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VARIABILITY AMONG FLORAL TRAITS AND POLLEN RECOVERY IN COCONUT (*COCOS NUCIFERA* L.) VARIETIES UNDER ASSAM CONDITIONS OF NORTH EAST REGION OF INDIA

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ABSTRACT

Fifteen coconut varieties, including dwarf, tall, and hybrid types, were studied for floral traits. Significant differences were observed in inflorescence length, stalk girth, stalk length, spikelet-bearing portion length, spikelet length, number of spikelets per inflorescence, number of male and female flowers, weight of 1000 male flowers, pollen recovery, and number of inflorescences. The hybrid Kera Sankara exhibited superior inflorescence length, number of spikelets per inflorescence, spikelet-bearing portion length, number of female flowers per inflorescence, and number of male flowers per spikelet. Additionally, WCT and Chandra Laksha varieties produced the most inflorescences per month and the highest pollen recovery, respectively. Significant positive correlations were found between inflorescence length and girth as well as stalk length, fresh and dry weights of 1000 male flowers, and spikelet length and inflorescence. Principal Component Analysis (PCA) revealed that the first three components accounted for 81.33% of the total variation, showing significant genetic variability among the coconut varieties, notably in GBGD and Fiji Tall. These findings highlight the importance of floral traits in genetic diversity and provide valuable insights for coconut breeding programs.
Keywords: Coconut, floral biology, pollen recovery, varieties

Introduction

Coconut (*Cocos nucifera* L.) is an important plantation crop grown in Assam mostly by small and marginal farmers. The area under coconut in Assam is estimated to be 20.800 hectares with a production of 148.51 million nuts and productivity of 7,140 nuts/ha (Hebbar *et al*., 2023). The average productivity of coconut in Assam is only 7,140 nuts per ha which is much less than the national average productivity of 9,430 nuts per ha (Thamban *et al*., 2023). The climatic condition of Assam is characterized by a warm humid sub-tropical climate with prolonged summer and mild to severe winter. Coconut requires a warm humid tropical climate with an ideal temperature range from 26ºC to 27ºC and a diurnal variation of 7-8 ºC for its optimum growth and development (Marar and Pandalai, 1957; Child, 1964). However, the winter season seems to be a limiting factor affecting coconut production (Patel, 1938). The negative impact of low temperature in coconut palms has been reported by various workers (Thampan, 1981; Bhaskaran and Leela, 1983; Vanaja and Amma, 2002; Timothy, 2010). Toward the development of improved varieties for specific agro-climatic zones, it is necessary to characterize the coconut populations and identify adaptive features for utilization in the coconut improvement program. Characterization of coconut germplasm has been undertaken based on fruit traits

(Whitehead, 1968; Harries, 1978; Niral *et al*., 2009), botanical and agronomic traits (Sugimura *et al*., 1997; Niral *et al*., 2008). A better understanding of climatic factors and the floral biology of coconut in specific regions will help to provide key information for the choice of parents and adoption of breeding methods. Taking this into consideration, the present study was undertaken to assess the flowering behavior of coconut varieties during the winter season under Lower Brahmaputra Valley Zone of Assam conditions.

Materials and Methods

The field experiment was conducted for two consecutive years 2021-22 and 2022-23 at ICAR-Central Plantation Crops Research Institute, Research Centre, Kahikuchi, Guwahati, Assam. Twenty-one-year-old palms of fifteen coconut varieties were used for experimenting. The experiment design was Randomized Block Design (RBD) with three replications. Three palms per replication were used for recording the data. Inflorescences produced in each palm were tagged from October to March and data for floral traits viz., inflorescence length, the girth of the stalk, stalk length, length of spikelet bearing portion, length of spikelet, number of spikelets per inflorescence, number of male and female flowers and number of inflorescences produced per palm were recorded as per coconut descriptors (Ratnambal *et al*., 1995, 2000). Mature, unopened male flowers were collected from fully opened inflorescences during the morning hours 8 am to 10 am. Flowers were placed between two sheets of blotting paper slightly crushed using a wooden rolling pin and dried in an oven at 39ºC (+/-1ºC) for 24 hours. The pollen was then collected by sieving (0.2 mm mesh sieve) the dried flowers and weighed. The fresh weight of 1000 male flowers was recorded on the fresh unopened male flowers collected for extraction of pollen. The dry weight of these 1000 male flowers was recorded after drying at 39ºC (+/-1ºC) for 24 hours. The mean values of all the above characters (both years) were subjected to analysis of variance (ANOVA) to test the effect of genotypes. The mean, standard error, and CD (0.05%) values were calculated according to Panse and Sukhatme (1961). The genotypic correlation coefficient was calculated based on the formulae given by Snedecor (1961). PCA analysis was also carried out through the statistical procedures suggested by Sneath and Sokal (1973). The statistical package R with the help of the agricolae package (De Mendiburu, 2014) was used for the analysis.

