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Research Article

RELATIONSHIP BETWEEN STRESS AND FLOWERING IN HELICONIA (*Heliconia stricta)*

NIHAD K.[1], KRISHNAKUMAR V.[2] AND SHEELA V.L.[3]

[1,2]Central Plantation Crops Research Institute, Regional Station, Kayamkulam, 690533, Kerala, India
[3]College of Agriculture, Vellayani, Kerala Agricultural University, Thiruvananthapuram, Kerala, 695522, India
*Corresponding Author: Email-nihadshukoor@gmail.com

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Abstract- Leaf chlorosis followed by flowering was noticed in *Heliconia* plants supplied with organics alone during its early vegetative phase. This finding was recorded from the experiment on standardizing nutrient management practices for *Heliconia* in low fertile sandy soils with lesser water holding capacity. The main experiment was laid out at Central Plantation Crops Research Institute (Regional Station), Kerala State, India with five nutritional treatments and four replications in Randomised block design. During initial growth phase (four months after planting), plants grown under integrated management exhibited a healthy vegetative growth. Nevertheless, 90% of the plants supplied with organics alone exhibited leaf yellowing. It was observed that more than 60% plants with leaf chlorosis started to flower early (180 days after planting) but the flowers were of smaller size with 3 to 4 bracts. The results showed that the leaf nutrients such as K, Ca, Mg, Mn and Fe were lower in plants supplied with organics alone. The deficient leaves were found to have significantly lower leaf chlorophyll, relative water content and wax content. However, the deficiency symptoms of these plants disappeared one month after the second dose of manuring (i.e. seven months after planting). Plant height differed significantly only during the reproductive phase. Other growth parameters such as suckering habit, number of leaves and leaf area was recorded higher in plants supplied with adequate organic manures (T3) from eight months after planting. After recovery from the stress, plants started producing quality flowers with 6 to 7 bracts at 280 days after planting.

Keywords- Nutrient management practices, Heliconia, stress

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Introduction

Heliconia stricta (Family: Heliconiaceae) is a clumping type tropical ornamental plant grown for its beautiful flowering bracts. It is a short day plant [1] attaining a height of 1.2 to 2.4m producing erect inflorescence in one plane with straight rachis. Nutritional deficiency affects Heliconia cut flower production and the success of its commercialization [2]. They grow well in soils rich in organic matter, but knowledge about its nutrient management practices when grown in low fertile soils with less water holding capacity is meagre. Hence the field experiment on standardizing a sustainable nutrient management practices for *Heliconia stricta* was conducted during 2010-13. But during the experiment, it was noticed that the plants grown under purely organic management, which later performed as the best treatment [3], started showing symptoms of yellowing at four months after planting (MAP). It was later observed that around sixty percentage of the plants with leaf chlorosis started flowering at six MAP. Similar conditions are reported from farmer's field [4] when grown as an intercrop with coconut in low fertile sandy soils. Hence this work was carried out to find out the reason of leaf necrosis and early flowering in Heliconia plants when grown in sandy soils under purely organic condition.

Materials and Methods

Coconut garden with palms aged 25 years spaced at 8 m was selected for the present study. The area is located in coastal humid tropics (9^0 8' North latitude, $76^0$30' East longitude and 3.05 m above mean sea level). The soil of the experimental site is sandy loam of the order Entisol with pH of 5.7, 0.15% organic carbon, 23.7 ppm P, 54.6 ppm K, 216.2 ppm Ca, 24.6 ppm Mg, 1.12 ppm Mn, 13.4 ppm Fe, 1.39 ppm Cu and 2.2 ppm Zn. The average maximum and minimum temperature experienced during the period (June 2010 to Feb.2011) was 32 ^{0}C and 22.2^0 C, respectively. The mean evaporation was 2.92 mm/day.

The field was ploughed to a fine tilth during second fortnight of May 2010 and plots of size 4 m x 4 m were taken in the interspaces of coconut garden leaving an area of 2 m radius from the base of the palms. Between plots, a spacing of 50 cm was maintained. The gross cropped area of the experimental plot was 1100 m^2 with a net cropped area of 160 m^2. Dried cowdung (1 kg/plant) and bone meal (250 g/plant) were applied uniformly at the time of land preparation. Seven month of vegetative shoots of *Heliconia* cv.Iris collected from an authorised Heliconia nursery of Kerala state, India were planted two weeks after application of the basal dose of manures. Heliconia suckers were planted at 1x1 m spacing with a plant density 16 plants/plot.

Treatment details

All the nutrients as per the treatment combinations were supplied at quarterly intervals from three MAP.

