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# Effect of Sett Size, Plant Population and Organic Manures on Growth Components of Arrowroot (*Maranta arundinacea* L.) Grown as Intercrop in Coconut Garden

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ABSTRACT

Field experiments were conducted during 1995-96 and 1996-97 at CPCRI, Kasaragod to find out the effect of agronomic practices on growth of arrowroot grown as intercrop in coconut garden. Sett sizes (15-20 g and 25-30 g) did not show significant difference with respect to different growth characters, whereas, lower plant population (111 thousand/ha) showed superiority in plant height, number of leaves, leaf area, LAI and LAD over higher density treatment (166 thousand/ha). Among organic manures, Farm Yard Manure, Vermicompost applied alone and FYM + NPK treatments showed significantly superior growth attributes compared to Composted Coir Pith applied alone and NPK alone. Control had significantly lower growth characters.

DUE to increased health consciousness of the people in general and carcinogenic hazards of the synthetic drugs, there is enhanced demand for the products of medicinal plants. However, as their availability from natural resources is limited, there is need to find a place for these crops in our existing cropping system and also workout appropriate agro-techniques. The arrowroot plant is an erect, perennial herb belonging to the family Marantaceae. 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 is rhizome, which is used for the production of starch. The starch is valued as a food especially for infants, invalids and convalescents. It is used in the preparation of biscuits, cakes, puddings and jellies. It possesses demulcent properties and is 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 preparing face powders and in the preparation of special glues. Arrowroot has been found to grow well under shaded conditions. The information available on effect of different agronomic practices on growth of arrowroot when grown as an intercrop in coconut gardens is scanty. Hence, a study was initiated at CPCRI, Kasaragod during 1995-97 with the objective to study the effect of agronomic practices on growth of arrowroot.

## MATERIAL 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 per cent 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 material and plant population levels formed main plot treatments *viz.*, 15-20 g with 111 thousand setts population $ha^{-1}$ ($S_1P_1$), and 166 thousand populations $ha^{-1}$ ($S_1P_2$), 25-30 g with 111 thousand population $ha^{-1}$ ($S_2P_1$) and 166 thousand population $ha^{-1}$ ($S_2P_2$). Organic manures *viz.*, Farm Yard Manure (FYM) at 26 t $ha^{-1}$ ($F_1$), FYM at 34 t $ha^{-1}$ ($F_2$), Composted Coir Pith (CCP) at 32 t $ha^{-1}$ ($F_3$), CCP at 42 t $ha^{-1}$ ($F_4$), Vermicompost (VC) at 22 t $ha^{-1}$ ($F_5$), VC at 30 t $ha^{-1}$ ($F_6$), FYM (20 t $ha^{-1}$) + NPK (75:50:50 kg $ha^{-1}$)($F_7$) NPK alone (75:50:50 kg $ha^{-1}$) ($F_8$) and Control ($F_9$) formed the subplot treatments. The same treatments were superimposed in the same plot during second year. Observations on growth characters were carried out from the labelled plants. The LA, LAI and LAD were calculated using the following formula as suggested by Watson (1952).

| | |
|---|---|
| Leaf area (LA) ($cm^2$ $plant^{-1}$) | Length x Breadth method was used<br>Leaf factor for arrowroot = 0.675 |
| Leaf area index LAI (Watson,1952) | LAI=Leaf area per plant ($cm^2$)/ Land area covered by individual plant ($cm^2$) |
| Leaf area duration (LAD) (days) (Watson, 1952) | $LAD = \frac{L_i + L_{(i+1)}}{2} \times t_2 - t_1$<br>LAD = Mean leaf area duration (days)<br>$L_{(i)}$ = Leaf Area index at ith stage<br>$L_{(i+1)}$ = Leaf area index at (i+1)th stage<br>$t_2$-$t_1$ = Time interval between $i^{th}$ and $(i+1)^{th}$ stage in days |

## Results and Discussion

*Sprouting* : Sprouting was not influenced by the size of planting materials or plant population level and different organic manures. The average sprouting per cent ranged between 87.0 and 87.5 (Table I). Sprouting was not influenced by the size of the planting material as presence of reserved food material in both the sizes was sufficient enough for the establishment of the crop. In other tuber/root crops, there was direct relationship between establishment and size of the planting material. Works done at AICRPS (Anon., 1992) suggested that the optimum size of planting material for ginger being 15-35 g. Pavithra *et al.* (1991) reported higher sprouting per cent when heavy seed tubers (71-85 g) were used as compared to smaller ones in glory lily. In *Diascorea alata* 15 g minisetts gave poor percentage of establishment compared to 30, 45 and 60 g minisetts (George, 1992).

