

Evaluation of Whorl-wise Floral Characters of Seedling Male Palms used in Pollination of cv. Dhakki in Dera Ismail Khan

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ABSTRACT

Nine seedling males of different age were selected from various wild grooves of date palm for evaluation of whorl-wise floral characteristics, fruit setting and yield for two successive years of 2001 and 2002. Data on days to spathe opening flower persistence days, length of spathe, length of floral head, number of strands per spathe, number of flowers/strand, number of flowers/spathe, weight of pollen grains/spathe, fruit setting, fruit drop and yield of fruit/bunch were recorded. It was found that seedling males as well as whorls differed from each other in all these characters. The days to spathe opening and flower persistence days were maximum in M₆ followed by M₁. The whorl-2 possessed maximum flower persistence days and spathe length as compared to other two whorls. The number of strands/spathe was maximum in M₃ while number of flowers/strand and number of flowers/spathe were highest in M₉. Whorl-2 also ranked first in these two characters the weight of pollens/spathe was maximum in M₉ and M₃ during 2001 and 2002 and in whorl-2 during both years. Fruit setting percentage was highest in M₁ and M₂ and lowest in M₅ and M₃. It was also highest in W₂ (M₁ in 2001 & M₂ in 2002). Fruit drop was highest in case of M₃ during first year and in M₅ during second year while lowest fruit drop percentage was recorded in M₂. The maximum yield of fruits was achieved from M₇ followed by M₁ and minimum from M₅ during both years of study.

Key Words: Floral; Pollination; Palm; Seedling; Evaluation

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is the third major fruit of the country and a source of fruit exchequer. Pakistan exports about 700,000 tons dates each year (Anonymous, 2003). Quite a large number of date cultivars are grown in the southern part of NWFP especially D.I. Khan. Amongst them a local selection namely Dhakki is very famous for its size, color and flesh percentage. Almost 70% of area under date palm orchards is occupied by Dhakki while in the rest of the 30% other cultivars are grown. Out of 11,000 tons annual production in the area, Dhakki contributes about 7,000 tons. In spite of maximum area under this cultivar, its yield is low. Amongst various factors responsible for yield, poor fruit setting is one of them for which male palms plays an important role. It is an established fact that some males are high potent as compared to others which contribute to increase fruit set and enhance yield/palm (Swingle & Nixon, 1928). Seedling males vary considerably with respect to their reproduction characters (Ahmed & Ali, 1960; Shaheen *et al.*, 1989; Al-Ghamaddi, 1988). Nasir *et al.* (1986) evaluated 600 male palms located in 209 date palm orchards in different sectors of central region of Saudi Arabia. They found that males differed in their floral characters, number of flowers per strand and quantity of pollen grains. El-Amer *et al.* (1993) studied six male pollinators on six date varieties for fruit setting at Al-Hassa Saudi Arabia. They reported that fruit setting was affected by pollen source, flowering behavior and pollen quantity. Ibrahim and Shahid

(1994) tested six males on cvs. Hillawi and Khadrawi and found that males differed in effectiveness of fruit setting and yield. El-Salhy, *et al.* (1997) studied the viability of pollen grains of different males and their effect of fruit set yield and concluded that males are variable in pollen viability, fruit set and yield. Rahimi (1998) reported that pollen grains from different male cultivars effect on fruit set and pomological fruit characters.

Growers of this area use pollen grains collected from males of unknown potency grown in wild grooves for pollination. They do not have the idea of high potency and importance of males floral characters. Consequently they get low yield. Realizing the importance of male, a study was conducted to evaluate different male palms used pollination of cv. Dhakki for their floral characteristics, quantity and potency of their pollen grains. The promising males will be propagated vegetatively through their offshoots so as to act as parent tree of a new clone.

MATERIALS AND METHODS

Nine seedling male palms of irrespective age possessing at least three suckers were selected from wild grooves of date palm during flowering season (January to April, 2001-2002) for two successive years of three whorls of each male were considered for studying different parameters. The experiment was conducted in split plot arrangement by using males as main plot, whorl sub plot replicated three times.

Data on days to flowering, flower persistent days, length of spathe (cm), length of floral head (cm), number of flower per strand, number of flower per spathe, weight of pollen grain per spathe (gm). Pollen grain from three male whorls (early, mid, late) were pollinated on the second whorl spathe of Dhakki date palm and the parameters were recorded, fruit setting percentage, fruit drop percentage and weight of fruits per bunch were recorded and statistically analyzed using analysis of variance.

The detail of seedling males is given as under: This experiment was conducted at Mithapur Kalan, Distt. D.I. Khan.