T1	17:17:17	17:17:17 NPK complex fertilizer @5g/plant
T2	13:5:13	13:05:13 NPK @ 5g/plant [5]
T3	VC*+NC**	Vermicompost @ 200 g/plant + Neem cake @100g/plant
T4	VC*+NC**+ bio	Vermicompost @ 100 g/plant + Neem cake @50g/plant + Biofertilisers (*Azospirillum* and Phosphate Solublising Bacteria)each @1g/plant
T5	VC*+NC**+ 13:5:13	13:05:13 NPK @ 2.5g + Vermicompost @ 100g/ plant + Neem cake @50g/plant

The experiment was laid out in Randomised block design (RBD) with five treatments and four replications.

Growth characters

The observations on growth characters were taken from randomly selected three sample plants in each plot at monthly intervals during the vegetative phase

Plant height (cm): The height of the plant was measured from the base of the plant to the tip of the longest leaf and the mean value was recorded.

Number of suckers: The number of suckers per clump was counted and the mean value was recorded.

No. of leaves: The number of leaves per clump was counted and the mean value was recorded.

Leaf Area: Leaf area of the plants [6] was calculated using the formula given below and the mean value was recorded.

Leaf Area (cm^2) = (1.72 + 0.35 x leaf length) ^{2}

Yield parameter

Days taken for production of first marketable flowers: Number of days taken for the plant t produces flowers of marketable size.

Nutrient analysis

For analysing the nutrients, chlorophyll content, relative water content (RWC) and wax content, the top most fully expanded leaves from vegetative shoots were taken at four MAP from all the plants in the abiotic stressed (yellowing) and normal plants using the standard procedure.

The leaf nutrient status was again analysed after recovering from the stress.

Statistical analysis

The data collected on different treatments were analysed by applying the technique of analysis of variance (ANOVA) for RBD [7].

Results and Discussion

At four MAP it was found that the plants supplied with organics alone started showing chlorotic leaf margin with necrosis. Incidence of pests and diseases were ruled out and the leaves were analysed for nutrient status [Table-1]. The results showed that the levels of K, Ca, Mg, Mn and Fe were lower in plants supplied with organics alone. On comparing with the nutrient status after recovering from the stress [Table-2] it is clear that the status of leaf K was below the critical level which might have resulted in yellowing and necrosis [8]. Lower nutrient status might have resulted in the early shift of vegetative phase to reproductive phase. Nutrient deficiency induced early flowering was reported in other ornamentals such as Dendrobium orchid [9].

Table.-1 *Leaf nutrient chlorophyll, relative water content(RWC) and wax content content of Heliconia stricta cv. Iris during the period of stress (4MAP)*

Treatment	N	P	K	Ca	Mg	Mn	Zn	Fe
			(%)				(ppm)	
17:17:17	2.14	0.288	0.672	0.235	0.149	34.16	23.89	27.20
13:5:13	2.12	0.293	0.688	0.233	0.156	34.17	25.58	27.41
VC*+NC**	2.00	0.267	0.106	0.174	0.111	24.50	24.29	09.40
VC*+NC**+bio	2.04	0.268	0.107	0.183	0.184	23.84	25.26	12.00
C.d (p= 0.05)	NS	0.010	0.024	0.007	0.16	02.37	NS	01.00

The treatments supplied with chemical fertilizers produced more number of leaves per plant than the purely organically treated plants at 6 MAP. The deficiency observed during initial growth phases in organic plots might be due to the delayed action of organic manures in enhancing root activity and photosynthesis rate [10]. The total chlorophyll content of plants exhibiting deficiency was found to be 23.26 % less in organically treated plots than the other plots. Significant reduction of chlorophyll content [Table-1] might also have adversely affected photosynthetic rate. The deficient leaves were found to have a significantly lower RWC and wax content resulting in reduced plant water status and increased leaf evapo-transpiration in terms of cellular hydration. This might be due to the impaired osmotic adjustment of nutrient deficient plants. Water stress induced early flowering was reported in *Mesembryanthemum crystallinum* [11].

