



***Heliconia stricta* as intercrop in coconut - Impact of cropping system and nutrition on floral traits**

(Manuscript Received: 01-02-13, Revised: 17-06-13, Accepted: 01-07-13)

Keywords: Coconut, floral traits, *Heliconia stricta*, intercrop, nutrition

The global cut flower export has risen from ₹ 4 million to ₹ 180 million during 1999-2009 (Janakiram, 2009). There is great scope for floriculture especially shade loving heliconias, ornamental ginger and foliage plants in a commercial scale in coastal belts of India, as there is ample scope for intercropping in coconut garden. Among the tropical flowers, *Heliconia* is outstanding for its diversity in form, color, size and its durability (Rodrigues, 2008). Currently, the demand for ornamental heliconias has increased dramatically, both at national and international market, and its cultivation has become a major factor in the agricultural economy of many countries (Jerez, 2007). *Heliconia* is a large genus of attractive monocots, mostly indigenous to the Neotropics (the North of Mexico to the South of Brazil). The main criteria for *Heliconia* inflorescence are the number of open bracts and the length of the inflorescence stem (Costa *et al.*, 2006). Among the Heliconias, *Heliconia stricta* cv. Iris Red is a commercial variety with higher market value due to its unique crimson colored bracts with more defined shape. According to Costa *et al.* (2009), this species is grouped under the high performance group and the inflorescence morphological characters comes in the medium range; fresh weight of stems (101-200 g), stem diameter (10.1-30.0 mm), stem length (50.1-150.0 cm), spike length (10.1-30.0 cm). The growth and flowering of some heliconias such as *H. psittacorum* are known to be light-intensity limited (Broschat and Donselman, 1983). Yet other species appear better adapted to slight shade conditions and are easily injured under full sunlight in the tropics. *Heliconia stricta* can be grown from full sunlight to

40 per cent shade (Berry and Kress, 1991). Fertilization rates strongly affect growth and flowering of heliconias under high light intensities (full sunlight) (Broschat and Donselman, 1983). The marketable yield of *Heliconia* flowers vary with nutrient content of the growing medium and light intensity among the species; ranging from 59.5 to 74.7 per cent (Powell, 1991). The nutrient and light requirement in *Heliconia* varies from species to species. But little is known about the performance of *H. stricta* cv. Iris Red under different manurial condition when grown in full sunlight to shaded condition. Hence, a field experiment was conducted at Central Plantation Crops Research Institute (Regional Station), Kayamkulam, Kerala State from June 2010 to June 2012 for studying the effect of nutrition in flower characters of *Heliconia* when grown under full sunlight and as an intercrop in coconut garden so as to assess the economic feasibility of *H. stricta* cv. Iris Red as a potential intercrop in coconut garden.

The experiment was conducted using five treatment combinations (T₁: 17:17:17 NPK @ 5g plant⁻¹, T₂: 13:5:13 NPK @ 5 g plant⁻¹, T₃: vermicompost @ 200 g plant⁻¹ + neem cake @ 100 g plant⁻¹, T₄: vermicompost @ 100 g plant⁻¹ + neem cake @ 50 g plant⁻¹ + biofertilisers (Azospirillum and Phosphate Solubilising Bacteria @ 1 g plant⁻¹), and T₅: vermicompost @ 100 g plant⁻¹ + neem cake @ 50 g plant⁻¹ + 13:5:13 NPK @ 2.5 g plant⁻¹) with four replications in RBD. Coconut garden with palms spaced at 8 m and aged 25 years was selected for the study. The average shade intensity of the plot was 26.2 per cent. The area is located in coastal humid tropics (9°38' North latitude, 76°30' East

longitude and 3.05 m above mean sea level) with sandy loam soil of the order Entisol having pH of 5.7, 0.15 per cent organic carbon, 23.7 ppm P and 54.6 ppm K. Plots of size 4 m x 4 m were prepared during second fortnight of May 2010 under open condition and in the interspaces of coconut garden leaving an area of 2 m radius from the base of the palms. *Heliconia* stumps were planted at 1 m x 1 m spacing with a plant density of 16 plants per plot during first week of June 2010. Between plots, a spacing of 50 cm was maintained. Cow dung (1 kg plant⁻¹) and bone meal (250 g plant⁻¹) were applied uniformly to all plots at the time of land preparation. All the nutrients as per the treatment combinations were supplied in full doses at quarterly intervals from three months after planting. Observations on inflorescence (length, average no. of bracts, average width of bract, peduncle length and girth) and spike parameters (length and width of unopened and opened spikes) were taken at monthly interval from nine months after planting up to 24 months. The quality parameters (carotenoid, wax content and relative water content) and vase-life were estimated during May to November 2011 and February 2012. The mean values were taken and statistically analyzed using statistical software SAS 9.3.

The system of cultivation and nutritional practices significantly influenced various inflorescence characters (Table 1). Application of vermicompost (VC) and neem cake (NC) *i.e.*, (T₃)

recorded significantly higher inflorescence characters under both the conditions of cropping system. This may be because of the higher organic content of the soil. The values in this treatment for inflorescence length, average no. of bracts, average width of bract, peduncle length and girth under open and intercropped conditions were respectively 105.6 cm and 104.7 cm; 5.5 and 6.75; 5.08 cm and 4.45 cm; 83.18 cm and 90.63 cm; 10.28 cm and 10.55 cm. In open condition, grade I marketable flowers (1 m length and >9 cm girth) were produced only in this treatment, whereas, plants applied with 13:5:13 NPK @ 5 g plant⁻¹ (T₂), vermicompost @ 200 g plant⁻¹+neem cake @ 100 g plant⁻¹ (T₃) and vermicompost @ 100 g plant⁻¹ + neem cake @ 50 g plant⁻¹ + 13:5:13 NPK @ 2.5 g plant⁻¹ (T₃) produced grade I flowers when intercropped in coconut garden. The flower peduncle length in *Heliconia* is positively related to the nutrients supplied (Clemens and Morton, 1999). The better performance of *Heliconia stricta* under intercropped condition strongly implies its suitability as a potential intercrop in coconut garden. Similar result has been recorded in *Heliconia psittacorum* where the plants grown under the 30 per cent shade cloth produced longer stems, bigger flowers of better quality and a higher marketable yield (Powell, 1991).