Identity No.	Name of Grooves	Number of suckers	Age (years)
M ₁	Saqlain Shah	6	15
M ₂	Iqbal Shah	4	17
M ₃	Zawar Shah	5	32
M ₄	Malik Gulab	7	18
M ₅	Malik Gulab	5	23
M ₆	Rab Nawaz	4	24
M ₇	Kazim	4	19
M ₈	Nasir Shah	7	15
M ₉	Malik Gulab	6	16

Dates of pollination

Seedling males	Years	
	2001	2002
M ₁	26 th March	21 st March
M ₂	16 th March	12 th March
M ₃	24 th March	20 th March
M ₄	25 th March	20 th March
M ₅	3 rd April	1 st April
M ₆	1 st April	30 th March
M ₇	5 th March	3 rd March
M ₈	31 st March	29 th March
M ₉	6 th March	30 th March

Three male spathe of various whorls were collected after being matured i.e. shortly after the sheath had opened or that a cracking noise was produced when the middle part of the spathe was pressed between the thumb and forefingers. The spathe were then cut and taken to the

laboratory for recording of the parameters. For pollen grains extractions, the protective sheath was removed and the spikes were placed on paper sheet for 3-4 h till complete opening of flowers. Then the pollen grains were separated from the flower parts by shaking and using of mesh type cloth. The pollen grains were dried in desiccators for 24 h. After this the pollen grains were packed in air tight bottle and stored in household refrigerator at 4°C. Pollination was done by dusting of pollen grain on the opening day of spathe of Dhakki plants and bagging was done to avoid contamination.

RESTULTS AND DISCUSSION

Days to spathe opening. Significant differences were observed due to difference in days to spathe opening by males as well as whorls during both the years of study. (Table Ia & Ib) The significantly maximum days of (22.333 & 19.333) were taken by M₆ followed by M₁ which were statistically similar to one another but differed significantly from all other seedling males during the two successive years of 2001 and 2002. The minimum time was taken by M₇ which took 10.222 and 10.00 days to spathe opening during 2001 and 2002 respectively. It was statistically alike to M₄ and M₈ by taking 11.337 and 12.333 days respectively. The time taken by males under study for spathe opening varied from 10.222 to 22.333 during 2001 and 10.000 to 19.333 during 2002. Among the three whorls W₁ took maximum days of 18.519 and 17.222 days followed by W₂ (15.033 and 13.66 days) and W₃ (12.222 & 12.333 days). All the three whorls were statistically dissimilar during both years of study.

The interactive effect of males and whorls were non-significant during both the years of study. The findings revealed that seedling male vary significantly whorl-wise in time taken for spathe opening. The maximum time (26.000 days) for spathe opening was observed in W₁ of M₆ during 2001 while in 2002 the maximum time of 24.000 days was taken by W₁ of M₁. The coefficient of variation of data

Table Ia. Number of days taken for spathe opening in the 3 whorls during 2001

Whorl	Seedling male									Mean
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	
W ₁	24.000	20.000	21.000	16.000	16.000	26.000	12.667	15.000	16.000	18.519a
W ₂	21.000	17.000	16.000	10.000	13.333	23.000	10.000	12.000	13.000	15.03b
W ₃	15.000	15.000	13.000	8.000	12.000	18.000	8.000	10.000	11.000	12.222c
Mean	20.000 ab	17.373 bc	16.667 c	11.337 de	13.778 d	22.333 a	10.222 e	12.333 de	13.333 d	

Table Ib. Number of days taken for spathe opening in the 3 whorls during 2002

Whorl	Seedling male									Mean
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	
W ₁	24.000	15.000	20.000	16.000	15.000	23.000	12.000	15.000	15.000	17.222a
W ₂	19.000	12.000	16.000	10.000	11.000	20.000	10.000	12.000	13.000	13.667b
W ₃	14.000	10.000	11.000	8.000	8.000	15.000	8.000	9.000	10.000	10.333c
Mean	19.000a	12.333c	15.667b	11.333cd	11.333cd	19.333a	10.000d	12.000c	12.667c	

CV (%) = 10.90 CV (%) = 12.27; LSD for Males = 2.765 LSD for Males = 1.830; LSD for Whorl = 1.947 LSD for Whorl = 2.779

during 2001 and 2002 was 10.90% and 12.27% respectively. Likewise Nasir *et al.* (1986) and El-Salhy (1997) found that males differ in their floral characters.

