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System productivity enhancement in coconut (*Cocos nucifera*) garden by intercropping with flower crops in Assam

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ABSTRACT

The field experiment was conducted at Horticultural Research Station, Kahikuchi of Assam Agricultural University for four consecutive years (2012–13 to 2015–16) to study the performance of flower crops as intercrop in adult coconut (*Cocos nucifera*) garden spaced at 7.5 m × 7.5 m taking five commercial flower crops, viz. Tuberose (*Polianthes tuberosa*) var. Single, Gerbera (*Gerbera jamesonii*) var. Red Monarch, Bird of Paradise (*Strelitzia reginae*) var. Glauca, Gladiolus (*Gladiolus grandiflorus*) var. Oscar, Marigold (*Tagetes erecta*) var. Siracole along with a control (coconut monocrop). Results showed that number of leaves on the crown, annual leaf production, number of inflorescences per palm and nut yield of coconut was not significantly influenced by the flower crops grown in coconut garden. Significantly the highest total coconut equivalent yield of 48920 nuts/ha/year was obtained in coconut + gerbera followed by coconut + tuberose (42717 nuts/ha/year), coconut + gladiolus (42334 nuts/ha/year) and the lowest in coconut as monocrop (10430 nuts/ha/year). Intercropping system of growing gerbera in coconut garden registered the highest net income (₹ 380075/ha) and B:C ratio (3.5) followed by tuberose (₹ 323420/ha and 3.1), gladiolus (₹ 315090/ha and 2.9), marigold (₹ 233050/ha and 2.8) and the lowest net income of ₹ 64050/ha and B:C ratio (1.6) obtained in monocropping of coconut.

Key words: Coconut, Economics, Flower crops, Intercropping

Coconut (*Cocos nucifera*) is an important perennial oilseed crop of Assam mostly grown in the homestead garden as monocropping. The venetian structure and orientation of adult coconut canopy permits about 55% active radiation to penetrate down (Nelliat 1979) and the gardens spaced at 7.5 m × 7.5 m offer ample scope for intercropping with suitable perennial, biennial and seasonal crops including flower crops leading to considerable increase in the production and productivity per unit area, cropping intensity by more efficient utilization of sunlight, soil, water and labour. The beneficial interaction of inter/mixed cropping of coconut with different crops in improving soil nutrient status of the system has been reported by Maheswarappa *et al.* (2005). In the present scenario of fluctuation of coconut price and high production cost, the pure crop of coconut is no more economical. Hence, intercropping with compatible crops in coconut garden becomes indispensable for augmenting the income of the coconut farmers. Commercial flower production helps in increased earning of the growers. Perfumes and scents can be extracted from the fragrance of flowers. Flowers can also be a source of huge foreign currency by exporting them. Although many crops can be grown well under coconut garden (Rethinam 2001), profitability of growing flower crops as intercrops under adult coconut garden has been reported by few workers (Ghosh *et al.* 2017, Basavaraju *et al.* 2018, Rani *et al.* 2018). Moreover, location specific research studies on flower crops as intercrops in coconut growing areas are limited. Hence, a field experiment was conducted to identify suitable flower crops for intercropping in coconut garden under Assam condition.

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MATERIALS AND METHODS

A field experiment was conducted for four consecutive years, 2012–13 to 2015–16 in 40 year old Assam Green Tall coconut garden at the Horticultural Research Station, Kahikuchi, Guwahati, which is situated at 26.3^0 N latitude and 91.7^0 E longitudes with an altitude of 64.0 m (amsl). The station enjoys a sub-tropical climate, with an annual rainfall of about 1500 mm. The soil of the experimental site was alluvial clay-loam with a *p*H of 4.8, low in available nitrogen (230.0 kg/ha), medium in available phosphorus (24.0 kg/ha) and available potassium (160.0 kg/ha) with an organic carbon of 0.45%. Five flower crops, viz. Tuberose (*Polianthes tuberosa*) var. Single, Gerbera (*Gerbera jamesonii*) var. Red Monarch, Bird of Paradise (*Strelitzia reginae*) var. Glauca, Gladiolus (*Gladiolus grandiflorus* L.) var. Oscar, Marigold (*Tagetes erecta*) var. Siracole were