Results and Discussion

Analysis of variance revealed significant variation for all the floral traits among the varieties (Table 1).The length of inflorescence among the varieties varied from 71.45 cm to 127.57 cm (Table 2). Hybrid Kera Sankara recorded a significantly higher length of inflorescence (127.57 cm) which was statistically at par with Assam Green Tall (125.54 cm). Lesser inflorescence length was observed in Ganga Bondam Green Dwarf (71.45 cm). Based on a study of 27 coconut accessions, comprising eight dwarfs and nineteen tall, Niral *et al*. (2008) reported inflorescence length varying from 56.25 cm to 119.50 cm with tall accessions having relatively larger inflorescences than dwarf accessions. Ratnambal *et al*. (2003) have also reported variations in floral biology studied among 64 tall and 16 dwarf coconut accessions.

The girth of inflorescence among the varieties varied from 7.30 cm to 12.27 cm. Assam Green Tall recorded the highest girth of inflorescence (12.27 cm), while the lowest girth of inflorescence was observed in the Ganga Bondam Green Dwarf (7.30 cm). Dwarf varieties were found to produce lesser girth than talls and hybrids studied. A relatively wider range of variation for the girth of inflorescence (6.93 cm-9.55 cm) has been observed in the local coconut population at ICAR-Central Plantation Crops Research Institute, Research Centre, Kahikuchi, Guwahati, Assam (Singh *et al*., 2020). Wide variability for inflorescence girth, with tall types showing higher girth of inflorescence, was also reported (Niral *et al*., 2008).

Pooled data showed that a higher length of inflorescence stalk was observed in hybrid Kera Sankara (66.32 cm) which was statistically at par with hybrid Chandra Sankara (64.50 cm) (Table 2). Lesser inflorescence stalk length was recorded in Ganga Bondam Green Dwarf (30.89 cm). Variation of floral traits in coconut has been reported by many workers (Panda, 1982; Patil *et al*., 1993; Kumaran *et al*., 2004; Niral *et al*., 2008), with much larger variation for inflorescence stalk length. Samanta *et al*., (2009) also observed seasonal variation in inflorescence stalk length with higher stalk length recorded during January.

The length of the spikelet bearing portion among the varieties varied from 33.48 cm to 64.64 cm. Variety Assam Green Tall (64.64 cm) showed a higher length of spikelet bearing portion, whereas, a relatively lesser length of spikelet bearing portion was recorded in variety MYD (33.48 cm). Similar variations have been reported in coconut cultivars (Niral *et al*., 2008).

Spikelet length differed significantly among the coconut varieties. Hybrid Chandra Sankara recorded the highest spikelet length (49.75 cm) followed by hybrid Lakshaganga (47.18 cm). A smaller length of spikelet was observed in the variety MYD (32.33 cm). Spikelet length ranging from 27-55 cm has been reported in the germplasm conserved at ICAR-CPCRI, Kasaragod (Ratnambal *et al*., 1995). Spikelet length variation among coconut varieties and seasonal changes were also reported by Samanta *et al*., (2009) and Srinivasu *et al*. (2022).

Significant differences were observed in the number of spikelets produced per inflorescence. The number of spikelets in the inflorescence among the varieties varied from 30.60 to 53.12. Hybrid Kera Sankara was found to produce the highest number of spikelets in the inflorescence (53.12). The lowest number of spikelets in the inflorescence was observed in MYD (30.60). Seasonal variations in the number of spikelets in the inflorescence were reported by Srinivasu *et al*., (2022). The findings are in agreement with those reported in coconut varieties by Balakrishnan *et al*., (1988), wherein a similar variation in the number of spikelets per inflorescence (20-65) was observed.

