

**INFLUENCE OF AGRONOMIC PRACTICES ON GROWTH,  
PRODUCTIVITY AND QUALITY OF GALANGAL  
(*KAEMPFERIA GALANGA* L.) GROWN AS  
INTERCROP IN COCONUT GARDEN\***

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Manuscript received: 11.11.98; revised: 23.2.99; accepted: 22.7.99

**ABSTRACT**

A field experiment was conducted to study the response of agronomic practices on galangal grown as intercrop in coconut garden during 1995 to 1998. Growth, yield characters and yield were superior when mother rhizome was used as planting material, whereas quality characters like oil and oleoresin contents did not differ significantly among mother rhizome and finger rhizome. Per cent reduction in yield under finger rhizome treatment was 2.1 per cent compared to mother rhizome treatment. Plant population level of 500000 per hectare (20 x 10 cm) recorded significantly superior rhizome yield as compared to 333000 population level, whereas quality characters were on par in both the population levels. The per cent reduction in the yield due to lower density population was 6.7 per cent. Growth, yield characters and yield were superior with farm yard manure + NPK combination followed by farm yard manure, vermicompost applied alone. Oil and oleoresin contents were significantly higher with farm yard manure + NPK, farm yard manure and vermicompost applied alone compared to composted coir pith application and control.

Key words: Coconut, Galangal, Intercrop, Organic manures.

**INTRODUCTION**

The scope for increasing the land area under cultivation being negligible, intensive cultivation of crops and raising the productivity per unit area is the only means of increasing food production. In case of coconut which remains committed to the land for decades with long gestation period, it is advisable to practice inter/mixed cropping for getting additional and staggered income. Studies on land and solar energy utilisation in coconut garden revealed the amenability of the palm in intensive cropping to harness

the unutilised space, solar energy and other resources.

Galangal or Kacholam (*Kaempferia galanga* L.) is an important medicinal-cum-aromatic herbaceous stemless plant belonging to Zingiberaceae family. The rhizomes of this crop are the economic part, and are used in ayurvedic medicine as stimulant, diuretic, stomachic, carminative and also used as flavouring agent etc. The rhizomes on distillation yields an essential oil, which finds use in perfumery and curry flavourings. In addition to essential oil, the rhizomes also yield oleoresin.

\* Part of Ph.D. Thesis submitted by senior author to UAS, Bangalore.

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Oleoresin is the total flavour extract comprising of essential oil, non-essential oil, pungent principles, colours and fats. This crop comes up very well under shaded condition (Rajagopalan *et al.*, 1992). The information on effect of planting material, plant population and organic manures on growth of galangal when grown as intercrop in coconut garden are meager. Hence, a study was conducted at CPCRI, Kasaragod with the objective to study the effect of agronomic practices on growth, yield and quality characters of galangal when grown as an intercrop in coconut garden.

#### MATERIALS AND METHODS

Field experiments were conducted during 1995 to 1998 at Central Plantation Crops Research Institute, Kasaragod which is situated at 12°30'N latitude and 75°00'E longitude at an elevation of 10.7 m above mean sea level. The age of the coconut garden was 35 years, wherein the light transmission was about 45-50 per cent. The coconut was maintained as per the recommendations of CPCRI under rainfed condition. The soil of the experimental site was red sandy loam with a 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. Types of planting material and population levels formed main plot treatments *viz.*, mother rhizome with 330000 population ha<sup>-1</sup> (20 x 15 cm) (S<sub>1</sub>P<sub>1</sub>), and 500000 population ha<sup>-1</sup> (20 x 10 cm) (S<sub>1</sub>P<sub>2</sub>), finger rhizome with 330000 population ha<sup>-1</sup> (S<sub>2</sub>P<sub>1</sub>), and 500000 population ha<sup>-1</sup> (S<sub>2</sub>P<sub>2</sub>). Organic manures like Farm Yard Manure (FYM) 24 t ha<sup>-1</sup>(F<sub>1</sub>), FYM : 32 t ha<sup>-1</sup>(F<sub>2</sub>),

Composted Coir Pith (CCP) : 29 t ha<sup>-1</sup> (F<sub>3</sub>), CCP : 39 t ha<sup>-1</sup> (F<sub>4</sub>), Vermicompost (VC): 21 t ha<sup>-1</sup> (F<sub>5</sub>), VC : 28 t ha<sup>-1</sup> (F<sub>6</sub>), FYM (20 t ha) + NPK (50:50:50 Kg ha<sup>-1</sup>) (F<sub>7</sub>), NPK alone (50:50:50 kg ha<sup>01</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 the second and third year.