*Height, Number of tillers, Number of Leaves and Leaf Area* : These growth characters did not differ significantly due to size of planting material used (Table I and II). This may be attributed to availability of sufficient reserved food material for the establishment and development of the crop. This findings is contradictory to the findings in other tuber/root crops. In yams, Singh *et al.* (1994) reported the optimum vegetative growth with 200 g weight planting material. Dalion *et al.* (1988) also reported increased petiole diameter, leaf area and number of leaves with an increase in sett size in taro.

Plant population levels showed significant difference with respect to above growth characters from 120 DAP till the harvest. Up to 60 DAP, these growth parameters were

TABLE I

*Sprouting (%), plant height (cm) and number of tillers plant $^{-1}$, number of leaves plant$^{-1}$ as influenced by size (weight) of planting material, plant population and different levels of organic manures in arrowroot**

| Treatment s | Sprouting | Height | | Number of tillers | | No. of leaves | | |
|---|---|---|---|---|---|---|---|---|
| | 30 DAP | 120 DAP | 240 DAP | 120 DAP | 240 DAP | 120 DAP | 180 DAP | 240 DAP |
| **A. Size/weight of planting material** | | | | | | | | |
| $S_1$ : 15-20 g | 87.1 | 52.8 | 84.9 | 2.8 | 4.5 | 23.6 | 40.3 | 24.6 |
| $S_2$ : 25-30 g | 87.3 | 52.9 | 84.6 | 2.8 | 4.5 | 23.6 | 40.2 | 24.5 |
| 'F' test | NS | NS | NS | NS | NS | NS | NS | NS |
| S.Em ± | 0.19 | 0.09 | 0.14 | 0.01 | 0.03 | 0.11 | 0.08 | 0.07 |
| CD (P=0.05) | — | — | — | — | — | — | — | — |
| **B. Plant population levels** | | | | | | | | |
| $P_1$ : 111 Thousand ha$^{-1}$ | 87.3 | 53.8 | 86.7 | 2.9 | 4.7 | 23.9 | 41.5 | 25.2 |
| $P_2$ : 166 Thousand ha$^{-1}$ | 87.2 | 51.9 | 81.9 | 2.7 | 4.3 | 23.2 | 38.9 | 25.2 |
| 'F' test | NS | * | * | * | * | * | * | NS |
| S.Em± | 0.19 | 0.09 | 0.14 | 0.01 | 0.03 | 0.11 | 0.08 | 0.07 |
| CD (P=0.05) | — | 0.31 | 0.49 | 0.03 | 0.11 | 0.40 | 0.29 | — |
| **C. Organic manures and levels** | | | | | | | | |
| $F_1$ : FYM : 26t ha$^{-1}$ | 87.1 | 61.7 | 90.8 | 3.2 | 4.9 | 27.4 | 45.9 | 30.1 |
| $F_2$ : FYM : 34 t ha$^{-1}$ | 87.2 | 62.0 | 89.8 | 3.2 | 5.0 | 27.7 | 46.0 | 30.0 |
| $F_3$ : CCP : 32 t ha$^{-1}$ | 87.0 | 33.2 | 59.2 | 2.1 | 3.1 | 12.7 | 22.7 | 10.4 |
| $F_4$ : CCP : 42 t ha$^{-1}$ | 87.2 | 33.6 | 61.7 | 2.1 | 3.1 | 12.6 | 23.9 | 10.4 |
| $F_5$ : VC :22 t ha$^{-1}$ | 87.5 | 67.0 | 100.4 | 3.2 | 5.8 | 28.4 | 49.3 | 30.2 |
| $F_6$ : VC : 30 t ha$^{-1}$ | 87.3 | 67.5 | 100.6 | 3.2 | 5.8 | 28.4 | 50.0 | 30.1 |
| $F_7$ :FYM (20 t/ha) + NPK (75:50:50 kg/ha) | 87.2 | 72.8 | 116.8 | 3.9 | 6.6 | 39.1 | 64.3 | 40.2 |
| $F_8$ : NPK (75:50:50 kg/ha) | 87.0 | 50.2 | 86.4 | 2.9 | 4.6 | 24.8 | 42.9 | 28.1 |
| $F_9$ : Control | 87.3 | 28.0 | 52.9 | 1.8 | 2.4 | 11.1 | 16.9 | 10.3 |
| 'F' test | NS | * | * | * | * | * | * | * |
| SEm ± | 0.16 | 0.18 | 0.22 | 0.04 | 0.06 | 0.13 | 0.23 | 0.13 |
| CD (P=0.05) | — | 0.52 | 0.64 | 0.13 | 0.16 | 0.38 | 0.65 | 0.37 |