Significant differences were observed in the number of female flowers produced per inflorescence. The average female flower produced per inflorescence among the varieties varied from 8.32 to 39.50. Hybrid Kera Sankara produced a higher number of female flowers per inflorescence (39.50), while Fiji Tall variety was found to produce the least female flowers per inflorescence (8.32) among the varieties studied. Variations concerning female flower production among coconut varieties and environmental conditions have been reported by many workers (Marechal, 1928; Niral *et al*., 2017; Sumitha *et al*., 2020). Rao (1988) also observed seasonal variation among coconut varieties for the number of female flowers produced.

Number of male flowers per spikelet among the varieties varied from 167.50 to 247.17. Hybrid Kera Sankara was found to produce more male flowers per spikelet (247.17) followed by Fiji Tall variety (238.22). A smaller number of male flowers per spikelet were observed in the COD variety (167.50). Seasonal variation in the production of male flowers per spikelet was reported by Srinivasu *et al*. (2022), where they observed male flower production ranging from 162.26 to 218.27 during winter, summer, and rainy seasons studied among various coconut varieties. Ohler (1999) reported 200 to 300 male flowers per spikelet.

Fresh weight of 1000 male flowers showed significant variation among the varieties. The maximum fresh weight of male flowers was recorded in the Fiji Tall variety (112.22 g), while the minimum fresh weight was observed in the Ganga Bondam Green Dwarf (67.89 g). Niral *et al*. (2008) observed fresh weight of 1000 male flowers ranging from 62.17 g to 109.47 g among coconut cultivars conserved in the national gene bank at ICAR-CPCRI, Kasaragod.

The dry weight of 1000 male flowers showed significant variation among the varieties. The dry weight of 1000 male flowers varied from 21.46 g to 44.30 g. The maximum dry weight of male flowers was recorded in the Fiji Tall variety (44.30 g), while the minimum dry weight was observed in the Ganga Bondam Green Dwarf (21.46 g). Niral *et al*., (2008) observed dry weight of 1000 male flowers ranging from 27.10 g to 45.71 g among tall and dwarf types of coconut conserved in the national gene bank at ICAR-CPCRI, Kasaragod.

The pollen yield of 1000 male flowers has been presented in Table 3. Significant variations were observed for pollen yield studied among coconut varieties. Pollen yield among the tall, dwarf, and hybrid varieties recorded varied from 0.14 g to 0.86 g. Maximum pollen yield was recorded in the hybrid Chandra Laksha (0.86 g). The minimum pollen yield was observed in the MYD variety (0.14 g). In the present study, dwarf varieties were found to produce comparatively lesser amounts of pollen yield as compared to tall and hybrid. In a study conducted by Niral *et al*. (2008), pollen yield of 1000 male flowers among tall and dwarf types varied from 0.66 g to 3.26 g. In another study by Srinivasu *et al*., (2022), the pollen yield of 100 g fresh male flower ranged from 0.59 g to 1.07 g with Ganga Bondam Green Dwarf and COD, dwarf varieties producing lesser pollen than tall coconut types. The present study also indicates that pollen yield was found to be comparatively lower in North East region as compared to Southern parts of India.

The number of inflorescences produced per month among coconut varieties from October to March has been presented in Table 4. Significant differences were observed in the number of inflorescences produced each month among the varieties. The average mean value indicates that the inflorescence production among the varieties varied from 0.27 to 0.78. The WCT variety produced the maximum inflorescence during this period (0.78), while the minimum inflorescence production was observed in the MYD variety (0.27). The study also indicates that none of the varieties produce continuous inflorescence during this

period. In a study conducted by Sivakumar *et al*., (2022) to assess the suitability of coconut cultivation in the Western Zone of Tamil Nadu, out of 10 coconut genotypes taken for study, San Ramon Tall (SNRT) was found to produce the maximum (10 Nos.) inflorescence per palm per year. Less inflorescence production in local coconut genotypes under the Assam condition of North East region of India has been reported (Singh *et al*., 2020). Marar and Pandalai (1957) reported the production of a larger number of spadices during the hot weather season as compared to other seasons. This might be attributed to low temperature (below 20ºC) and day length during the period affecting the photosynthetic efficiency (Wickremasurya, 1968; Siju Thomas *et al*., 2008). Louis (1981) also observed phenotypic variations in the number of inflorescences produced in coconut varieties.

