield of cassava with closer spacing. Ramakrishnan Nayar and Sadanandan (1990) reported the maximum yield of cassava at 90 cm x 90 cm spacing compared to 60 cm x 60 cm and 120 cm x 120 cm spacings.

Among organic manures, FYM+NPK treatment recorded significantly higher fresh rhizome yield (16.9 and 17.3 t/ha during 1995-96 and 1996-97, respectively) compared to other treatments. (Table 2) FYM at both the levels (13.5 to 15.0 t/ha) and VC at both the levels (13.9 to 15.9 t/ha) also recorded significantly higher yield compared to CCP at both the levels (9.7 to 10.3 t/ha) and NPK alone (12.6 and 12.5 t ha<sup>-1</sup> during 1995-96 and 1996-97, respectively). The per cent reduction in yield under different treatments compared to FYM+NPK was 16.4 and 17.0 per cent with FYM, 41.5 and 42.7 per cent with CCP, 12.9 and 14.0 per cent with VC and 26.9 per cent with NPK alone. The per cent reduction was 63.7 per cent with control. Superior yield with FYM+NPK was mainly due to the combined effect of

organic and chemical fertilizers on growth characters, yield components, chlorophyll 'a' and 'b' contents and higher AGR and CGR coupled with higher nutrient uptake. FYM and VC applied at two levels alone also favoured the growth of the crop and in higher yield. The leaf area and LAD were maintained for a longer period under these treatments. With NPK alone, the reduction in the yield might be due to insufficiency of applied N, P and K, since uptake is more than the present level of fertilizer applied. Application of increased dose of NPK 150:75:150 kg ha<sup>-1</sup> resulted in higher yield of arrowroot compared to lower doses (Ramesan, 1991). Increase in yield due to combined application FYM and inorganic fertilizer has been reported in turmeric (Rao *et al.*, 1996) and ginger (Pawar and Patil, 1987). Application of FYM alone resulting in higher yield of amorphophallus (Pawar and Mehta, 1987) and turmeric (Balashanmugam *et al.*, 1989) have been documented. VC application alone or in combination found to increase the yield of turmeric (Vadiraj *et al.*, 1996). The overall better growth and yield under FYM, VC treatments is also attributed to higher microbial population and DHA which might have influenced nutrient uptake, chlorophyll synthesis, plant growth and further these microbes found to promote soil aggregation and thus indirectly influencing root environment and plant growth.

The CCP application alone though, found to increase the yield significantly compared to control, the plant growth was affected much under this as reflected in lower growth components, yield components, lower chlorophyll content and less nutrient uptake compared to other manurial treatments.

#### Harvest Index:

The harvest index which indicates the efficiency of accumulation of photosynthates in the economic parts did not differ significantly due to sizes of planting material.

Table 2. Fresh rhizome yield, Harvest index and qualitative characters of arrowroot as influenced by different treatments.