The raised beds of 2 m x 1.8 m size were prepared in between coconut rows by leaving 2 m radius from the bole of the coconut, thus 77 per cent of the coconut garden was intercropped with galangal. The rhizomes were planted on the raised bed during first week of June (during 1995-96), second week of May (during 1996-97) and third week of May (during 1997-98) and harvested during first week of February (during 1995-96), third week of January (during 1996-97) and fourth week of January (during 1997-98). The intercrop was irrigated during November till the harvest. Duration of the crop was 8 months.

Observations on growth and yield characters were carried out from five labelled plants at different growth stages. The LAI and LAD were calculated by following the procedure given by Watson (1952). The fresh rhizome yield from the net plot (1.7 m x 1.0 m) was recorded in kgs and was worked out for one hectare intercrop raised area. The oil and oleoresin contents were estimated by following the procedure given by AOAC (AOAC, 1965). The data recorded on various characteristics was subjected to Fisher's method for analysis of variance and interpreted following the procedure given by Gomez and Gomez (1984). The level of significance considered for "F" and "t" tests was P=0.05 (5%). Critical

Difference (CD) was calculated for the significant "F" values. The interactions were also given whenever found significant. Pooled data of the three years were analysed and the results interpreted.

## RESULTS AND DISCUSSION

### Growth characters

Number of tillers, number of leaves and leaf area produced with mother rhizome were significantly more at 120 and 180 DAP (Table 1 and Table 2) compared to finger rhizome. The mother

rhizome, which is heavier than finger rhizome produced vigorous plants compared to finger rhizome. Rajagopalan and Gopalakrishnan (1985) also reported the vigorous growth of galangal with mother rhizome compared to finger rhizome.

Plant population levels did not show any significant difference with respect to number of tillers, number of leaves during 60 and 120 DAP, whereas plant population at 333000 ha<sup>-1</sup> produced more number of tillers and more number of leaves at 180 DAP

**Table 1. Number of tillers plant<sup>-1</sup> and number of leaves plant<sup>-1</sup> as influenced by different treatments in galangal\***

Treatments	Number of tillers			Number of leaves		
	60 DAP	120 DAP	180 DAP	60 DAP	120 DAP	180 DAP
<b>A. Planting material</b>						
S1: Mother rhizome	2.2	3.1	3.5	4.4	7.4	11.0
S2: Finger rhizome	2.2	3.0	3.4	4.4	7.1	10.7
'F' test	NS	*	*	NS	NS	*
SEm±	0.08	0.02	0.02	0.09	0.02	0.08
CD (P=0.05)	-	0.07	0.06	-	0.09	0.28
<b>B. Plant population</b>						
P1: 333 000 ha <sup>-1</sup>	2.2	3.0	3.6	4.4	7.3	11.4
P2: 500 000 ha <sup>-1</sup>	2.3	3.0	3.4	4.4	7.3	10.3
'F' test	NS	NS	*	NS	NS	*
SEm±	0.08	0.02	0.02	0.09	0.02	0.08
CD (P=0.05)	-	-	0.06	-	-	0.28
<b>C. Organic manures</b>						
F1: FYM : 24 t ha <sup>-1</sup>	2.5	3.3	3.8	4.8	8.5	11.7
F2: FYM : 32 t ha <sup>-1</sup>	2.4	3.2	3.8	4.8	8.3	11.5
F3: CCP : 29 t ha <sup>-1</sup>	2.1	2.3	3.2	3.8	6.0	9.3
F4: CCP : 39 t ha <sup>-1</sup>	2.0	2.4	3.1	3.8	5.6	9.0
F5: VC : 21 t ha <sup>-1</sup>	2.3	3.4	3.7	5.0	8.4	11.3
F6: VC : 28 t ha <sup>-1</sup>	2.4	3.4	3.8	5.0	8.6	12.4
F7: FYM(20t/ha)+NPK (50:50:50kg/ha)	2.4	3.5	3.9	5.0	8.6	12.2
F8: NPK (50:50:50kg/ha)	2.3	3.3	3.5	4.4	7.4	11.2
F9: Control	1.8	2.3	2.9	3.0	5.0	8.8
'F' test	*	*	*	*	*	*
SEm±	0.05	0.03	0.03	0.05	0.04	0.11
CD (P=0.05)	0.15	0.11	0.11	0.14	0.13	0.32