* POOLED DATA, DAP : Days after planting, NS : Non significant

TABLE II

*Leaf area ($cm^{-2}$ $plant^{-1}$), LAI and LAD (days) as influenced by size (weight) of planting material, plant population levels and levels of organic manures in arrowroot*

| Treatments | Leaf area | | | LAI | | LAD | |
|---|---|---|---|---|---|---|---|
| | 120 DAP | 180 DAP | 240 DAP | 60 DAP | 180 DAP | 60-120 DAP | 180-240 DAP |
| **A. Size/weight of planting material** | | | | | | | |
| $S_1$ : 15-20 g | 2341.3 | 3706.1 | 2294.5 | 1.58 | 5.13 | 144.7 | 249.5 |
| $S_2$ : 25-30 g | 2331.4 | 3700.6 | 2289.1 | 1.58 | 4.12 | 144.3 | 249.1 |
| 'F' test | NS | NS | NS | NS | NS | NS | NS |
| S.Em ± | 4.76 | 4.10 | 3.59 | 0.004 | 0.01 | 0.14 | 0.34 |
| CD (P=0.05) | — | — | — | — | — | — | — |
| **B. Plant population levels** | | | | | | | |
| $P_1$ : 111 Thousand $ha^{-1}$ | 2370.6 | 37.63.3 | 2289.5 | 1.26 | 4.18 | 116.8 | 201.8 |
| $P_2$ : 166 Thousand $ha^{-1}$ | 2302.1 | 3643.3 | 2294.2 | 1.90 | 6.07 | 172.2 | 296.9 |
| 'F' test | * | * | NS | * | * | * | * |
| S.Em± | 4.76 | 4.10 | 3.59 | 0.004 | 0.01 | 0.14 | 0.34 |
| CD (P=0.05) | 16.48 | 24.20 | — | 0.02 | 0.02 | 0.51 | 0.96 |
| **C. Organic manures and levels** | | | | | | | |
| $F_1$ : FYM : 26t $ha^{-1}$ | 2570.8 | 3855.6 | 2395.9 | 1.84 | 5.33 | 161.9 | 259.7 |
| $F_2$ : FYM : 34 t $ha^{-1}$ | 2589.7 | 3621.4 | 2410.9 | 1.84 | 5.29 | 162.8 | 259.3 |
| $F_3$ : CCP : 32 t $ha^{-1}$ | 1575.2 | 2526.6 | 1615.1 | 1.13 | 3.51 | 99.2 | 172.7 |
| $F_4$ : CCP : 42 t $ha^{-1}$ | 1621.9 | 2270.0 | 1562.1 | 1.16 | 3.15 | 102.3 | 159.9 |
| $F_5$ : VC :22 t $ha^{-1}$ | 2723.4 | 4038.8 | 2468.6 | 1.87 | 5.60 | 169.4 | 271.0 |
| $F_6$ : VC : 30 t $ha^{-1}$ | 2910.8 | 4102.9 | 2500.4 | 1.88 | 5.68 | 177.4 | 274.7 |
| $F_7$ :FYM (20 t/ha) + NPK (75:50:50 kg/ha) | 3317.4 | 69.32.5 | 4211.5 | 1.86 | 9.59 | 193.5 | 463.1 |
| $F_8$ : NPK (75:50:50 kg/ha) | 2440.5 | 3775.6 | 2395.4 | 1.49 | 5.36 | 146.2 | 260.6 |
| $F_9$ : Control | 1273.3 | 1906.0 | 1066.6 | 1.15 | 2.63 | 87.7 | 122.9 |
| 'F' test | * | * | * | * | * | * | * |
| SEm ± | 12.47 | 9.73 | 6.63 | 0.02 | 0.01 | 0.72 | 0.52 |
| CD (P=0.05) | 35.19 | 27.46 | 18.72 | 0.04 | 0.04 | 2.03 | 1.48 |

* POOLED DATA, DAP : Days after planting, NS : Non significant

TABLE II (a)