Flower persistent days. The persistence of flower is an important character of males. Table IIa and IIb reveal that males as well as whorls varied significantly in flower persistence time during both the years of study. The flowers of M₆ persisted for longer times (6.000 & 5.667 days) followed by flowers of M₁ which remained alive for 4.667 and 5.000 days respectively during 2001 and 2002. Both the males were statistically akin in this regard. The flowers of M₄ persisted for shortest time (2.000 days) during both the years. The period of flower persistence in M₂, M₃, M₅, M₇, M₈ and M₉ was recorded as 2.333, 2.000, 3.000, 3.667, 4.446 and 4.338 days during 2001 whereas it was 2.667, 2.333, 2.333, 2.667, 4.000 and 3.000 days during 2002 respectively. The flower persistence days of different whorls was also significantly affected both years. The flowers of W₁ persisted for longer time (4.556 & 4.815 days) due to fluctuation of temperature followed by W₂ (3.370 & 3.000 days). However in 2001 the two whorls (W₁ & W₂) were statistically similar but differed significantly in 2002. The flowers of W₃ remained persistent for shortest period (2.963 & 2.667 days).

The cumulative effect of males and whorls was not significant during 2001 but was significant during 2002. However, during both years of flowers of M₆ from W₁, persisted for longest time *viz.* 8.000 and 9.000 days during 2001 and 2002 respectively. The data varied 11.44% and 15.14% during 2001 and 2002. These findings are in agreement with the results of Nasir *et al.* (1986) who found differences in characters among 600 different seedling males.

Spathe length (cm). Length of spathe of various male whorl was affected significantly during both the years. The length of male spathe is given in Table IIIa and IIIb. The longest spathes were found in M₃ (84.899 cm & 90.444 cm) followed by M₅ (84.111 cm & 82.333 cm) which were statistically similar during 2001 and different during 2002. These were succeeded by M₉, M₈, M₇, M₆, M₄ and M₁ which possessed spathes of 63.444, 62.444, 61.000, 55.667, 51.778 and 46.222 cm long in 2001 and of 61.444, 60.333, 59.556, 52.000, 48.778 and 46.000 cm length in 2001. The spathes of M₂ were the shortest measuring 42.8890 and 42.000 cm during 2001 and 2002 respectively.

All the three whorls differed significantly in spathe length during both the years of study. The spathe length ranged from 49.556 to 72.815 cm and 49.296 to 71.185 cm during 2001 and 2002 respectively being maximum in W₁ and minimum in W₃.

The interaction of males × whorls was significant during both years of study. However, the lengthiest spathe of 100 cm was recorded in Whorl-1 and M₃ during 2001, whereas the spathe of Whorl-1 of M₅ was the longest (102 cm) during 2002. The variability of data was 9.87% and 9.67% during two consecutive years of study. The results

reveal that males and whorls vary in length of spathe as reported by Nasir *et al.* (1986).

Floral head length (cm). The data pertaining to length of floral head as influenced by various whorls of males is presented in Table IVa and IVb. Different males and whorls did not influence the length of floral head during 2001 yet their effect was significant during 2002. During 2001, the numerically floral head of maximum length (52.222 cm) was found M₅ followed by M₉, M₆, M₇, M₃, M₈, M₁ and M₂ which contained floral heads of 49.111, 45.889, 44.444, 43.778, 40.778, 38.889 and 36.889 cm long. During 2002, the significantly longest floral head (55.000 cm) was observed in M₃ followed by M₅, M₆, M₉, M₇, M₈, M₁ and M₂ which possessed floral head of 50.667, 46.667, 46.333, 44.333, 40.000, 38.667 and 35.667 cm length. The shortest floral head (28.556 cm & 28.667 cm) were found in M₄ during 2001 and 2002 respectively. The results are in agreement with the findings of Abdulla and Al-Ghamadi (1993).

The floral heads of maximum length (52.556 cm) were recorded in M₃ during 2001 followed by W₁ (44.667 cm) and W₂ (43.778) whereas W₁ contained the floral heads of maximum length (47.778 cm) during 2002 followed by W₂ (43.333 cm) and W₃ (37.556 cm). All the three whorls differed significantly from one another during 2002 only.

The interactive effect of males and whorls was not significant. However, the floral heads of maximum length (59.333 cm) were found in whorl-1 of M₅ during 2001 and Whorl-1 of M₃ (58 cm) during 2002. The variability in data during 2001 and 2002 was 10.141% and 6.18% respectively.