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

compared to 50000 ha<sup>-1</sup> population level. Leaf area observed with 333000 ha<sup>-1</sup> population was significantly superior at 120 and 180 DAP, compared to 500000 ha<sup>-1</sup> population level. The growth of galangal is very slow upto 120 DAP, thereafter it picks up its growth. From 120 DAP, due to faster growth, the higher plant population resulted in competition within the plant community resulting in lower leaf area per plant. Among organic manures, FYM+NPK, FYM and VC at both the levels had higher number of tillers, number of leaves and leaf area at all the observed growth stages compared to CCP at both the levels, NPK alone and control. Better growth under these treatments might be attributed to better availability of nutrients.

Interaction effects of all the factors studied were significant at 180 DAP for all the growth parameters (Table 1a, Table 2a). Mother rhizome with 333000 ha<sup>-1</sup> population plus F<sub>7</sub>, FYM at both the levels and VC at both the levels produced significantly higher number of tillers, leaf area compared to other combinations.

#### **Leaf Area Index (LAI) and Leaf Area Duration (LAD)**

LAI and LAD were significantly superior with mother rhizome treatment compared to finger rhizome at all the growth stages (Table 2). Higher LAI and LAD with mother rhizome were mainly due to vigorous growth, production of more number of leaves and higher leaf area. Plant population level of 500000 ha<sup>-1</sup> had higher LAI and LAD compared to 333000 ha<sup>-1</sup> population level. At higher population level, the leaf area produced for the given area was higher due to narrow spacing provided within the rows (20 cm x 10

cm) resulting in higher LAI and LAD compared to lower plant population level which has wider spacing within the rows (20 cm x 15 cm).

Among organic manures, FYM+NPK, FYM and VC at both the levels recorded significantly higher LAI and LAD at all the growth stages. This was mainly attributed to higher leaf area produced under these treatments and maintenance of functional leaves till attainment of physiological maturity period.

Interaction effect of mother rhizome with 500000 per ha plus F<sub>6</sub>, showed significantly higher LAI and LAD (Table 2b and 2c) compared to other treatment combinations. Treatments like FYM+NPK, FYM at both the levels in combination with S<sub>1</sub>P<sub>2</sub> also produced significantly higher LAI during 180 and LAD values during 120-180 days compared to other combinations.

#### **Yield components and yield**

Yield components like number of rhizomes and volume of rhizomes were significantly superior with mother rhizome compared to finger rhizome (Table 3). This is mainly attributed to better growth of the crop with mother rhizome as reflected in better growth components like leaf area, which contributed to increase in photosynthetic area resulting in increase in photosynthetic rate and translocation of photosynthates towards the sink leading to increase in volume of the rhizomes and more number of rhizomes per plant.

