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PERFORMANCE IN RELATION TO POLLINATION SYSTEMS IN PEARL MILLET

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The relative efficiencies of three pollination methods, namely, bulk sibbing, random mating and self pollination in maintaining mean performance of pearl millet populations have been investigated. These pollination methods were applied to 16 varieties and synthetics and their influence was observed on nine characters related to flowering, plant height, head length and grain yield. The present study clearly demonstrated the superiority of random pollination, even in the absence of perfect isolation distance, in both, the maintenance of the mean performance of the varieties and relative ease in multiplication of several pearl millet populations at the same location.

Pearl millet is a highly cross-pollinated crop and inbreeding causes considerable depression for yield, vigour and viability (Pokhryal *et al.*, 1966; Khadr and El Rouby, 1978 and Rai *et al.*, 1985). This fact poses considerable difficulty in deciding an appropriate pollination method for maintaining the means and variance of pearl millet germplasm and breeding populations for their major attributes. The relative efficiencies of the three pollination methods to maintain the desirable level of mean performance of pearl millet populations have been examined in the present study.

MATERIALS AND METHODS

Varieties

Sixteen pearl millet open pollinated varieties (populations) of African and Indian origin (Table 1) were planted in a 200 m^2 adjacent plots in an off-season nursery with irrigation on January 10, 1981 at the Centre National de Recherches Agronomique (CNRA), Maradi, Republic of Niger, West Africa. The soil was sandy loam applied with N and P_2O_5 at 20 and 30 kg/ha as basal dose, respectively. The row to row and plant to plant distance was kept at 80 cm and 40 cm, respectively. After 20 days of planting, the excess plants were thinned to leave one plant per hill.

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Table 1. Pearl millet open pollinated varieties used in this study

Varieties	Developed by	Varieties	Developed by
ITMV 8006	ICRISAT-Niger	FS 546	ICRISAT-Burkina
ITMV 8007	" "	Ex-Bornu	IAR-Nigeria
ITMV 8008	" "	ITMV 8010	ICRISAT-Niger
ITMV 8009	" "	ICMS 7819	ICRISAT-India
IMMV 8018	" "	FS 547	ICRISAT-Burkina
ITMV 8024	" "	3/4 Ex-Bornu	INRAN-Niger
ITMV 8025	" "	ITMV 8003	ICRISAT-Niger
3/4 Ex-Bornu	INRAN-Niger	3/4 HK (tall)	INRAN-Niger

Pollination systems

Three pollination systems were practised for each of the varieties mentioned above.

(*a*) *Bulk sibbing* : On the dates when more than 50 selfed plants produced pollen, fresh pollen was collected from as many plants as possible, thoroughly mixed and equally distributed to 50 selfing bags. Fifty single earheads with fresh stigmas, from different plants, were pollinated each day with bulk pollen described above. The bulk sibbing was repeated for five days at one day intervals, thus resulting in 250 (5x50) bulk crossed earheads in each of the varieties.

(*b*) *Random pollination* : Natural random mating was allowed within each variety without control on the flow of the pollen.

(*c*) *Self pollination* : The heads of each plant which were covered by parchment paper bags before emergence of stigma, and from where pollen was collected for bulk sibbing, were bagged again to generate seeds by self pollination.

At maturity, 250 earheads were harvested and retained for each pollination system for each of the 16 populations. Heads were threshed and seed bulks of each pollination system for each of the populations were obtained.

Experimental design

Progenies of each of the 48 seed lots were evaluated for nine characters, namely, days to first flowering (DF 1), days to last flowering (DF 2), shortest plant's height, cm (PH 1), tallest plant height, cm (PH 2), mean plant height, cm (MPH), shortest head's length, cm (HL 1), longest head's length, cm (HL 2), mean head length, cm (HLM), and grain yield, g/20 m^2 (GYG) during the rainy season (June-Sept.) of 1981 at Maradi in a split-plot design. The sixteen varieties

Table 3. Means for varieties and pollination systems

Varieties	Mean of characters								
	DF-1	DF-2	PH-1	PH-2	PHM	HL-1	HL-2	HLM	GYG
1. ITMV 8006	44.0	59.1	156.3	214.3	177.9	29.5	52.5	38.6	2256
2. ITMV 8007	42.9	57.3	144.7	204.1	169.9	23.5	42.0	32.8	1844
3. ITMV 8008	46.7	59.1	136.5	215.1	170.4	23.3	40.7	32.4	2333
4. ITMV 8009	44.9	59.0	150.4	218.5	179.6	27.5	50.8	36.7	2422
5. ITMV 8018	44.0	56.8	134.5	222.2	181.7	24.4	47.9	35.1	2133
6. ITMV 8024	44.3	59.0	134.4	200.3	169.2	22.7	35.4	28.9	1756
7. ITMV 8025	45.7	58.8	143.3	207.1	177.8	24.1	43.5	32.6	2244
8. 3/4 Ex-Bornu	48.8	60.0	88.5	168.1	123.7	30.2	50.5	38.5	2056
9. FS 546	47.1	62.4	144.2	209.4	170.2	26.5	43.1	38.5	2822
10. Ex-Bornu	49.3	60.1	153.8	212.5	185.4	24.9	39.4	33.1	2311
11. ITMV 8010	48.7	59.3	159.9	228.1	202.2	24.5	44.2	33.4	2311
12. ICMS 7819	46.8	61.5	120.4	204.9	166.3	24.7	48.4	34.5	2144
13. FS 547	50.8	64.3	134.8	207.9	170.8	30.3	52.2	38.8	2189
14. 3/4 Ex-B (Tall)	48.8	58.7	141.1	225.7	189.6	25.2	47.9	35.9	2489
15. ITMV 8003	44.9	59.1	143.2	223.8	181.7	30.9	57.0	41.6	2178
16. 3/4 HK (Tall)	46.5	59.7	124.1	214.0	175.8	29.2	53.4	39.9	2144
SE of difference between means	1.5	1.3	10.2	12.3	10.9	1.7	2.3	1.5	230
LSD (p. 05)	3.1	2.7	20.8	25.1	22.2	3.4	4.8	3.0	470
Pollination systems									
1. Bulk sibbing	45.3	58.7	139.3	205.7	173.2	25.9	44.6	34.5	2271
2. Random pollination	46.5	59.7	144.4	217.6	179.6	28.4	50.7	37.6	2371
3. Self pollination	47.7	60.5	130.8	209.7	170.7	24.7	45.1	34.2	2040
SE of difference between means	0.44	0.36	4.24	4.04	3.02	0.57	1.08	0.53	78
LSD (P. 05)	0.88	0.72	8.47	8.07	6.04	1.13	2.16	1.06	156