Number of strands/spathe. The data regarding number of strands/spathe is given in Table Va and Vb. The number of strands/spathe were significantly different for various males as well as in 3 whorls during 2001 but no significant differences were observed during 2002. The trend in number of strand per spathe were similar during both years. The maximum number of strands/spathe (237.000 & 236.000) was recorded in M₃ during two successive years of study. It was followed by M₉, M₇, M₆, M₈, M₅, M₄, M₂ and M₁ during both the years. The number of strands/spathe varied from 98.556 to 237.000 during 2001 and from 99.000 to 236.000 during 2002. These results are in agreement with the findings of Nasir *et al.* (1986) and Marzouk *et al.* (2002).

Similarly the maximum strands/spathe (230.880 & 203.889) was found in Whorl-2 during 2001 and 2002 respectively. It was followed by W₁ (173.852 & 176.037) and W₃ (149.593 and 148.333). It is natural phenomenon. The whorls differed significantly from each other during 2001 but no significant difference was noticed during 2002.

The cumulative effect of males × whorls was significant during 2001 but not significant during 2002. However, during both years the maximum number of strands/spathe were recorded in Whorl-2 of M₃ being 258.667 during 2001 and 259 during 2002. The data varied

Table IIa. Number of days taken for flower persistent in 3 whorls during 2001

Whorl	Seedling male									
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	Mean
W ₁	6.000	3.000	2.000	2.000	4.000	8.000	3.667	5.667	6.000	4.556 a
W ₂	5.000	2.000	2.000	2.000	3.000	5.000	3.333	4.333	3.667	3.370 ab
W ₃	3.000	2.000	2.000	2.000	2.000	5.000	4.000	3.333	3.333	2.963 b
Mean	4.667 ab	2.333 de	2.000 e	2.000 e	3.000 ce	6.000 a	3.667 bd	4.446 c	4.333 bc	

Table IIb. Number of days taken for flower persistent in 3 whorls during 2001

Whorl	Seedling male									
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	Mean
W ₁	8.000 a	4.000 bc	3.000 cd	2.000 d	3.000 cd	9.000 a	5.000 b	5.000 b	4.000 bc	4.815 a
W ₂	5.000 b	2.000 d	2.000 d	2.000 d	2.000 d	4.000 dc	3.000 cd	4.000 bc	3.000 cd	3.000 b
W ₃	3.000 cd	2.000 d	2.000 d	2.000 d	2.000 d	4.000 bc	3.000 cd	3.000 cd	3.000 cd	2.667 c
Mean	5.000 a	2.667 ce	2.333 de	2.000 e	2.333 de	5.667 a	3.667 bc	4.000 b	3.000 bd	

CV (%) = 11.44; CV % = 15.14; LSD for Males = 1.354; LSD for Males = 1.143; LSD for Whorl = 1.336; LSD for Whorl = 1.029; LSD for Male × Whorl = 1.521

Table IIIa. Spathe Length (cm) of 3 whorls of male during 2001

Whorl	Seedling male									
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	Mean
W ₁	54.333 h-m	49.600 k-o	100.000 a	63.000 f-h	103.667 a	61.667 g-i	73.667 c-e	77.000 cd	73.000 d-f	72.815 a
W ₂	45.333 lp	44.333 m-p	84.000 bc	51.667 i-m	89.333 b	54.333 h-m	61.333 g-j	63.667 c-h	62.000 d-i	61.778 b
W ₃	39.000 op	35.333 o-p	70.667 d-g	40.667 n-p	59.333 h-k	51.000 jk	48.000 l-o	46.667 l-o	55.333 h-l	49.556 c
Mean	46.222 ef	42.889 f	84.889 a	51.778 de	84.111 a	55.667 cd	61.000 bc	62.444 b	63.444 b	

Table IIIb. Spathe Length (cm) of 3 whorls of male during 2002

Whorl	Seedling male									
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	Mean
W ₁	53.000 h-l	49.000 k-n	103.000 a	57.667 h-k	102.000 a	57.000 h-j	72.000 d-f	76.000 ce	71.000 e-g	71.185 a
W ₂	45.000 l-o	42.000 m-o	87.000 b	48.667 k-n	85.000 bc	51.000 i-m	61.667 gh	61.000 g-l	63.000 f-h	60.481 b
W ₃	40.000 no	35.000 o	81.000 b-d	40.000 no	60.000 h-j	48.000 k-n	45.000 l-o	44.000 l-o	50.333 j-m	49.296 c
Mean	46.000 ef	42.000 t	90.444 a	48.778 de	82.333 b	52.000 d	59.556 c	60.333 c	61.444 c	

CV (%) = 9.87; CV (%) = 9.67; LSD for Males = 6.208; LSD for Males = 5.086; LSD for Whorl = 7.092; LSD for Whorl = .892; LSD for Male × Whorl = 10.48; LSD for Male × Whorl = 10.19