As unopened and fully opened *Heliconia* inflorescences are used for floral decoration, length and width of the spike at unopened and fully opened

Table 1. Impact of cropping system and nutrition on inflorescence parameters (2010-2012)

Treatment	Inflorescence length (cm)	No .of bracts	Av. width of bract (cm)	Peduncle length (cm)	Peduncle girth (cm)	Unopened spike length (cm)	Unopened spike width (cm)	Opened spike length (cm)	Opened spike width (cm)
Open condition (OC)									
17:17:17 NPK	64.2	3.0	3.98	38.85	7.03	16.7	3.38	21.80	17.35
13:05:13 NPK	88.8	4.5	4.30	58.35	7.78	23.2	3.15	23.93	17.45
VC+NC	105.6	5.5	5.08	83.18	10.28	25.0	3.89	30.60	23.40
VC+NC+BF	78.7	3.5	4.25	53.15	6.63	20.6	3.63	27.83	17.55
VC+NC+CF	83.8	4.5	4.75	54.70	6.98	22.3	3.38	29.65	17.73
CD (P=0.05)	11.9	0.97	0.45	7.47	0.86	2.79	NS	2.17	2.34
Intercropped condition (IC)									
17:17:17 NPK	70.52	3.75	3.60	43.05	6.88	22.15	3.10	23.40	31.93
13:05:13 NPK	101.70	4.75	4.13	73.85	9.30	22.73	2.20	17.73	27.00
VC+NC	104.70	6.75	4.45	90.63	10.55	26.55	3.63	31.93	26.83
VC+NC+BF	97.18	4.50	4.38	69.20	6.70	19.63	2.98	17.45	24.93
VC+NC+CF	103.28	5.25	3.78	69.55	9.43	23.30	3.53	17.35	24.58
CD (P=0.05)	5.48	0.84	0.52	6.72	1.17	2.99	0.79	2.34	3.62

NS - Not Significant; VC - vermicompost; NC - neem cake; BF - biofertilizer; CF - chemical fertilizer

Table 2. Impact of cropping system and nutrition on flower quality

Treatments	Carotenoid content (%)		Wax content (mg g ⁻¹)		Relative water content (%)		Vase life (days)	
	OC	IC	OC	IC	OC	IC	OC	IC
17:17:17 NPK	0.077	0.011	168.6	170.9	76.95	93.32	3.9	6.6
13:05:13 NPK	0.082	0.010	202.0	222.9	92.49	102.77	5.1	7.6
VC+NC	0.126	0.009	219.8	248.4	102.64	113.57	10.5	12.9
VC+NC+BF	0.103	0.008	172.2	192.5	59.81	78.23	7.3	7.4
VC+NC+CF	0.101	0.009	196.7	215.4	92.69	101.34	7.4	9.1
CD (P=0.05)	0.021	NS	10.4	12.9	9.11	5.84	1.6	1.8

NS - Not significant; OC - open condition; IC - intercropped condition; VC - vermicompost; NC - neem cake; BF - biofertilizer; CF - chemical fertilizer

stages of harvest were also recorded (Table 1). These spike characters were significantly higher in plants supplied with vermicompost and neem cake (T₃). The spike length and width (l x w) of unopened and opened inflorescence were 25.0 cm x 3.9 cm and 30.6 cm x 23.4 cm, respectively under open condition, whereas, it was 26.5 cm x 3.6 cm and 31.9 cm x 26.8 cm, respectively when grown as an intercrop. However, plants in the intercropped condition produced superior quality spikes than when grown in open condition. Higher incident solar radiation might have resulted in inferior quality flowers under open condition even though same nutrition was given under both the cropping systems.

Flower carotenoid content was found to be influenced by various treatment combinations only in the open condition with T₃ giving the highest value (0.126%). Wax content and relative water content of flower bracts (Table 2) were also significantly the highest in the plants supplied with vermicompost and neem cake (T₃) in both systems of cropping, the values being 219.8 mg g⁻¹ and 102.64 per cent, respectively in open condition and 248.4 mg g⁻¹ and 113.57 per cent, respectively under intercropped condition. These plants also recorded higher vase life of 10.5 days and 12.9 days, respectively under open and intercropped conditions. In several species of *Heliconia*, photosynthetic efficiency and chlorophyll content were lower when plants were grown under full sun, than when they were under light shade (He *et al.*, 1996). However, they later found that this occurred only when the nutrient supply to plants was limited and photo-inhibition of plants grown under full sun disappeared when nutrients particularly, nitrogen were applied (He *et al.*, 2003).

Application of vermicompost @ 200 g plant⁻¹ + neem cake @ 100 g plant⁻¹ is found to be the best treatment for *Heliconia stricta* cv. Iris Red when grown as a monocrop or inter crop in coconut garden. Eventhough it has been reported to grow under full sunlight to 40 per cent shade, this variety performing better under intercropped condition strongly implies its suitability as a potential high value intercrop in coconut gardens.

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