Plant population levels did not influence the number of rhizomes and volume of rhizomes. This is mainly attributed to the fact that, per cent DM

Table 1(a) Interaction effects of SxPxP on number of tillers of galangal at 180 DAP\*

Treatments	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	F <sub>7</sub>	F <sub>8</sub>	F <sub>9</sub>
S <sub>1</sub> P <sub>1</sub>	4.1	4.1	3.1	3.1	4.2	4.1	4.2	3.8	2.8
S <sub>1</sub> P <sub>2</sub>	3.7	3.8	3.1	3.1	3.6	3.8	3.8	3.4	2.8
S <sub>2</sub> P <sub>1</sub>	3.7	3.7	3.1	3.1	3.8	3.8	4.0	3.3	2.8
S <sub>2</sub> P <sub>2</sub>	3.7	3.7	3.1	3.1	3.6	3.6	3.8	3.3	2.8

CD (5%) for F at the same levels of SxP = 0.20  
 CD (5%) for S x P at the same or different levels of F = 0.21

Table 2(a) Interaction effects of SxPxP on leaf area (cm<sup>2</sup> plant<sup>-1</sup>) of galangal at 180 DAP\*

Treatments	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	F <sub>7</sub>	F <sub>8</sub>	F <sub>9</sub>
S <sub>1</sub> P <sub>1</sub>	425.0	402.3	282.3	287.9	442.5	517.6	491.8	462.3	241.7
S <sub>1</sub> P <sub>2</sub>	388.1	380.1	270.4	230.9	427.4	490.9	422.5	418.9	207.6
S <sub>2</sub> P <sub>1</sub>	406.8	381.7	274.0	288.5	403.7	482.3	440.3	417.6	214.7
S <sub>2</sub> P <sub>2</sub>	345.2	333.0	239.1	243.1	336.2	397.1	401.5	305.4	213.5

CD (5%) for F at the same levels of SxP = 10.45  
 CD (5%) for S x P at the same or different levels of F = 13.79

Table 2 (b) Interaction effects of SxPxP on LAI of galangal at 180 DAP\*

Treatments	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	F <sub>7</sub>	F <sub>8</sub>	F <sub>9</sub>
S <sub>1</sub> P <sub>1</sub>	1.420	1.344	0.942	0.959	1.475	1.729	1.636	1.545	0.802
S <sub>1</sub> P <sub>2</sub>	1.946	1.905	1.352	1.155	2.137	2.454	2.113	2.099	1.043
S <sub>2</sub> P <sub>1</sub>	1.359	1.272	0.914	0.962	1.346	1.608	1.474	1.395	0.729
S <sub>2</sub> P <sub>2</sub>	1.726	1.665	1.195	1.216	1.681	1.986	2.007	1.527	1.083

CD (5%) for F at the same level of SxP = 0.045  
 CD (5%) for S x P at the same or different levels of F = 0.060

Table 2 (c) Interaction effects of SxPxP on LAD during 120-180 DAP in galangal\*

Treatments	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	F <sub>7</sub>	F <sub>8</sub>	F <sub>9</sub>
S <sub>1</sub> P <sub>1</sub>	74.5	71.8	46.1	45.6	76.1	83.1	80.9	66.6	39.2
S <sub>1</sub> P <sub>2</sub>	102.0	100.2	63.3	58.3	108.3	116.7	108.5	92.1	51.8
S <sub>2</sub> P <sub>1</sub>	71.4	67.7	44.6	45.0	70.5	78.1	73.9	60.9	35.4
S <sub>2</sub> P <sub>2</sub>	86.3	83.2	55.7	55.0	88.7	98.1	103.2	75.7	52.2

CD (5%) for F at the same levels of SxP = 1.47  
 CD (5%) for S x P at the same or different levels of F = 2.0

## \*POOLED DATA

S: Sizes of planting material, P: Population levels, F: Organic manures

accumulated in rhizome at both the levels of population was almost similar (62.0 and 62.2% at 333000 and 500000 ha<sup>-1</sup> level of population).