Table IVa. Floral head length (cm) of 3 whorls of males during 2001

Whorl	Seedling male									
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	Mean
W ₁	44.000	39.000	41.000	34.333	59.333	51.667	49.000	46.667	55.000	46.667
W ₂	39.000	37.000	52.333	28.333	52.667	46.000	46.000	41.667	51.000	43.778
W ₃	33.667	34.667	38.333	23.000	44.667	40.000	38.333	34.000	41.333	52.556
Mean	38.889	36.889	43.888	28.556	52.222	45.889	44.444	40.778	49.111	

Table IVb. Floral head length (cm) of 3 whorls of males during 2002

Whorl	Seedling male									
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	Mean
W ₁	45.000	39.000	58.000	34.000	57.000	52.000	49.000	44.000	52.000	47.778 a
W ₂	38.000	36.000	56.000	28.000	51.000	48.000	45.000	41.000	47.000	43.333 b
W ₃	33.000	32.000	51.000	24.000	44.000	40.000	39.000	35.000	40.000	37.556 c
Mean	38.667 e	35.667 f	55.000 a	28.667 g	50.667 b	46.667 c	44.333 d	40.000 e	46.333 cd	

CV (%) = 10.141; CV (%) = 6.18; LSD for Males = 2.324; LSD for Whorl = 3.102

3.93% in 2001 and 6.20% in 2002 respectively.

Number of flowers/strand. The number of flowers/strand was significantly affected by various seedling males as well as whorls during 2001 yet their effect of non-significant during 2002 (Table VIa & VIb). During both years, the maximum number of flowers/strand (89.111 & 95.000) was recorded in M₉. It was followed by M₈, M₅, M₆, M₇, M₁, M₃, and M₄ during 2001 which contained 84.778, 75.333, 68.667, 67.333, 61.444, 55.000 and 52.667 flowers/strand. During 2002, M₉ was followed by M₅, M₈, M₇, M₆, M₁ and M₄ which possessed 79.333, 76.889, 67.333, 64.333, 61.333, 56.333 and 55.000 flowers/strand respectively. The lowest number of flowers/strand (43.000 & 42.333) was observed in M₂ during both years. The W₂ contained number of flowers/strand (84.370 & 85.667) followed by W₁ (63.111 & 63.963) and W₃ (51.630 & 49.667). The whorl differed significantly from each other with respect to number of flowers/strand during 2001 but no significant difference was observed during 2002.

The interactive effect of males and whorls was non-significant during both years (Table VIa & VIb). However, the maximum number of flowers per strand (110.333 & 126) was recorded in M₉W₂ during both years of study. The data varied 13.27% in 2001 and 7.36% in 2002. Difference in number of flowers/strand was also observed by Nasir *et al.* (1986) who evaluated 600 males for different parameters. Likewise Marzouk *et al.* (2002) reported that number of flowers/strand were different in various males.

Number of flowers/spathe. The perusal of Table VIIa and VIIb indicate that number of flowers/spathe was not significantly affected by difference in males as well as whorls during both years of study. The maximum number of flowers/spathe was counted in M₃ (27538) followed by M₉, M₈, M₇, M₆, M₅, M₄ and M₁ during 2001 which contained 21701, 16805, 15332, 13393, 12950, 8066 and 6082 flowers/spathe. During 2002 the maximum number of flowers (23877) was found in M₉. It was followed by M₈, M₃, M₇, M₆, M₅, M₄ and M₁ which possessed 18189, 17744, 17644, 17003, 11931, 8723 and 5800 flowers/spathe. The M₂ contained the minimum flowers/spathe (4857 & 5064) during two successive years of trial. The number of flowers/spathe in different whorls also not significantly affected during both the years. However, numerically the maximum number of flowers of 20895 and 16566 were observed in whorl-2 during both years whereas minimum number of flowers (7711 & 11355) were recorded in W₃. The W₁ contained 13634 and 14071 flowers/spathe during 2001 and 2002 respectively.

The interactive effect of males×whorl was not significant both years. However, the maximum number of flowers (60847) was found in whorl-2 of M₃ during 2001 while during 2002, whorl-2 of M₉ contained the maximum number of flowers (27578). The coefficient of variation of data during 2001 was 10.319% while 12.141% variation was computed during 2002. Marzouk *et al.* (2002) reported that number of flowers per spathe were variable in various

males.