Correlation analysis

The magnitude and degree of floral traits and their relationship between them can be well studied using correlation analysis. In the present study, 11 floral traits of coconut were analyzed for correlation between them and represented in Fig. 1. The highest positive correlations were observed between length of inflorescence and girth of inflorescence (0.84), and between length of inflorescence and length of inflorescence stalk (0.84) followed by fresh weight of 1000 male flowers, dry weight of 1000 male flowers (0.81), length of spikelet bearing portion and length of inflorescence (0.77) and number of male flowers/spikelet and length of inflorescence bearing portion (0.76). The highest negative correlation was observed between the dry weight of 1000 male flowers and the number of female flowers/inflorescence (-0.59), followed by the fresh weight of 1000 male flowers and the number of female flowers/ inflorescence (-0.49). The trait number of female flower/inflorescence showed a negative to nil correlation between all other characters and the trait length of inflorescence had a positive correlation with almost all other characters. Similar results were reported by Niral *et al*. (2008).

Principal Component Analysis

Principal Component Analysis (PCA) is one of the most important multi-variate analytics which decomposes the total variation into simple and fewer variables that are uncorrelated to each other (Karl Pearson, 1901). In the current research, data on fifteen coconut varieties/hybrids on 11 floral traits were considered for PCA. The total variation was divided into 11 principal components equaling the number of variables considered for analysis. Among the 11 principal components, the first three principal components were considered major contributors to the total variation as they have Eigen values greater than one (Table 4). Similarly, Eigen values were used as potential criteria in the selection of major PCs that contribute to the total variation and it was reported by many researchers (Gerrano *et al*., 2019; Vijayakumar *et al*., 2020). The first principal component contributed 51.66% of the total variation, i.e., followed by PC 2 with 19.046% and PC 3 with 10.624% contribution. In the present study, the first three PCs contributed to 81.33% of the total variation. Similarly, Gixhari *et al*., 2014 reported that more than 80% of total variation is enough to explain the genetic variation.

The first two principal components were used as axes to visualize the biplot where 15 coconut varieties/hybrids are scattered apart (Fig 2). In the present study, the genotypes are scattered in all four quadrants representing the wider genetic variability among the hybrids/varieties taken under the study. The genotypes like Keraganga, LO, WCT, and Kerasree were closer to the origin and closer to each other. Hence, they are considered closely related to each other. Genotypes like GBGD, Fiji Tall, AGT, MGD, and Kera Sankara were located far apart from origin and apart from each other. Hence, they are considered to have more genetic variation among them.

The first principal components which contributed 51.66% of the total variation was attributed to the characters like length of inflorescence, girth of inflorescence, length of spikelet bearing portion, and number of spikelets in the inflorescence. The second PC was majorly attributed to the characters like number of female flower inflorescence, fresh weight of 1000 male flowers, and dry weight of 1000 male flowers, and the third PC was highly attributed to length of inflorescence stalk, length of spikelet bearing portion and length of spikelet. The contribution of characters towards its principal components is given in Table 5.

The extent of variation and relation among the 11 floral traits were also represented in Fig. 2. The traits that are closer to the origin are considered the lowest contributors to the total genetic divergence. However, in the present study, all the floral traits were fairly apart from the origin. Hence, all the characters contributed majorly to the genetic divergence in the present study. Length of inflorescence is considered to have the highest axes length and it is considered as the major contributor to the total variation. In the current study, all the characters are placed in the three quadrants. The floral traits that are placed in the same

quadrant will have a positive association among them and floral traits that are placed in the opposite quadrants will have a negative or opposite association/correlation among them (Molosiwa *et al*., 2016). The number of female flowers/inflorescence had a negative or opposite association with the traits viz., pollen yield of 1000 male flowers, fresh weight of 1000 male flowers, and dry weight of 1000 male flowers. Similarly, all other characters had positive associations among them.

The genotypes MGD and GBGD were present in the first quadrant along with the number of female flowers/inflorescences. Hence, these two genotypes are considered to have more female flowers/inflorescence and positive relations among them. Similarly, the varieties/hybrids placed in the particular quadrant will have a positive association with the floral traits or be similar to the floral traits present in that quadrant.