Among organic manures, FYM+NPK, FYM and VC at both the levels had significantly more number of rhizomes and higher volume of

**Table 2. Leaf area ( $\text{cm}^2 \text{ plant}^{-1}$ ), leaf area index and leaf area duration (days) as influenced by different treatments in galangal\***

Treatments	Leaf area		LAI		LAD	
	120 DAP	180 DAP	120 DAP	180 DAP	60-120 DAP	120-180 DAP
<b>A. Planting material</b>						
S <sub>1</sub> : Mother rhizome	253.6	377.6	1.006	1.558	47.9	79.9
S <sub>2</sub> : Finger rhizome	236.1	340.8	0.928	1.396	44.8	69.8
F <sup>*</sup> test	*	*	*	*	*	*
SEM $\pm$	0.75	1.99	0.01	0.02	0.32	0.72
CD (P = 0.05)	2.60	6.89	0.01	0.03	0.45	1.02
<b>B. Plant population</b>						
P <sub>1</sub> : 333 000 ha <sup>-1</sup>	246.7	381.8	0.822	1.272	38.5	62.9
P <sub>2</sub> : 500 000 ha <sup>-1</sup>	232.0	336.5	1.112	1.683	54.1	83.8
F <sup>*</sup> test	*	*	*	*	*	*
SEM $\pm$	0.75	1.99	0.01	0.02	0.32	0.72
CD (P = 0.05)	2.60	6.89	0.01	0.03	0.45	1.02
<b>C. Organic manures</b>						
F <sub>1</sub> : FYM : 24 t ha <sup>-1</sup>	313.4	392.0	1.256	1.613	57.7	86.1
F <sub>2</sub> : FYM : 32 t ha <sup>-1</sup>	296.5	374.8	1.144	1.546	53.9	80.7
F <sub>3</sub> : CCP : 29 t ha <sup>-1</sup>	159.6	266.5	0.647	1.100	32.7	52.4
F <sub>4</sub> : CCP : 39 t ha <sup>-1</sup>	156.7	267.1	0.626	1.073	33.0	50.9
F <sub>5</sub> : VC : 21 t ha <sup>-1</sup>	298.2	402.5	1.203	1.659	55.6	85.9
F <sub>6</sub> : VC : 28 t ha <sup>-1</sup>	299.2	472.2	1.189	1.944	55.7	94.0
F <sub>7</sub> : FYM (20t/ha)+NPK (50:50:50kg/ha)	303.6	439.3	1.247	1.807	57.3	91.6
F <sub>8</sub> : NPK (50:50:50kg/ha)	198.7	401.8	0.819	1.641	40.6	73.8
F <sub>9</sub> : Control	135.7	260.1	0.574	0.914	30.0	44.6
F <sup>*</sup> test	*	*	*	*	*	*
SEM $\pm$	0.92	1.84	0.01	0.01	0.17	0.24
CD (P = 0.05)	2.66	5.24	0.02	0.022	0.50	0.71

\*POOLED DATA, DAP: Days after planting, NS: Non Significant

rhizomes compared to CCP at both the levels and NPK alone. Increase in number of rhizomes and volume of rhizomes were mainly attributed to better growth of plants under these treatments as reflected in growth components.

The pooled data of fresh rhizome yield under mother rhizome (4.8 t ha<sup>-1</sup>) was significantly higher compared to finger rhizome (4.7 t ha<sup>-1</sup>). The per cent reduction in the yield under finger rhizome treatment was only 2.1 per cent compared to mother rhizome.

Increase in yield was mainly attributed to more number of rhizomes and higher volume of rhizomes under mother rhizome treatment. Similar results of superior yield with mother rhizome in galangal has been reported by Rajagopalan and Goplakrishnan (1985) and in turmeric (Patil and Borse, 1981). In taro, Mohankumar and Sadanandan (1988) reported similar yields by planting side corms (cormel) or mother corms.