Weight of pollen grain/spathe (g). The data concerning weight of pollen grain/spathe of various males and whorls are presented in Table VIIIa and VIIIb. No significant differences existed among males as well as whorls during study period of two years. The maximum weight of pollen grain/spathe (11.805 g) was recorded in M₉ during 2001 while minimum weight of pollen grain (5.578 g) was found in M₁. The M₂, M₃, M₄, M₅, M₆, M₇ and M₈ possessed pollens of 6.478, 10.767, 6.233, 6.778, 7.011, 8.911 and 9.744 g per spathe. The M₉ ranked first with regards to weight of pollen grain/spathe while M₃ and M₈ ranked second and third. During 2002, M₃ stood first by containing 16.500 g pollen grain/spathe. It was followed by M₇ and M₉ which contained 13.667 and 12.333 g pollens/spathe. The M₂ had the least number of pollen grain which weighed 4.256 g. Although different whorls did not contain significantly different pollen grains weight, yet the W₂ possessed the maximum weight of pollen grains/spathe during both years. The pollens of W₂ weighed 11.704 and 12.678 g during 2001 and 2002 respectively. The pollen grains of W₃ weighted the least (5.574 & 6.630 g). The weight of pollen grains of W₁ was found as 7.174 and 8.444 g during two successive years respectively.

The collective influence of males and whorls was not significant during both years of study. The maximum weight of 17.800 g of pollen grains was recorded for pollens collected from whorl-2 of M₉ during 2001 whereas during 2002 the maximum pollen grains weight was found in W₂ of M₃. The data varied 18.91% during 2001 and 23.73% during 2002.

The findings suggest that different males as well as whorls vary in their ability of producing pollens and their viability. Similar findings were reported by Swingle and Nixon (1928) who found the same males high potency as compared to Ahmed and Ali (1960). Shaheen *et al.* (1989) and Al-Ghamaddi (1988) also found that seedling males vary considerably with respect to reproductive characters.

Fruit setting percentage. The data regarding fruit set percentage is given in Table IXa and IXb. The results show that fruit setting percentage varied significantly by fertilization of pollens obtained from different males and whorls. The highest fruit set (81.111%) was recorded when second whorl of cv. Dhakki was pollinated by pollens collected from M₁ during 2001. It was followed by M₂ (77.444%). However, both the males were statistically similar in fruit set. The fruit setting percentage varied from 40.611 to 81.111 percent being minimum by pollination with M₅ and maximum with M₁. During 2002, the maximum fruit set (93.556%) was recorded from M₂ followed by M₁ (68.889%) which differed significantly from one another. It ranged from 41.889 to 93.558%, indicating that males differ in their capability of producing fruits. The minimum fruit set was observed with M₃. Whorls differ significantly in fruit setting during 2001 but no significant difference amongst whorls was recorded during

Table Va. Number of strands per spathe of 3whorls of males during 2001

Whorl	Seedling male									Mean
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	
W ₁	93.667 m	102.667 m	243.333 bc	143.333 k	167.333 hi	190.667 f	205.000 e	181.333 fg	237.333 c	173.852 b
W ₂	123.000 l	143.667 k	258.667 a	168.333 hi	186.667 fg	222.000 d	253.667 ab	224.000 d	255.000 ab	230.880 a
W ₃	79.000 n	91.667 m	209.000 e	125.333 l	160.333 ij	181.333 fg	177.667 gh	154.667 jk	167.333 hi	149.593 c
Mean	98.556 i	112.667 h	237.000 a	145.667 g	171.444 f	198.000 d	212.111 c	186.667 e	219.689 b	

Table Vb. Number of strands per spathe of 3 whorls of males during 2002

Whorl	Seedling male									Mean
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	
W ₁	94.000	101.000	240.000	174.333	161.000	191.000	205.000	180.000	238.000	176.037
W ₂	124.000	141.000	259.000	186.000	187.000	222.000	253.000	223.000	258.000	203.889
W ₃	79.000	89.000	209.000	123.000	158.000	181.000	176.000	155.000	165.000	148.333
Mean	99.000	110.333	236.000	161.111	168.667	198.000	211.333	186.000	220.333	

CV (%) = 3.93; CV (%) = 6.20; LSD for Males = 5.12; LSD for Whorl = 8.094

Table VIa. Number of Flower per Strand of 3 Whorls of Males during 2001

Whorl	Seedling male									Mean
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	
W ₁	61.000	41.000	47.000	50.000	70.667	66.667	63.333	84.000	84.000	63.111 b
W ₂	71.000	56.000	72.000	76.000	90.667	95.667	83.000	104.667	110.333	84.370 a
W ₃	52.000	32.000	39.000	39.000	64.667	43.667	55.667	65.667	72.667	51.630 c
Mean	61.444 de	43.000 f	52.667 ef	55.000 e	75.333 bc	68.667 cd	67.333 cd	84.778 ab	89.111 a	