Conclusion

Flowering and floral behavior of coconut palms varies across location. Under optimum conditions, an adult, healthy coconut palm produces about 12 inflorescences per year. However, under Assam conditions, season as well as variety has an influence on the growth and development of coconut palm and also the inflorescence production. Hence, understanding the floral biology of coconut varieties will help the breeder in undertaking the selection of desirable varieties for crop improvement research and also planning crop management. In the present study, variety Kera Sankara recorded higher values for most of the important floral traits *viz*., Inflorescence length, number of spikelets per inflorescence, length of spikelet bearing portion, number of female flowers per inflorescence, and number of male flowers per spikelet. Interestingly, more number of inflorescence produced each month was recorded in the WCT variety with higher pollen recovery in the Chandra Laksha variety. This variety namely Kera Sankara, WCT, and Chandra Laksha may be considered for their unique floral traits. Further study is needed for these varieties for their potential for improving coconut production in the North East region of India.

Table 1 : ANOVA Table for various floral characters among coconut varieties

Characters	Mean sum of squares					
	Replications		Varieties		Errors	
	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
Length of inflorescence (cm)	258.18	32.55	16889.48*	12209.87*	524.64	225.38
Girth of inflorescence (cm)	1.63	67.29	117.91*	102.33*	109.59	71.50
Length of spikelet bearing portion	112.36	430.45	5765.20*	4753.27*	781.05	528.64
Length of inflorescence stalk (cm)	163.71	438.94	5780.50*	5358.86*	242.99	341.33
Length of spikelet (cm)	174.58	145.75	1405.38*	1300.13*	202.87	129.33
No. of the spikelet in the inflorescence	193.31	35.96	2880.66*	1585.17*	256.48	311.46
No. of female flowers/inflorescence	15.68	159.56	3506.90*	5551.01*	169.71	146.50
No. of male flowers/ spikelet	213.80	379.54	85339.55*	88963.97*	122.23	297.17
Fresh weight of 1000 male flower (g)	308.85	272.13	9098.16*	3000.06*	219.08	272.43
Dry weight of 1000 male flower (g)	106.26	192.42	3000.62*	1223.06*	106.11	120.10
Pollen yield of 1000 male flowers (g)	0.86	0.008	8.33*	3.01*	3.84	0.35

Table 2. Performance of coconut varieties for inflorescence traits

Varieties	Length of inflorescence (cm)			Girth of inflorescence (cm)			Length of spikelet bearing portion (cm)			Length of inflorescence stalk (cm)			Length of spikelet (cm)			No. of the spikelet in the inflorescence		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
COD	82.18	90.32	86.23	8.17	7.95	8.06	35.92	46.47	41.18	46.26	43.85	45.05	42.20	46.30	44.25	34.34	42.67	38.50
MYD	80.13	74.54	77.31	7.40	7.56	7.48	35.44	31.56	33.48	44.68	42.98	43.83	33.26	31.41	32.33	33.45	27.75	30.60
MOD	80.32	78.14	79.26	7.63	9.32	8.47	41.29	43.41	42.38	39.04	34.73	36.88	33.98	31.86	32.92	38.76	40.90	39.83
MGD	80.40	96.28	88.34	8.98	9.58	9.28	49.04	55.98	52.69	31.00	40.30	35.65	35.36	43.31	39.33	42.00	48.32	45.16
GBGD	65.28	77.62	71.45	6.68	7.92	7.30	39.31	41.80	40.56	25.96	35.82	30.89	31.20	39.02	35.11	33.04	35.60	34.32
Chandra Sankara	98.67	123.97	111.32	10.83	12.64	11.73	39.10	54.54	46.82	59.57	69.43	64.50	46.84	52.66	49.75	36.39	46.28	41.33
Chandra Laksha	112.32	98.54	105.43	10.21	9.82	10.02	64.04	58.18	61.11	48.28	40.36	44.32	45.26	42.58	43.92	44.74	39.86	42.30
Kera Sankara	134.30	120.84	127.57	10.44	10.68	10.56	65.94	56.56	60.67	68.36	64.28	66.32	44.38	42.62	43.50	58.03	48.21	53.12