Treatments	Fresh rhizome yield (t/ha)			HI			Starch (%)		Crude protein(%)	
	a	b	c	a	b	c	a	b	a	b
<b>A. Sizes of planting</b>										
S <sub>1</sub> : 15-29 g	12.1	12.9	12.5	0.419	0.436	0.428	69.33	69.90	4.89	4.91
S <sub>2</sub> : 25-30 g	12.2	12.9	12.5	0.417	0.436	0.427	69.34	69.91	4.89	4.90
'F' test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SEm± 0.001	0.07	0.02	0.04	0.001	0.001	0.001	0.001	0.01	0.01	0.001
CD (P=0.05)	-	-	-	-	-	-	-	-	-	-
<b>B. Plant population levels</b>										
P <sub>1</sub> : 111 Thousands ha <sup>-1</sup>	12.0	12.9	12.5	0.415	0.440	0.428	71.00	70.82	4.93	4.98
P <sub>2</sub> : 166 Thousands ha <sup>-1</sup>	12.3	13.1	12.7	0.410	0.431	0.421	69.46	69.76	4.74	4.78
'F' test	NS	NS	NS	.	.	.	.	.	.	.
SEm±	0.07	0.02	0.04	0.001	0.001	0.001	0.01	0.01	0.001	0.001
CD (P=0.05)	-	-	-	0.004	0.005	0.004	0.04	0.05	0.004	0.005
<b>C. Organic manures &amp; levels</b>										
F <sub>1</sub> : FYM : 26 t ha <sup>-1</sup>	13.5	14.9	14.2	0.451	0.459	0.455	71.31	73.26	5.20	5.25
F <sub>2</sub> : FYM : 34 t ha <sup>-1</sup>	13.5	15.0	14.3	0.453	0.459	0.456	71.34	73.28	5.41	5.31
F <sub>3</sub> : CCP : 32 t ha <sup>-1</sup>	9.7	10.3	10.0	0.324	0.361	0.342	67.80	66.11	4.30	4.35
F <sub>4</sub> : CCP : 42 t ha <sup>-1</sup>	9.8	9.9	9.8	0.326	0.344	0.335	66.80	66.77	4.10	4.08
F <sub>5</sub> : VC : 22 t ha <sup>-1</sup>	13.9	15.5	14.7	0.438	0.461	0.451	73.40	73.30	5.24	5.26
F <sub>6</sub> : VC : 30 t ha <sup>-1</sup>	14.0	15.9	14.9	0.439	0.460	0.451	73.41	73.30	5.25	5.30
F <sub>7</sub> : FYM(20 t/ha)+NPK (75:50:50kg/ha)	16.9	17.3	17.1	0.437	0.463	0.451	73.33	73.24	5.48	6.00
F <sub>8</sub> : NPK(75:50:50 kg/ha)	12.6	12.5	12.5	0.385	0.397	0.391	72.70	73.23	4.81	5.28
F <sub>9</sub> : Control	5.9	6.4	6.2	0.362	0.362	0.362	63.00	66.11	3.08	3.18
'F' test	.	.	.	.	.	.	.	.	.	.
SEm±	0.12	0.07	0.08	0.002	0.003	0.002	0.04	0.04	0.003	0.003
CD (P=0.05)	0.33	0.19	0.20	0.005	0.006	0.005	0.09	0.09	0.009	0.008

a:1995-96, b: 1996-97 data, C: Pooled, NS: Non Significant

Lower plant population density had significantly higher HI (0.428) compared to higher plant density (0.421) (Table 2). This is mainly because, higher plant density generally decreases the proportion of total DM diverted into the rhizomes. This is reflected in higher rhizome DM at lower planting density. This findings is in conformity with the results of Enyi (1973) and Ramakrishnan Nayar and Sadanandan (1990) in cassava crop. Among organic manures, the HI observed under FYM at both the levels (0.455 and 0.456), VC at both the levels (0.451 each) and under FYM+NPK (0.451) was significantly higher compared to CCP at both the levels (0.342 and 0.335) and NPK alone (0.391). This is mainly attributed to higher DM production and better partitioning into rhizome as reflected in higher DM in rhizomes. Control had significantly lower HI, mainly because of lower DM production and its partitioning into rhizomes.

#### Qualitative Characters:

Sizes of the planting material did not show any significant effect on the starch and crude protein content. Population level of 111 thousands ha<sup>-1</sup> had significantly higher starch (70.82%) and crude protein content (4.98%) compared to 166 thousands ha<sup>-1</sup> (Table 2). This is attributed to the accommodation of optimum number of plants per hectare, which provided proper space for better development and ensured sufficient fillings of the storage cells. In sweet potato, Sharfuddin and Voican (1984) also reported the significant higher content of starch and crude protein at lower density level compared to higher density. Ramakrishnan Nayar and Sadanandan (1991) reported significantly higher starch and lower HCN in cassava under lower planting density.

Among organic manures, FYM and VC at both the levels, FYM+NPK and NPK alone had significantly higher starch and crude protein content compared to CCP at both the

levels and control. Increase in the starch and crude protein content was mainly attributed to sufficient fillings of the storage cells due to better growth of the crop. Increase in starch and crude protein content also attributed to increase in the uptake of N, P and K. The beneficial effects of K on starch content can be attributed to the role of K in carbohydrate synthesis and translocation. Ramesan (1991) and Ramesan *et al.* (1996) reported the higher starch and crude protein contents at higher doses of K in sweet potato. In cassava also, Nair and Aiyar (1996) reported the increase in starch content as the levels of K increased.

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