Table VIb. Number of Flower per Strand of 3 Whorls of Males during 2002

Whorl	Seedling male									Mean
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	
W ₁	65.000	39.000	57.000	53.000	80.000	56.000	64.000	66.667	95.000	63.963
W ₂	67.000	54.000	70.000	73.000	95.000	97.000	87.000	102.000	126.000	85.667
W ₃	52.000	34.000	42.000	39.000	63.000	40.000	51.000	62.000	64.000	49.667
Mean	61.333	42.333	56.333	55.000	79.333	64.333	67.333	76.889	95.000	

CV (%) = 13.27; CV (%) = 7.36; LSD for Males = 10.04; LSD for Whorl = 10.32

Table VIIa. Number of flowers/spathe of 3 whorls during 2001

Whorl	Seedling male									Mean
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	
W ₁	6685.000	5747.000	12181.000	8405.000	13193.333	14786.667	17020.000	18541.333	26149.333	13634.296
W ₂	7421.667	5884.000	60847.333	10928.000	15288.000	18241.333	19060.000	21875.000	28520.333	20896.185
W ₃	4138.667	2940.000	9585.000	4865.000	10369.333	7151.333	9914.667	9999.333	10433.333	7710.741
Mean	6081.778	4857.000	27537.778	8066.000	12950.222	13393.111	15331.565	16805.222	21701.000	

Table VIIb. Number of flowers/spathe of 3 whorls during 2002

Whorl	Seedling male									Mean
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	
W ₁	6484.000	5762.333	17598.000	7720.000	12861.333	16476.000	17464.000	18568.000	23705.667	14071.037
W ₂	6946.000	6238.333	19688.333	11481.333	14346.000	20467.000	21689.333	20656.667	27578.333	16565.704
W ₃	3970.000	3190.333	15946.667	6967.667	8585.333	14067.333	13778.333	15341.667	20348.333	11355.111
Mean	5800.111	5063.667	17744.333	8723.000	11930.889	17003.444	17643.889	18188.778	23877.444	

CV (%) = 10.319 CV (%) = 12.141

Table Xa. Fruit drop percentage in cv. Dhakki pollinated by 3 whorls of males during 2001

Whorl	Seedling male									Mean NS
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	
W ₁	38.500	35.000	60.000	54.500	59.500	61.500	42.833	58.500	41.000	50.148
W ₂	37.333	29.167	56.000	55.500	53.167	53.167	40.500	49.500	39.167	45.944
W ₃	40.000	36.000	62.333	55.000	57.000	57.000	48.667	48.167	43.000	49.685
Mean	38.611 e	33.389 f	59.444 a	55.000 b	56.556 b	57.222 ab	44.000 d	52.056 c	41.056 e	

Table Xb. Fruit drop percentage in cv. Dhakki pollinated by 3 whorls of males during 2002

Whorl	Seedling male									Mean NS
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	
W ₁	43.500	31.500	58.333	58.500	67.667	58.000	47.000	57.667	52.333	52.722
W ₂	40.500	30.000	56.500	48.500	58.883	56.833	44.667	45.667	48.333	47.759
W ₃	42.500	41.667	52.500	65.333	60.167	56.500	48.000	57.167	52.000	52.870
Mean	42.167 d	34.389 e	55.778 ab	57.444 ab	62.222 a	57.111 ab	46.556 cd	53.500 bc	50.889 bc	

CV = 9.89%; CV = 12.21%; LSD for Males = 2.526 LSD for Males = 7.482

Table XIa. Weight of fruit/bunch as affected by pollination of 3 whorls of males of cv. Dhakki during 2001

Whorl	Seedling male									Mean
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	
W ₁	7.167	6.667	6.000	6.333	4.167	6.500	7.167	6.667	6.500	6.352 a
W ₂	6.500	7.167	6.667	6.667	5.500	7.333	8.500	6.667	7.167	6.907 a
W ₃	7.167	6.167	5.500	5.500	4.667	5.833	7.500	6.667	5.500	6.056 a
Mean	6.944	6.667	6.056	6.667	4.778	6.556	7.722	6.667	6.389	

Table XIb. Weight of fruit/bunch as affected by pollination of 3 whorls of males of cv. Dhakki during 2002