Kerasree	93.62	100.94	97.28	11.35	11.95	11.65	52.17	55.40	53.78	41.45	45.54	43.50	32.90	39.58	36.24	48.26	52.20	50.23
Lakshaganga	110.58	97.66	104.12	11.48	9.62	10.55	50.85	41.88	46.37	59.73	55.78	57.75	49.25	45.11	47.18	53.37	49.98	51.67
Keraganga	111.76	78.72	95.24	10.67	9.27	9.97	65.93	45.25	55.60	45.83	33.47	39.65	42.53	38.78	40.65	49.15	43.17	46.16
WCT	88.48	120.28	104.38	9.82	11.74	10.78	42.08	69.90	55.98	46.40	50.38	48.39	39.66	47.68	43.67	39.62	46.24	42.93
AGT	130.15	120.93	125.54	12.58	11.96	12.27	66.74	62.00	64.64	62.85	58.95	60.90	46.71	38.95	42.83	53.60	41.74	47.67
LO	112.00	96.56	104.28	10.85	9.62	10.23	53.32	35.58	44.45	58.69	60.98	59.83	41.99	39.98	40.98	52.74	46.92	49.83
Fiji Tall	111.70	105.22	108.46	9.97	9.76	9.86	62.22	59.70	60.96	49.48	45.52	47.50	40.62	44.38	42.50	49.65	41.48	45.56
S. Em.(+/-)	2.49	1.63	2.06	1.14	0.92	1.03	3.04	2.50	2.77	1.70	2.01	1.85	1.55	1.24	1.39	1.74	1.92	1.83
C. D. (0.05%)	7.23	4.74	5.98	3.30	2.67	2.98	8.83	7.26	8.04	4.92	5.83	5.37	4.50	3.59	4.04	5.06	5.57	5.31

Table 3 : Performance of coconut varieties for inflorescence traits and pollen yield

Varieties	No. of female flowers/inflorescence			No. of male flowers/spikelet			Fresh weight of 1000 male flowers (g)			Dry Weight of 1000 male flowers (g)			Pollen yield of 1000 male flowers (g)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
COD	21.82	7.84	14.83	150.32	184.68	167.50	78.55	84.21	81.38	21.56	38.08	29.82	0.10	0.32	0.21
MYD	20.08	26.00	23.04	208.41	168.21	188.31	73.30	80.54	76.92	24.28	30.34	27.31	0.12	0.16	0.14
MOD	15.89	31.65	23.77	196.28	178.26	187.27	84.16	86.32	85.24	28.55	30.53	29.54	0.05	0.27	0.16
MGD	29.87	47.80	38.83	224.20	246.80	235.50	65.66	76.28	70.97	21.40	28.00	24.70	0.08	0.22	0.15
GBGD	30.26	41.30	35.78	201.42	220.14	210.78	66.32	69.46	67.89	19.30	23.62	21.46	0.20	0.14	0.17
Chandra Sankara	15.28	35.06	25.17	211.13	248.53	229.83	69.56	71.84	70.70	27.00	28.20	27.60	0.28	0.30	0.29
Chandra Laksha	20.36	24.28	22.32	236.35	214.25	225.30	85.77	93.25	89.51	20.96	35.64	28.30	0.59	1.13	0.86
Kera Sankara	35.40	43.61	39.50	250.38	243.96	247.17	88.42	96.30	92.36	31.94	34.12	33.03	0.30	0.32	0.31
Kerasree	35.75	29.25	32.50	202.64	220.52	211.28	84.06	90.52	87.29	25.88	31.46	28.67	0.14	0.30	0.22
Lakshaganga	13.14	39.40	26.27	312.14	123.36	217.75	84.14	87.14	85.64	35.95	39.87	37.91	0.46	0.62	0.54
Keraganga	10.94	28.72	19.83	247.36	175.94	211.65	93.28	87.24	90.26	36.27	25.77	31.02	0.58	0.28	0.43
WCT	19.75	24.45	22.10	149.33	309.53	229.43	90.32	78.24	84.28	39.82	32.22	36.02	0.40	0.14	0.27
AGT	25.06	33.10	29.08	302.48	169.32	235.90	97.15	85.17	91.16	37.41	22.79	30.10	0.39	0.09	0.24
LO	10.81	17.13	13.97	220.26	208.70	214.48	88.36	82.18	85.27	35.98	32.64	34.31	0.28	0.18	0.23
Fiji Tall	5.65	11.00	8.32	223.76	252.68	238.22	125.28	99.16	112.22	48.12	40.48	44.30	0.70	0.54	0.62
SEm (+/-)	1.42	1.32	1.37	1.20	1.88	1.54	1.61	1.80	1.70	1.12	1.19	1.15	0.21	0.06	0.13
C. D. (0.05%)	4.11	3.82	3.96	3.50	5.44	4.47	4.67	5.21	4.94	3.25	3.46	3.35	0.61	0.18	0.39