The fresh rhizome yield was significantly higher at 500000 ha<sup>-1</sup>

**Table 3. Yield, yield components and qualitative characters of galangal as influenced by different treatments\***

Treatments	Fresh rhizome yield (t/ha)	Number of rhizomes plant <sup>-1</sup>	Volume of rhizomes (ml plant <sup>-1</sup> )	Harvest index	Oil (%)	Oleoresin (%)
<b>A. Planting material</b>						
S <sub>1</sub> : Mother rhizome	4.8	7.6	22.0	0.620	2.00	3.62
S <sub>2</sub> : Finger rhizome	4.7	7.5	21.2	0.618	1.98	3.63
'F'test	*	*	*	*	NS	NS
SEm±	0.02	0.01	0.08	0.0004	0.001	0.001
CD (P = 0.05)	0.07	0.04	0.29	0.001	-	-
<b>B. Plant population</b>						
P <sub>1</sub> : 333 000 ha <sup>-1</sup>	4.5	7.3	21.5	0.621	1.95	3.66
P <sub>2</sub> : 500 000 ha <sup>-1</sup>	4.8	7.3	21.5	0.619	1.94	3.65
'F'test	*	NS	NS	*	NS	NS
SEm±	0.02	0.01	0.08	0.0004	0.001	0.001
CD (P = 0.05)	0.07	-	-	0.001	-	-
<b>C. Organic manures</b>						
F <sub>1</sub> : FYM : 24 t ha <sup>-1</sup>	5.2	8.9	26.2	0.635	1.99	3.65
F <sub>2</sub> : FYM : 32 t ha <sup>-1</sup>	5.2	8.9	26.0	0.636	1.95	3.75
F <sub>3</sub> : CCP : 29 t ha <sup>-1</sup>	3.4	5.6	17.2	0.588	1.90	3.52
F <sub>4</sub> : CCP : 39 t ha <sup>-1</sup>	3.4	5.6	16.7	0.588	2.00	3.52
F <sub>5</sub> : VC : 21 t ha <sup>-1</sup>	5.2	8.9	26.0	0.630	2.05	3.60
F <sub>6</sub> : VC : 28 t ha <sup>-1</sup>	5.3	8.9	26.2	0.629	2.02	3.85
F <sub>7</sub> : FYM (20t/ha)+NPK (50:50:50kg/ha)	6.0	9.1	26.0	0.628	2.05	3.75
F <sub>8</sub> : NPK (50:50:50kg/ha)	4.6	8.1	26.0	0.634	2.01	3.77
F <sub>9</sub> : Control	2.5	4.2	13.5	0.589	1.65	3.15
'F' test	*	*	*	*	*	*
SEm±	0.03	0.03	0.19	0.002	0.01	0.02-
CD (P = 0.05)	0.09	0.07	0.54	0.004	0.04-	0.07

\*POOLED DATA, NS: Non Significant

population level (4.8 t ha<sup>-1</sup>) compared to 333000 ha<sup>-1</sup> population level (4.5 t ha<sup>-1</sup>). The per cent reduction in yield due to lower density population was 6.7 per cent. The increase in yield under higher population was attributed to more population per hectare. Even though the growth components were superior with 333000 ha<sup>-1</sup> population level, as the yield components were only on par at both the levels of population, the 333000 ha<sup>-1</sup> population level could

not compensate the total yield that was realized in 500 000 ha<sup>-1</sup> population level. Randhawa *et al.* (1972) reported that the yield obtained under spacing of 20 cm x 20 cm or 20 cm x 30 cm was found to be optimum compared to lesser or wider spacing in ginger. Mohanty *et al.* (1990) and Singh and Neopaney (1993) also reported that closer spacing was found to be optimum for getting maximum yield in ginger compared to wider spacing.

Fresh rhizome yield obtained was significantly superior with FYM+NPK (6.0 t ha<sup>-1</sup>) compared to other treatments. Combination of organic manure with chemical fertilizer resulted in better growth of the crop as reflected in more number of leaves, tillers, higher LAI, LAD and yield components. FYM and VC at both the levels also recorded significantly higher yield compared to CCP at both the levels, NPK alone and control. NPK alone recorded significantly higher yield compared to CCP at both the levels.