grown in the inter-row spaces of coconut. The intercropping system of flower crops with coconut was compared with the sole crop of coconut. The experiment was laid out in randomized block design with four replications taking four palms per treatment. The intercrops were grown in 84% of the area in the interspaces of coconut leaving 16% in the coconut basins. Marigold and gladiolus were planted every year while tuberose, gerbera and bird of paradise which are perennial in nature were planted during first year and maintained during subsequent years. All through the experimental period, vermicompost and FYM were applied as organic manure basally and inorganic fertilizers were applied as top dressing in split doses. The recommended package of practices was followed as per the regular schedule. Bird of paradise started yielding flowers from second year of planting. The flowers were harvested every year and yield data recorded.

The coconut equivalent yield (CEY) of flower crops was computed based on the selling price of flowers and coconut as (Rani *et al.* 2018);

$$\text{Coconut equivalent yield (CEY)} = \frac{\text{(Yield of intercrop} \times \text{price of intercrop)}}{\text{Prevailing market price of a nut}}$$

The economics of the cropping system was worked out based on the market price of inputs and produce prevailed during respective years. The data on yield and returns of four years were averaged to get the data of mean yield and returns. The data were statistically analyzed for variance by the procedure of Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Growth and yield of coconut: The mean data of four years from 2012–13 to 2015–16 showed that the number of leaves on the crown, annual leaf production, inflorescences and nut yield per palm did not differ significantly among the coconut based flower intercropping system (Table 1). This indicated that flower crops can be grown as intercrops in coconut without affecting the growth and yield of coconut. However, increases nut yield of about 2.5–8.4% was observed in different flower intercropped palms. It is likely- that part of the fertilizers applied to the intercrops which would have been otherwise lost through run-off or by other means, had been absorbed by the coconut palms, thereby there was improvement in the yield. The congenial microclimate due to intercropping associated with increased microbial activities, improvement in soil fertility, higher interception of sun light might have favored the growth and yield of coconut. Moreover, weed management and cultivation intended mainly for the intercrops to improve soil aeration and make the nutrient more available to the plants also benefited the main crop. Similar results were reported earlier by Margate and Magat (1983) in coconut based multiple cropping systems. The improvement in nut yield of the main crop by intercropping is also supported by the findings of Maheswarappa *et al.* (2003), Nath *et al.* (2008), Basavaraju *et al.* (2011) and Rani *et al.* (2018).

Flower yield and its coconut equivalent yield: The yield from flower crops in terms of number of spikes (cut flower) in case of tuberose, gladiolus, gerbera and bird of paradise and for marigold as kg/ha recorded during four years of experimentation is presented in Table 1 and Fig 1. The mean flower spikes production per ha was 314987 number in Tuberose, 743200 number in Gerbera, 32175 number in Bird of Paradise, 61987 number in Gladiolus

Fig 1 Intercropping of gladiolus in coconut garden.

Table 1 Growth and yield parameters of coconut and yield of flower crops in the intercropping system of flower crops with coconut (Mean of 4 years: 2012–13 to 2015–16)

Treatment	No. of leaves on the crown	Annual leaf production (No./year)	No. of inflorescences/palm	Nut yield (No./palm/year)			Yield of flowers (kg/ha for marigold and No. of spikes/ha for rest of flower crops)
				Pre-treatment nut yield (No./palm/year)	Mean nut yield (No./palm/year) (Average of 4 years)	% increase nut yield	
Coconut + Tuberose	32.2	11.6	11.4	61.7	64.1	3.9	314987
Coconut + Gerbera	32.8	11.9	11.6	62.0	67.2	8.4	743200
Coconut + Bird of paradise	31.7	11.3	11.0	60.3	63.5	4.9	32175
Coconut + Gladiolus	32.0	11.7	11.3	63.2	64.8	2.5	61987
Coconut + Marigold	31.8	11.5	11.1	59.0	61.8	4.7`	20810
Coconut monocrop	31.2	11.0	10.9	58.8	59.6	1.4	--
SEm(±)	0.8	0.6	0.4	3.1	4.5	0.5	--
CD (P=0.05)	NS	NS	NS	NS	NS	1.72	--

