Indian J. Genet., 48(2): 161–166 (1988)

INFLUENCE OF DIFFERENT MATING SYSTEMS ON THE PERFORMANCE OF CERTAIN POPULATIONS OF PEARL MILLET, *PENNISETUM AMERICANUM* (L.) LEEKE

B. B. SINGH* AND SANI OUSMAN

ICRISAT-Niger Cooperative Programme
B.P. 260 Maradi, Republic of Niger

(Received: May 3, 1987; accepted: October 20, 1987)

ABSTRACT

The search for an efficient and easy mating system to maintain the performance of promising open pollinated varieties and populations, available in a breeding nursery, over years, is of great significance. The paper aims to compare three practicable mating systems, namely, bulk sibbing, selfing, and random mating and their influence on five vegetative and yield characteristics in nine pearl millet populations, being maintained in Niger, West Africa. The present study reveals that random mating is the best method as it is easier to practice and it minimises the inbreeding depression and losses due to genetic drift.

Key words: *Pennisetum americanum*, pearl millet, mating systems.

Pearl millet *(Pennisetum americanum* (L.) Leeke) is a highly cross–pollinated crop, where a satisfactory method of maintaining desirable level of performance of the varieties and populations over years is being evolved. The crop does not favour inbreeding and selfing causes considerable inbreeding depression and reduction of vigour and viability [1, 2]. Planting a few rows each of several varieties being maintained by the breeder and artificial hand crossing either by bulk sibbing or any other procedure will result in genetic drift [3, 4]. With small sample size and involvement of human error, these methods are bound to result in the loss of several useful genotypes. In order to gather information on certain practicable mating systems, nine populations of pearl millet with narrow, moderate and wide genetic base were subjected to three mating systems, the results of which are summarised here.

MATERIALS AND METHODS

A brief description of the origin and development of the nine pearl millet populations used in the present study is given below:

*Present address: Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, B.H.U., Varanasi 221005.

1. Dwarf derivative composite 1 (DDC 1), developed by pooling together and random mating of tall, long headed (+40 cm) segregants from d_2 dwarf populations (INMG 3).
2. African composite (AC), developed by mass selection of 500 long (+40 cm) ear heads from INMG 1.
3. Indian composite (IC), a composite derived from INMG 2 by mass selection of 500 compact ear heads harvested from different plants.
4. Dwarf derivative composite 2 (DDC 2), developed from INMG 3 by pooling together medium headed (–40 cm) genotypes.
5. INMG 1 ICRISAT–Niger millet genepool 1, developed by three cycles of random mating involving 79 African land races and varieties.
6. INMG 2 ICRISAT–Niger millet genepool 2, derived by three cycles of random mating among 252 high tillering, medium–high stature, medium–short headed genotypes, received from ICRISAT centre in India and varieties from East African countries.
7. INMG 3 ICRISAT–Niger millet genepool 3, developed by pooling together and three cycles of random mating of 114 tall segregants from d_2 dwarf populations, namely, 3/4 Heine Keiri, 3/4 Souna, and 3/4 Ex-Bornu.
8. Composite Souna III × CIVT, a composite developed by intercrossing Souna III × CIVT, the varieties recommended for cultivation in Senegal and Niger, respectively.
9. INMG 4 ICRISAT–Niger genepool 4 developed by three cycles of random mating of 58 bristled genotypes.

During dry season 1982 (January–April), 1000 hills were planted with each of the nine populations at the spacing of 1 × 0.5 m. Two plants per hill were maintained after thinning. Irrigation was provided as and when required. All the populations were subjected to three mating systems described below.

1. *Bulk sibbing (BS) at head emergence stage.* Two ear heads per hill were covered with selfing bags as soon as they emerged from the flag leaf. At anthesis, pollen from all the heads which produced pollen on a particular day, was collected and mixed together in a large parchment bag and sufficient pollen was placed in as many selfing bags as the ear heads with fresh stigmas. Effort was made to sample intraplot variation for flowering date, height and head length by sampling large number of plants (50+) each day and by carrying out bulk sibbing repeatedly over a 10-day period. At maturity, all the bulk pollinated heads were harvested, of which 500 heads were threshed in each population separately.

2. *Selfed bulk (SB).* The selfing bags described above, after transferring fresh pollen at anthesis to the parchment bag, were replaced and stapled. At maturity, 500 selfed heads were threshed in each population.

3. *Random mating (RM).* All ear heads other than the ones used for selfing and bulk sibbing were left unbagged for random mating. At maturity, 500 ear heads were harvested from centrally located hills by discarding four border rows from all the four sides of the plots for each population.

Bulk threshing of dry ear heads in each of the three mating systems of nine populations resulted into 27 treatments.

The main trial utilising the seed material described above was sown on June 22, 1982, in sandy soil commonly used for millet cultivation in Niger, applied with 25 kg P_2O_5 and 5 tonnes/ha farmyard manure as the basal dose. The trial was laid out in split plot design in three replications with populations as main plot and mating systems as subplot treatments. Each main plot was of 60 m^2 consisting of three subplots (mating systems) of 20 m^2 each. Each subplot was arranged in four linear rows of 5 m each. The row-to-row and hill-to-hill distance was kept at 1 m and 0.5 m, respectively. Two plants/hill were retained by thinning out the extra plants 20 days after sowing. Top dressing with 30 kg N/ha was done in two split doses, first 3 days efter thinning, and second 15 days after the first application.

Observations were recorded on days to 50% flowering, plant height, ear head length, head yield, and grain yield in each subplots.

RESULTS AND DICUSSION

The analysis of variance for split plot design is given in Table 1. The populations did not differ significantly for all the characters studied, except head length. It was appropriate to examine the relative efficiency of different mating systems in the populations with comparable performance.