The first flowering dates varied from 43 days for ITMV 8007 to 51 days for FS 547 whereas days to last flowering ranged between 57 days for ITMV 8018 to 64 days for FS 547. In general, the genotypes where flower initiation took place earlier, termination of flowering also took place in the same sequence. This clearly indicated the usefulness either of these characters to describe maturity cycle in pearl millet. The height of shortest plant varied from 88 cm for 3/4 Ex-

were used as main plots and pollination systems as sub-plot treatments. The trial consisted of 3 replications with the plot size of 20 m^2 for each sub-plot treatment. The hill planting as practised in Africa was done at a distance of 1 m x 50 cm and thinned to two plants/hill 20 days after planting. All the plants in the central two rows (10 m^2) were observed.

RESULTS AND DISCUSSION

The analysis of variance of split plot design for the nine characters examined in this study is presented in Table 2. The variance due to differences among varieties was found to be highly significant for all the characters studied except for mean head length. The magnitude of variance due to varieties was higher for days to first flower than days to last flower and for shortest plant's height than tallest plant's height. The variance due to pollination system was also highly significant for all the characters with similar trend as for varieties. This indicated influence of pollination systems on the expression of populations for the characters examined.

Table 2. Analysis of variance for split plot design, varieties and pollination systems

		Mean sum of squares								
Source	df	DF-1	DF-2	PH-1	PH-2	PHM	HL-1	HL-2	HLM	GYG
Replication	2	1244.9	1476.6	19055.3	34860.1	24392.2	26.6	46.8	8.6	7472.5**
Varieties	15	46.8**	30.0**	2610.0**	1775.3**	2409.2**	71.9**	312.0**	102.6	547.1**
Error A	30	10.3	7.9	466.4	680.4	531.7	12.5	24.9	10.0	238.9
Pollination System	2	71.4**	41.5**	2252.3**	1757.5**	994.9**	177.5**	546.6**	170.7**	1385.6**
Interaction	30	9.7**	7.5**	488.3	717.9*	399.4*	24.2**	77.3**	23.6**	230.4*
Error B	64	4.7	3.1	431.9	392.6	219.4	7.7	28.1	6.8	146.0

*Significant at P= 0.05, ** Significant at P= 0.01

The population x pollination system interaction was highly significant for days to first flowering, days to last flowering, length of shortest head, length of longest head, mean head length, and grain yield. This component was significant at 5% probability for tallest plant height and mean plant height, and non-significant for the height of the shortest plant. The comparison of population x pollination system interactions with variance due to populations or due to pollination system as such indicated that the interaction component was much weaker than the main effects of population or pollination system. The means of populations averaged over pollination systems and means of pollination systems averaged over populations are summarised in Table 3.

Bornu to 160 cm for ITMV 8010, whereas tallest plant varied from 168 cm for 3/4 Ex-Bornu to 228 cm for ITMV 8010 with the mean plant height varying from 124 cm to 202 cm for these varieties, respectively. Therefore, any of these plant height traits can be used to describe the plant stature. The shortest head length varied from 22 cm for ITMV 8024 to 31 cm for 3/4 Ex-Bornu (tall). The longest head length of these varieties and their mean lengths were also in the same order. The close relation of different parameters used to describe characters such as days to flowering, plant height and head length in this study strongly supports high heritability for these characters. The grain yield varied from 1755 g/20 m^2 for ITMV 8024 to 2822 g/20 m^2 for 3/4 EX-Bornu with all other populations performing in between these.

The means of three pollination systems computed over populations for all the nine characters are also presented in Table 3. Comparison of means of different characters for the three systems of pollination indicated that the magnitude of the difference caused by the pollination systems was much lower than variability between populations themselves. Selfing and random pollination resulted into delaying first and last flowering by one and two days as compared to bulk sibbing. Plant height was adversely affected by random mating as the means of three plant height (PH 1, PH 2 and PHM) characters were highest for random mating. Self pollination appeared to have reduced the plant height.

Random pollination even without recommended isolation favourably increased head length attributes such as length of the shortest head, length of the longest head and mean head length. The crop resulting from random pollination showed longer head length compared to those produced by bulk sibbing and self pollination. For grain yield, random pollination also was found to be more favourable than the two other pollination systems employed. The study clearly demonstrated the merit of random pollination, even in the absence of perfect isolation, in maintaining the mean performance of the subjected pearl millet populations. Furthermore, random pollination was a relatively easier system to use.

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