Interaction effects of mother rhizome with FYM+NPK recorded significantly higher yield (6.1 t/ha) compared to other combinations (Table 3a and 3b). FYM+NPK treatment with both the levels of population recorded significantly higher yield compared to other combinations. With the combination of organic manures and chemical fertiliser, there was improvement in the available nutrients resulting in better growth and yield components. Increase in yield due to combined application of FYM and inorganic fertilizer has been reported

in turmeric (Rao *et al.*, 1975), ginger (Pawar and Patil, 1987). Application of FYM alone resulting in higher yield has been reported in turmeric (Balashanmugam *et al.*, 1989). Application of VC alone or in combination with inorganic fertilizer was found to increase the yield of turmeric (Vadiraj *et al.*, 1996). The overall better growth and yield with FYM, VC treatments also attributed to higher microbial population and DHA which might have influenced nutrient uptake, chlorophyll synthesis, plant growth and yield. Further, these microbes are found to promote soil aggregation and thus indirectly influence root environment and plant growth (Manickam, 1993).

#### Qualitative characters

Mother rhizome and finger rhizome did not result in significant variation in the oil (2.00 and 1.98%, respectively) and oleoresin (3.62 and 3.63%, respectively) contents (Table 3). Plant population levels also did not influence significant variation in the oil and oleoresin content of rhizomes. Rajagopalan and Gopalakrishnan (1985)

Table 3(a) Interaction effects of SxF on fresh rhizome yield (t ha<sup>-1</sup>) of galangal\*

Treatments	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	F <sub>7</sub>	F <sub>8</sub>	F <sub>9</sub>
S <sub>1</sub>	5.5	5.5	3.8	3.9	5.5	5.6	6.1	5.1	2.9
S <sub>2</sub>	5.4	5.4	3.8	3.9	5.4	5.4	6.0	5.0	2.8
CD (5%) for F at the same levels of S = 0.12									
CD (5%) for S at the same or different levels of F = 0.14									

Table 3(b) Interaction effects of Px F on fresh rhizome yield (t ha<sup>-1</sup>) of galangal\*

Treatments	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	F <sub>7</sub>	F <sub>8</sub>	F <sub>9</sub>
P <sub>1</sub>	5.2	5.1	3.8	3.8	5.2	5.2	6.1	4.9	2.8
P <sub>2</sub>	5.7	5.9	3.8	4.0	5.4	5.7	6.2	5.2	3.0
CD (5%) for F at the same levels of S = 0.12									
CD (5%) for P at the same or different levels of F = 0.14									

\*Pooled data

S: Planting material, P: Population levels, F : Organic manures

also reported that the types of planting material did not influence the essential oil and oleoresin content. In galangal, essential oil is present in translucent globules (90 to 110 micron in size) located in cortical cells of rhizomes (Aiyer and Kolammal, 1964). The number of oil globules, therefore determine the essential oil content. Rajagopalan *et al.* (1989) also reported that the essential oil content was unaffected by planting time, stage of harvest and seed material in galangal.

The oil and oleoresin contents under FYM, VC applied at two levels, FYM+NPK and NPK alone was higher compared to CCP at both the levels and control treatments. Higher oil and oleoresin contents under these treatments was mainly attributed to higher nutrient uptake and better growth of the crop resulting in higher oil synthesis. In turmeric, Mohanbabu and Muthuswami (1984) reported the higher curcumin content at 90 kg K ha<sup>-1</sup> and different K levels failed to

influence the essential oil and oleoresin contents of rhizomes. According to Venkatesha (1994), curing per cent and curcumin content of turmeric were not influenced by the different levels of chemical fertilizers.

Thus, from this study it can be concluded that, use of finger rhizome as planting material with 20 cm x 15 cm spacing on a raised bed along with the application of FYM (20 t/ha) + NPK (50:50:50kg/ha) could be recommended for higher net return and sustainable productivity of galangal when grown as an intercrop in coconut garden.

#### ACKNOWLEDGEMENTS

The authors are grateful to Dr. M. K. Nair, Former Director, Dr. KUK. Nampoothiri, Director, CPCRI, Kasaragod, for providing the facilities to carry out this experiment and Dr. A. A. Farooqui, Professor of Horticulture, UAS, GKVK, Bangalore, for helping in laboratory analysis.

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