The influence of mating systems was obvious as this component was significant for grain yield, head yield, and flowering time. The population × mating system interaction component of variance was significant for head yield, ear head length and flowering time.

The means of various populations and mating systems along with LSD values are given in Table 2. All the populations, when averaged over mating systems exhibited similar expression for various characters examined in the present study. The top three populations for grain yield were INMG 2, INMG 3 and African composite, although their differences were statistically nonsignificant. Numerically highest head yield was recorded in INMG 2, followed by DDC 2 and AC 2. Longest head length was exhibited by INMG 1 and shortest by INMG 2. The plant height varied from 191 cm in DDC 1 to 229 cm in INMG 1. All the populations were similar in days to 50% flowering. The mating systems, as indicated by analysis of variance, did influence grain yield, head yield, and flowering time. The comparison of character means indicated that selfing resulted in delay in flowering by one day and so did random mating. Bulk sibbing and random mating were desirable for head and grain yield; both these systems were found to be better than selfing. For grain yield, random mating appeared to be significantly superior to selfing and numerically superior to bulk sibbing.

The influence of mating systems for various characters was variable (Table 3). Significant influence of mating systems was observed for grain yield in four of the nine millet populations. Selfing reduced grain yield in six populations. Random mating resulted in higher or equal grain yield in comparison with those obtained after bulk sibbing in all these populations.

Table 1. ANOVA for split plot design (mean squares)

Source	d.f.	Grain yield	Head weight	Ear length	Plant height	Days to 50% bloom
Replications	2	489359	216790	10.8	403.1	0.16
Populations	8	47611	227809	191.1**	1267.9	5.43
Error A	16	142450	451096	14.8	686.6	3.62
Mating systems	2	194326*	674198**	12.4	409.0	18.75**
Population × Mating systems	16	86166	240586	11.9*	247.0	3.88**
Error B	36	72586	120802	5.9	128.5	1.49

*, ** Significant at 0.05 and 0.01 levels, respectively.

Significant effect of mating systems for head yield was noted in IC, DDC and INMG 2, where selfing adversely affected this character. Random mating and bulk sibbing were equally effective in maintaining the population means for head yield.

Table 2. Means of populations and mating systems

Comparison	Grain yield, kg/ha	Head weight, kg/ha	Ear length, cm	Plant height, cm	Days to 50% flowering
Populations:					
DDC 1	1880	2533	46.3	191	56
AC	1920	2700	47.4	222	58
IC	1867	2811	41.5	217	57
DDC 2	1887	2722	36.8	218	57
INMG 1	1891	2633	49.1	229	58
INMG 2	2058	2944	36.0	213	58
INMG 3	1938	2378	39.3	216	57
Souna III × CIVT composite	1908	2622	44.5	197	56
INMG 4	1782	2500	41.2	208	56
LSD	377	671	3.8	26	2
Mating systems:					
Bulk sibbing (BS)	1947	2792	41.7	214	56
Selfed bulk (SB)	1805	2478	42.1	208	58
Random mating (RM)	1957	2611	43.0	215	57
LSD	148	192	1.3	6	0.7

Marked influence of mating systems on ear head length was observed in INMG 1 where random mating increased head length in most populations. Selfing had adverse affect on, ear head length, may be, due to inbreeding depression caused by selfing. The influence of mating systems on plant height was noticeable only in INMG 2 and composite Souna III × CIVT, where selfing resulted in reduced plant height. Days to 50% flowering were influenced in five out of nine populations, namely DDC 1, IC, INMG 1, INMG 2 and INMG 4 but without any definite trend. Bulk sibbing, as compared to selfing and random mating, reduced days to flowering in four out of five populations where significant influence of mating system was noted. However, in INMG 4, random mating reduced days to 50% flowering.

A critical analysis of the results obtained in the present study indicated that random mating is more or equally effective in maintaining means of the pearl millet populations over years as bulk sibbing. This system is significantly superior to self bulk which causes considerable inbreeding depression. Random mating is much easier to practice as this does not involve bagging and induced crossing, thus minimises the cost and human error. This method results in minimal genetic drift in relatively large populations [2, 3]. Even if several populations are to be maintained without the availability of perfect isolation for seed production, means of their main characters can be maintained by growing them separately in large plots, allowing random mating and discarding border rows, as was done in the present study.

Table 3. Means of different populations for various mating systems in pearl millet

Population	Grain yield, kg/ha			Head yield, kg/ha			Ear length, cm			Plant height, cm			Days to 50% flowering		
	BS	SB	RM	BS	SB	RM	BS	SB	RM	BS	SB	RM	BS	SB	RM
DDC 1	2033	1500	2107	2633	2333	2633	42	46	45	186	189	199	55	57	57
AC	1933	1880	1967	2800	2767	2833	48	45	49	228	212	226	58	58	59
IC	2050	1613	1937	3167	2200	2467	44	39	42	222	210	221	56	59	57
DDC 2	1987	1643	2030	3000	2367	2800	34	38	37	218	219	217	57	58	58
INMG 1	1817	1750	1907	2767	2667	2867	46	49	52	229	227	231	55	58	60
INMG 2	2160	1793	2220	3100	2333	3400	35	35	38	206	205	228	55	57	58
INMG 3	1987	1947	1880	2700	2300	2133	39	41	38	216	217	214	57	57	56
Souna III × CIVT composite	1820	2087	1817	2433	2867	2567	46	42	45	217	177	197	57	55	56
INMG 4	1737	1637	1773	2533	2467	2500	41	42	40	203	217	206	56	58	55
LSD		346			475			4			19			2	

BS—bulk sibbing, SB—selfed bulk, RM—random mating.

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