Table 4 : No. of inflorescence produced per month among coconut varieties

Varieties	October	November	December	January	February	March	Mean
COD	0.33	1.00	--	1.00	0.33	0.83	0.57
MYD	--	0.33	0.66	0.66	--	--	0.27
MOD	--	--	1.00	0.83	0.33	--	0.36
MGD	0.49	--	1.00	--	0.33	0.49	0.38
GBGD	1.00	--	--	0.65	0.66	--	0.38
Chandra Sankara	0.49	1.00	--	1.00	0.49	0.83	0.63
Chandra Laksha	--	0.33	0.33	0.49	0.33	0.66	0.34
Kera Sankara	0.50	--	0.66	0.66	0.83	0.66	0.58
Kerasree	--	0.33	--	0.49	0.65	--	0.24
Lakshaganga	0.33	--	0.66	0.83	0.16	0.66	0.44
Keraganga	--	--	1.00	0.49	0.49	0.66	0.44
WCT	0.83	--	1.00	0.83	1.00	1.00	0.78
AGT	1.00	--	1.00	0.50	0.33	0.66	0.58
LO	0.33	--	1.00	0.50	0.49	0.66	0.49
Fiji Tall	0.49	--	1.00	0.66	0.33	0.33	0.47
SEm (+/-)	0.12	0.21	0.05	0.08	0.15	0.16	0.12
CD (0.05)	0.34	0.62	0.18	0.24	0.43	0.48	0.38

Table 5 : Eigen values and contribution of floral traits towards total divergence

Principal components	Eigen values	Percentage of variance	Cumulative percentage of variance
PC 1	5.683	51.660	51.660
PC 2	2.095	19.046	70.706
PC 3	1.169	10.624	81.330
PC 4	0.811	7.375	88.705
PC 5	0.368	3.349	92.054
PC 6	0.350	3.182	95.236
PC 7	0.257	2.336	97.572
PC 8	0.167	1.522	99.094
PC 9	0.085	0.777	99.871
PC 10	0.014	0.129	100
PC 11	0.000	0.000	100

Table 6 : Percent contributions of floral traits toward principal components

Variables	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8
Length of inflorescence	15.76	1.77	1.23	0.15	5.34	1.50	7.90	2.67
Girth of inflorescence	12.16	4.87	1.03	0.87	3.65	30.76	4.57	24.38
Length of spikelet bearing portion	11.71	0.58	19.93	0.56	1.01	13.44	0.53	17.91
Length of inflorescence stalk	9.17	1.72	29.33	1.39	6.56	1.32	21.98	1.51
Length of spikelet	8.97	0.07	17.12	25.94	3.11	0.75	8.50	23.64
No. of spikelet in the inflorescence	11.32	1.70	0.39	12.27	48.42	5.96	0.18	0.00
No. of female flowers in the inflorescence	0.25	38.23	7.17	0.09	1.13	13.01	8.09	2.47
No. of male flowers in the spikelet	9.64	7.56	7.89	1.58	23.35	11.58	14.73	9.64
Fresh weight of 1000 male flowers	7.66	16.54	8.64	9.38	1.11	0.51	8.64	3.47
Dry weight of 1000 male flowers	7.81	17.51	0.61	8.21	0.57	18.78	10.21	0.02
Pollen yield of 1000 male flowers	5.51	9.41	6.62	39.52	5.70	2.33	14.62	14.26