*Interaction effects of P x F on leaf area ($cm^2$ $plant^{-1}$) of arrowroot at 120 DAP**

| Treatments** | $F_1$ | $F_2$ | $F_3$ | $F_4$ | $F_5$ | $F_6$ | $F_7$ | $F_8$ | $F_9$ |
|---|---|---|---|---|---|---|---|---|---|
| $P_1$ | 2611.1 | 2631.7 | 1620.2 | 1612..8 | 2756.7 | 2942.4 | 3395.2 | 2475.8. | 1289.5 |
| $P_2$ | 2530.6 | 2547.8 | 1530.1 | 1630.9 | 2890.1 | 2879.3 | 3239.5 | 2467.1 | 1265.2 |

CD (5%) for F at the same level of P = 49.77
CD (5%) for P at the same or different level of F = 50.11

TABLE II (b)

*Interaction effect of P x F on leaf area ($cm^2$ $plant^{-1}$) of arrowroot at 180 DAP**

| Treatments | $F_1$ | $F_2$ | $F_3$ | $F_4$ | $F_5$ | $F_6$ | $F_7$ | $F_8$ | $F_9$ |
|---|---|---|---|---|---|---|---|---|---|
| $P_1$ | 3943.1 | 3876.2 | 2534.2 | 2266.6 | 4057.9 | 4154.8 | 7086.2 | 3958.2 | 1981.9 |
| $P_2$ | 3768.4 | 3766.6 | 2519.0 | 2273.4 | 4019.6 | 4051.1 | 6766.8 | 3792.9 | 1830.0 |

CD (5%) for F at the same level of P = 38.84
CD (5%) for P at the same or different level of F = 39.19

* POOLED DATA
** Treatment details are in Table I

on par with both the levels. This is mainly because of slower growth rate of arrowroot up to 60 DAP. Plant population at 111 thousand $ha^{-1}$ had significantly taller plants with more number of tillers, leaves and leaf area compared to 166 thousand $ha^{-1}$ population level. Under lower plant density, the leaf length and breadth were more resulting in more leaf area consequently increased the photosynthetic surface resulting in higher amount of photosynthates. Whereas, due to greater competition within the plants at higher density which resulted in poor growth of the crop. Greater suppression in plant height, production of less number of leaves with closest spacing in cassava has been reported by Ramakrishnan Nayar and Sadanandan (1990).

Among organic manures, FYM + NPK treatment had significantly taller plants, more number of tillers, leaves and higher leaf area. These growth factors were also significantly

superior under FYM and VC at both the levels compared to CCP at both the levels and NPK alone. NPK alone had significantly superior growth characters compared to CCP at both the levels, whereas, control had significantly shorter plants with few leaves. The leaf length and breadth under FYM + NPK, FYM, VC at both the levels were more contributing, higher leaf area resulting in more photosynthetic area. Satheesan (1984) reported the higher growth components of turmeric when grown as an intercrop with higher N levels.

Interaction effects of plant population and organic manures influenced the leaf area significantly (Table II a & b). Plant population of 111 thousand $ha^{-1}$ with FYM + NPK had significantly superior leaf area. Plant population of 111 thousand $ha^{-1}$ with FYM and VC at both the levels also had significantly superior leaf area compared to CCP at both the levels, NPK alone and control with 111 thousand $ha^{-1}$ population.

*Leaf area index and leaf area duration* : LAI and LAD did not differ significantly due to size of planting material at all the growth stages (Table II). The leaf production and leaf area produced by both the sizes of planting material were similar resulting in similar LAI and LAD.

Plant population level of 166 thousand $ha^{-1}$ had significantly higher LAI and LAD at all the growth stages. At higher population level, the leaf area produced for the given area was higher due to narrow spacing provided within the rows (30 x 20 cm) resulting in higher LAI and LAD compared to 111 thousand $ha^{-1}$ population, wherein the spacing provided within the row was wider (30 x 30cm). Greater values of LAI at various stages in cassava (Ramakrishnan Nayar and Sadanandan, 1990). Enyi (1973) also reported the increase in LAI with increase in plant density in cassava.

Among organic manures, FYM + NPK treatment had significantly higher LAI and LAD compared to other treatments. FYM and VC at both the levels also had significantly higher LAI and LAD compared to CCP at both the levels and NPK alone. Significant increase in LAI and LAD under above treatments was attributed to production of more number of leaves with higher length and breadth resulting in higher leaf area and also the number of functional leaves were higher till the physiological maturity period resulting in higher LAD. Satheesan (1984) reported the higher LAI and LAD due to higher N dose compared to lower doses in turmeric. Interactions of 166 thousand $ha^{-1}$ population with FYM + NPK had significantly higher LAI and LAD compared to other combinations.

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