Table-2 *Leaf nutrient status of Heliconia stricta after recovering from stress*

Heading	Chll.a	Chll.b	Total chll.	RWC	Leaf Wax content
		(%)			(mg/cm^2)
17:17:17	1.762	0.366	2.18	61.65	122.19
13:5:13	1.812	0.514	2.38	68.97	131.9
VC*+NC**	0.297	0.172	0.498	57.84	119.19
VC*+NC**+bio	0.469	0.174	0.561	55.15	112.76
C.d (p= 0.05)	0.034	0.049	0.145	2.71	1.63

Treatment	N	P	K	Ca	Mg	Mn	Zn	Fe
			(%)				(ppm)	
17:17:17	1.41	0.680	1.39	0.50	0.44	32.55	25.98	170.73
13:5:13	1.80	0.711	1.67	0.61	0.40	47.33	25.00	240.93
VC*+NC**	1.62	0.890	1.47	0.86	0.65	50.90	30.22	356.27
VC*+NC**+bio	1.71	0.771	1.33	0.40	0.37	42.90	30.56	236.13
VC*+NC**+13:5:13	1.80	0.681	1.75	0.47	0.32	49.68	27.74	248.10
C.d (p= 0.05)	0.02	0.070	0.10	0.07	0.03	10.50	NS	27.57

The deficiency symptoms of plants supplied with organics alone disappeared with the production of new leaves, one month after the second dose of manuring (i.e. seven months after planting).The growth performance of the plants improved with the subsequent application of manures. This might be due to the residual effect of organic manures. Decomposition of organic matter requires soil microbial deploymerization. The low organic matter content of the soil limits the available energy for soil microorganisms for the mineralization [12] which might have resulted in delayed availability of the supplied nutrient.

Table-3 *Effect of nutrition on growth characters Plant height, number of suckers, number of leaves and leaf area*

Treatment	Plant height (cm)	
	8 MAP	9MAP
17:17:17	103.9	106.2
13:5:13	122.1	136.2
VC*+NC**	124.0	130.1
VC*+NC**+bio	108.7	120.6
VC*+NC**+13:5:13	109.3	121.5
C.d (p= 0.05)	**NS**	**14.6**

Treatment	No.of suckers			No.of leaves		
	6 MAP	7MAP	8MAP	6 MAP	7MAP	8MAP
17:17:17	6.75	8.50	9.50	18.50	20.50	27.50
13:5:13	8.00	9.25	11.25	20.50	25.75	31.25
VC*+NC**	7.25	8.50	11.25	16.25	23.75	33.00
VC*+NC**+bio	6.25	6.50	10.00	16.50	16.50	20.75
VC*+NC**+13:5:13	5.25	6.25	7.25	16.50	21.25	25.75
C.d (p= 0.05)	**1.32**	**1.29**	**1.56**	**2.89**	**2.94**	**5.50**

Treatment	Leaf area (cm^2)		
	6 MAP	7MAP	8MAP
17:17:17	295.8	372.5	390.4
13:5:13	414.4	488.2	566.9
VC*+NC**	376.3	479.2	674.7
VC*+NC**+bio	286.5	370.4	432.3
VC*+NC**+13:5:13	327.8	362.0	489.0
C.d (p= 0.05)	**80.6**	**71.1**	**133.5**

Plant height, being one of the important plant character determining the size of the inflorescence, showed significant difference between treatments only after the vegetative phase ie., 9 MAP [Table-3]. The increase in leaf area was also recorded higher in T2 plants during six MAP but by eight MAP T3 plants recorded higher leaf area which was sustained during later growth phases. Progress of suckering and leaf production from the mid vegetative phase (6MAP) was higher in plants supplied with vermicompost and neemcake which might have resulted in better performance and reduced vegetative phase for quality flower production [Table-4] during the latter phases of growth [13].

Table-4 *Effect of nutrients on days to first marketable flower*

Treatment	Days to first marketable flower
17:17:17	309.5
13:5:13	362.5
VC*+NC**	280.3
VC*+NC**+bio	316.3
VC*+NC**+13:5:13	335.8
C.d (p= 0.05)	**17.6**

*Vermicompost – 1.84:0.22:0.28 %NPK
** Neem cake -1.5:1:1.4%NPK.

The transition to flowering/generative development is controlled by several pathways that mediate various environmental and endogenous signals [14]. In plants, abiotic stresses could accelerate flowering as part of stress-avoidance strategy and instead of improving stress tolerance, plants could shorten their life cycle to ensure at least some seed production [15].

Conclusions

Abiotic stress experienced due to insufficient leaf nutrients and cellular water deficit accelerated flowering in *Heliconia stricta* during its early vegetative phase. Improved growth of plants subsequent to further application of adequate organic manure from mid vegetative phase indicated the need for an alternate strategy in organic farming for better nutrition in sandy soils during initial phase of growth.

Application of research: This research warrants the need for an alternate strategy in organic farming for better nutrition during initial phase of growth in intensive horticulture.

Research Category: Nutrient management practices

Abbreviations:
RWC – Relative water content
RBD – Randomised block design
MAP : Months after planting
VC : Vermicompost
NC : Neem cake

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***Research Guide: Dr V.L. Sheela**
University: Kerala Agricultural University, Thrissur, Kerala 680656

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