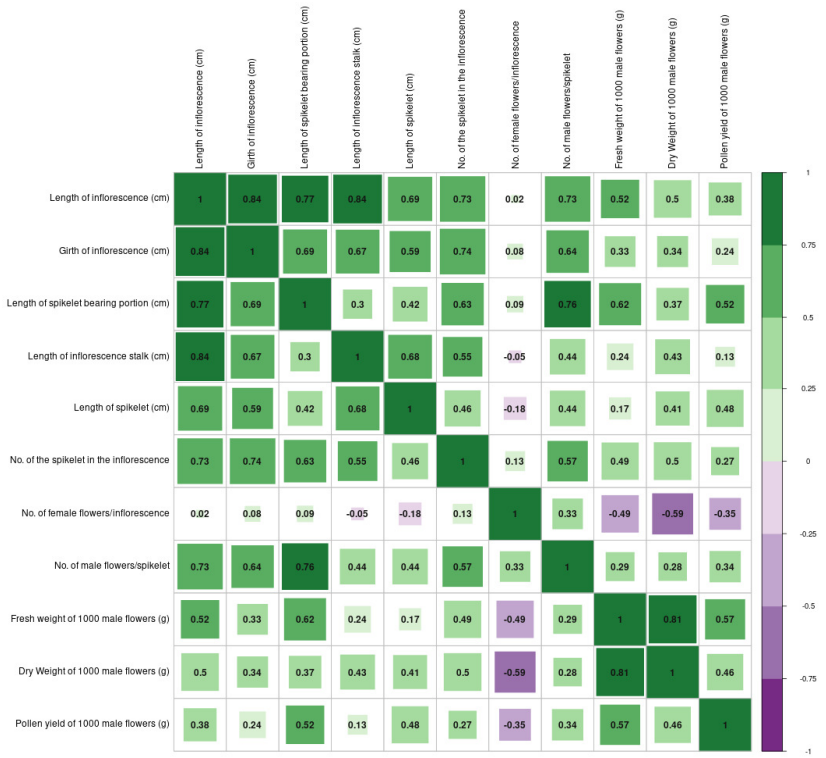

Fig. 1 : Correlation among floral traits of coconut varieties

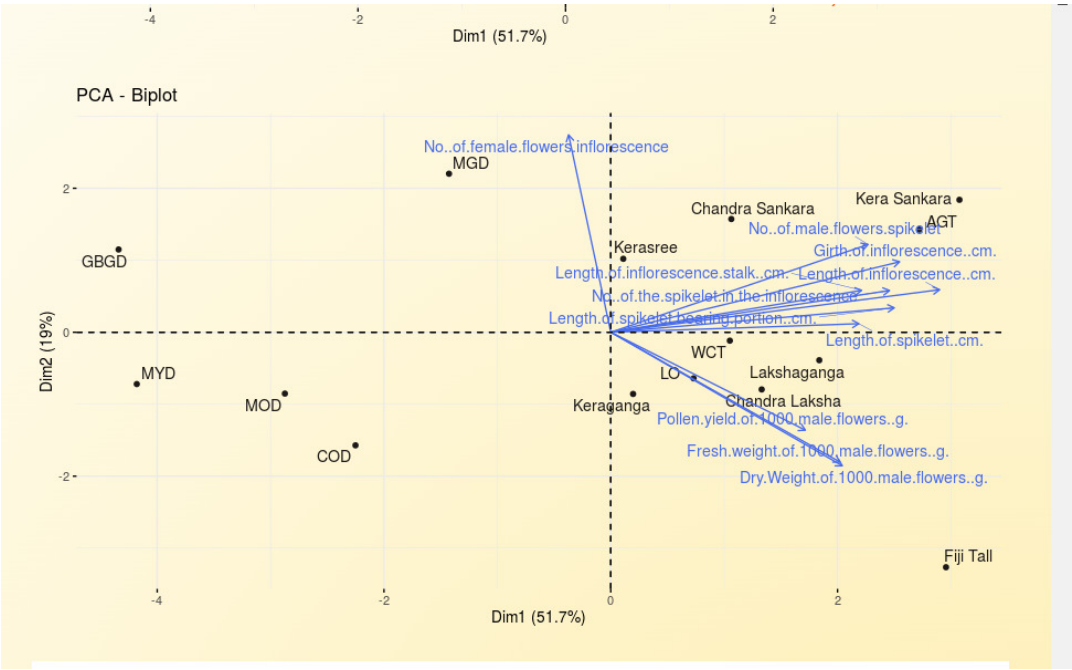

Fig. 2. Biplot showing variation among floral traits in coconut varieties

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