Whorl	Seedling male									Mean
	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉	
W ₁	6.833	6.000	4.000	4.833	4.000	7.000	6.833	7.000	5.667	5.796
W ₂	6.333	8.000	5.833	6.667	5.333	5.667	7.000	5.667	6.667	6.352
W ₃	6.500	5.833	5.500	5.833	6.000	5.833	6.667	7.000	6.000	6.130
Mean	6.556	6.611	5.111	5.778	5.111	6.167	6.833	6.556	6.111	

CV (%) = 19.75 CV (%) = 16.33

2002. The significantly highest fruit set (66.167%) was observed from W₂ followed by W₁ and W₃ in which fruit setting 62.074% and 54.074% was observed during 2001. The W₂ and W₁ were statistically similar whereas W₁ and W₃ were also statistically alike. Although no significant difference was found in fruit setting by different whorls during 2001 yet the maximum fruit set (62.574%) was observed in W₂ followed by W₃ (62.056%) and W₁ (60.296%).

The interactive effect of males and whorls as fruit setting was not significant during 2001 yet they exhibited significant effect during 2002. The maximum fruit set of 93.50% was recorded when cv. Dhakki was pollinated with pollens of Whorl-2 from M₁ during 2001. Similarly during 2002, the maximum fruit setting (95.667%) was obtained when cv. Dhakki was fertilized with pollens collected from Whorl-2 of M₂. The variability in data was found as 13.70% during 2001 and 6.62% in 2002.

The results suggest the different males and whorls have different capability of fruit setting. Ibrahim and Shahid (1994) reported difference in effectiveness of six males in

fruit setting. Likewise El-Amer *et al.* (1993) reported variation in fruit setting due to pollen source, quality and flowering behavior of six males pollinators.

Fruit drop percentage. Data for fruit drop percentage on second whorl of cv. Dhakki are presented in table Xa and Xb. The perusal of data show that males varied significantly in fruit drop during both years of study but whorls did not differ significantly. The maximum fruit drop of 59.444% was recorded when pollinated by M₃ during 2001. It was followed by M₆ and M₅. The least fruit drop of 33.389% was found when second whorl of female cv. Dhakki was pollinated by pollens of M₂. During 2002, the maximum fruit drop of 62.222% was recorded with M₅ followed by M₄ (57.444) and M₆ (57.111%). Different whorls did not vary significantly in fruit drop percentage during both years. However, maximum fruit drop of 50.148% was found in W₁ followed by W₃ and W₂ in which fruit drop was 49.685% and 45.944% respectively during 2001. The least fruit drop of 47.759% was recorded in W₂ while highest fruit drop of 52.870% was observed in W₃ during 2002.

The interactive effect of males and whorls was non-

significant during both years. However, the least fruit drop of 29.187% and 30.00% was found when pollination was done with pollens collected from whorl-2 of M₂ during 2001 and 2002 respectively. The coefficient of variations of data was computed as 9.89% during 2001 and 12.21% during 2002.

Weight of fruit per bunch (kg). The data pertaining to weight of fruit/bunch as affected by pollination form pollen of various males and whorls are given in Table XIa and XIb. The results reveal that males as well as whorls did not differ significantly in fruit yield/bunch during both years of study. The maximum fruit yield of was obtained by M₇ both the years. It gave fruits of 7.722 kg/bunch during 2001 and 6.833 kg/bunch during 2002 which was followed by M₁ (6.944 kg/bunch) and M₂, M₄, M₈ (each gave fruits of 6.667 kg/bunch) during 2001. During 2002, M₇ was succeeded by M₁ and M₈ which gave fruits of 6.556 kg/bunch each. The minimum fruit yield of 4.778 kg/bunch and 5.111 kg/bunch was achieved by M₅ during both years. Statistically similar yields were obtained by different whorls both the years, however, maximum yields (6.909 & 6.312 kg/bunch) received by pollination from W₂ while minimum yields of 6.056 and 5.796 kg/bunch were recorded in W₃ and W₁ during 2001 and 2002 respectively.

The interactive effect of males and whorls was non-significant both years. The maximum yield of 8.500 kg/bunch was obtained by pollination of pollen from whorls-2 of M₇ during 2001 while in 2002 the maximum yield (8.000 kg/bunch) was achieved by whorl-2 of M₂. The coefficient of variation of data was 19.75% and 16.33% during 2001 and 2002 respectively. Difference in yield was reported by pollination with different males by Ibrahim and Shahid (1994) which coincide with the findings of the present study.

CONCLUSIONS

It is evident from the foregoing results that seedling males whorl wise differ greatly in morphological characters like spathe size, spathe opening day, flower persistent day,

number of strand/spathe, number of flower/strand and weight of pollen grain. Also they were variable in pollination response in fruit setting of Dhakki date.

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