Table 2 Coconut equivalent yield and economics of intercropping system of flower crops in coconut garden (Mean of 4 years: 2012–13 to 2015–16)

Treatment	Coconut equivalent yield (No. of nuts/ha)			Cost economics		
	Coconut	Flower crops	Total	Cost of production (₹ ha)	Net return (₹/ha)	B:C ratio
Coconut + Tuberose	11218	31499	42717	103750	323420	3.1
Coconut + Gerbera	11760	37160	48920	109125	380075	3.5
Coconut + Bird of paradise	11113	16088	27201	72650	199360	2.7
Coconut + Gladiolus	11340	30994	42334	108250	315090	2.9
Coconut + Marigold	10815	20810	31625	83200	233050	2.8
Coconut monocrop	10430	0	10430	40250	64050	1.6
SEm(±)	665	486	801	1413	6520	0.08
CD (P=0.05)	NS	1460	2405	4240	19750	0.24

Price of flowers (per dozen of spike): Tuberose: ₹ 12; Gerbera: ₹ 6; Gladiolus: ₹ 60; Bird of paradise: ₹ 60; Marigold: ₹ 10 (per kg); Coconut: ₹ 10 per nut

and 20810 kg/ha in Marigold. Nut equivalent yield for an intercrop was significantly higher in case of Gerbera (37160 nuts/ha/year) followed by Tuberose (31499 nuts/ha/year) and Gladiolus (30994 nuts/ha/year) intercropping system (Table 2). Similarly, the highest total coconut equivalent yield was recorded in Coconut + Gerbera (48920 nuts/ha/year) followed by Coconut + Tuberose (42717 nuts/ha/year) and Coconut + Gladiolus (42334 nuts/ha/year). The monocrop of coconut recorded significantly the lowest coconut equivalent yield 10430 nuts/ha/year. The increases in nut yield as well as coconut equivalent yield in the coconut based system was due to additional input received in terms of irrigation, fertilizers and weed control, etc. (Korikanthimath 2005). Similar increase in productivity of the intercropping system of flower crops with coconut in terms of coconut equivalent yield was reported by Basavaraju *et al.* (2018) with intercropping of jasmine, chrysanthemum, crossanda, china aster and marigold and Rani *et al.* (2018) with intercropping of gomphera, chrysanthemum, marigold, celosia and zinnia.

Economics of the intercropping system: The cropping system of coconut + gerbera recorded significantly higher net income of ₹ 380075/ha and B:C ratio of 3.5 followed by coconut + tuberose with a net income of ₹ 323420/ha and B:C ratio of 3.1 (Table 2). The lowest net income (₹ 64050/ha) and B:C (1.6) ratio were obtained with coconut alone as a monocrop. Similar results of increased economic income in the intercropping systems of coconut with field crops (Hanumanthappa *et al.* 1996), vegetables (Basavaraju *et al.* 2008), medicinal and aromatic plants (Nath *et al.* 2015) and flower crops (Ghosh *et al*. 2017, Basavaraju *et al.* 2018, Rani *et al.* 2018) were also reported.

Based on the performance and economics of the commercial flower crops, gerbera, tuberose, gladiolus and marigold can be grown as remunerative flower crops in adult coconut garden as intercrops without reduction in nut yield. The coconut crop benefited from the additional fertilizers applied for the intercrops, in addition to spinoffs' from weed management and cultivation, thereby increasing yield.

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