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HYBRID POTENTIAL OF 81A—A DWARF MALE-STERILE LINE OF PEARL MILLET

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ABSTRACT

Two sets of about 50 diverse variety-cross progenies each were crossed onto 5141A and 81A, a d_2 dwarf male-sterile line of pearl millet [*Pennisetum americanum* (L.) Leeke]. Results from yield trials showed that the 81A hybrids yielded significantly more than the 5141A hybrids. There were indications that pollen parents of high yielding 5141A hybrids will also produce high yielding hybrids when crossed onto 81A. Relatively longer heads, larger seeds and perhaps more head girth of the 81A hybrids, which matured 2–4 days later, contributed to their yield superiority over the 5141A hybrids which, however, had more tillers. Although 81A is shorter than 5141A, hybrids on 81A were significantly taller but there was no increase in lodging since the 81A hybrids have stronger stems than the 5141A hybrids. The hybrids on 81A also showed higher grain protein content than those on 5141A. Under field conditions line 5141A registered up to 65% downy mildew, whereas 81A remained free of downy mildew.

Key words: Pearl millet, male sterile, hybrid potential.

Continued long-term improvement in pearl millet hybrid yields is dependent on the breeding of new male-sterile lines (A lines) as well as pollen parents (R lines). Most of the hybrid work in India in the last few years has involved testing many pollen parents on relatively few male-sterile lines. About 60% of the hybrids under test in the recent AICMIP Advanced Hybrid Trials have been made on 5141A alone. The possibilities for genetic advance are, therefore, diminished and genetic vulnerability is increased since there is evidence that 5141A has, of late, become more susceptible to downy mildew. The breeding of new male-sterile lines has, therefore, recently been given more attention at ICRISAT.

We were able to produce a d_2 - dwarf [1] downy mildew resistant male-sterile line 81A and its maintainer 81B (also known as ICMA 1 and ICMB 1, respectively) in May 1981. The B line was developed from gamma-irradiated seed of an otherwise highly susceptible Tift $23D_2B$, and the A line by extensive

plant (A) × plant (B) crossing and intense selection for resistance in the ICRISAT downy mildew screening nursery [2,3]. At the time 81A was released there were, however, no firm data available to indicate how it compared with 5141A in hybrid potential. This paper compares the performance of 81A and 5141A hybrids based on the results from two trials evaluated in 1983 at ICRISAT Center and Bhavanisagar.

MATERIALS AND METHODS

Fifty two diverse F_3 progenies derived from intercrosses of 15 restorers were each crossed onto 5141A and 81A to produce 104 hybrids which were tested in Trial I. Forty eight F_5–F_7 progenies derived from diverse crosses were each crossed onto 5141A and 81A, producing 96 hybrids which were compared in Trial II.

Both trials were planted on 28 June, 1983 at ICRISAT Centre and on 4 July, 1983 at Bhavanisagar in a randomized complete block design with three replications. Plots were single rows, 4 m long, spaced 75 cm apart at ICRISAT Centre and 50 cm apart at Bhavanisagar. Both the locations received 40 kg N+40 kg P_2O_5/ha as the basal dose with another 40 kg N/ha side dressed within 21 days after planting.

Days to 50% flowering and grain yield were recorded on a plot basis, with samples of 5 equidistant, adjacent plants used for plant height and head length measurements. Numbers of tillers per plant were obtained from head count/plant count per plot. Thousand-seed weight was determined by weighing three samples of 100 seeds from every plot.

In another trial from a breeding programme for grain quality, the 81A and 5141A hybrids, produced by crossing 39 common high grain-protein lines, were evaluated at ICRISAT Centre in the rainy season of 1982. The trial was planted in two replications with similar plot size, spacing and fertilizer levels as described above for Trials I and II. Seed samples were ground in a Udy cyclone mill using a 0.4 mm screen. Nitrogen content was estimated using a Technicon auto analyzer [4] and the nitrogen values were converted into protein by multiplying with 6.25.

RESULTS AND DISCUSSION

The relationship between grain yields of 5141A hybrids and 81A hybrids both at ICRISAT Centre and Bhavanisagar is given in Fig. 1 for Trial I, and

in Fig. 2 for Trial II. Points above the diagonal line indicate that with the same common pollen parents, 81A hybrids yield more than 5141A hybrids. The opposite applies to those points below the line.

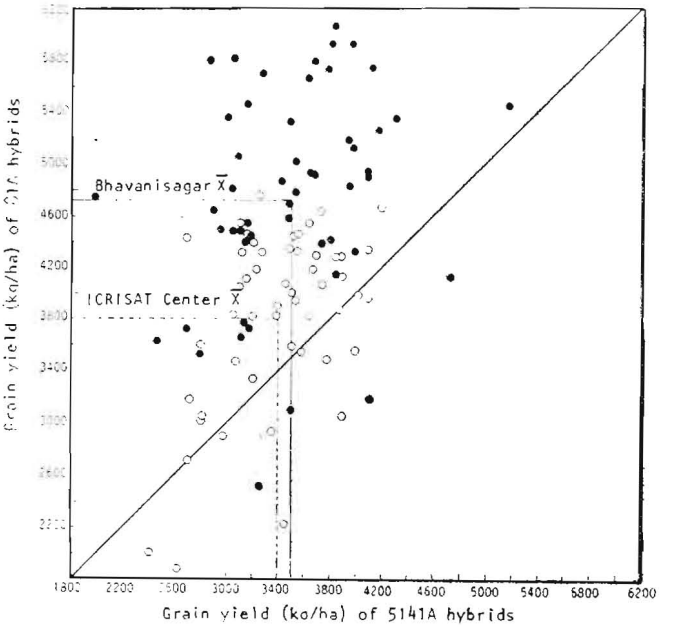

Fig. 1. Relationship between the yielding ability of 5141A and 81A hybrids at ICRISAT Centre (o) and Bhavanisagar (●) in Trial I.

In Trial I at ICRISAT Centre, in 39 out of 52 comparisons, hybrids made on 81A yielded more than the corresponding hybrids made on 5141A, whereas at Bhavanisagar, in 48 out of 52 comparisons the hybrids on 81A yielded more than the hybrids on 5141A (Fig. 1). The mean difference between the 81A and 5141A hybrids was statistically significant at both locations ($P<0.01$). The results (Fig. 1) also indicate that the yields of 5141A and 81A hybrids were not correlated ($r=0.10$ for ICRISAT Centre and $r=-0.23$ for Bhavanisagar). On an average, 81A hybrids yielded more than 5141A hybrids, and this superiority was greater at Bhavanisagar than at ICRISAT Centre (Table 1).

In Trial II at ICRISAT Centre, in 31 out of 48 comparisons, hybrids made on 81A yielded more than those made on 5141A, whereas in 41 out of 48 comparisons at Bhavanisagar the 81A hybrids yielded more than the 5141A

Table 1. Mean, standard error (SE) and range for grain yield and other characters of 5141A and 81A hybrids in Trial I

Character	Hybrid group	ICRISAT Centre			Bhavanisagar		
		mean	SE	range	mean	SE	range
Grain yield (kg/ha)	5141A hybrids	3400	±281.8	2400-4220	3510	±399.8	1970-5190
	81A hybrids	3820	±366.9	1870-4770	4730	±472.92	2510-6070
Plant height (cm)	5141A hybrids	210	±10.08	153-243	180	±4.51	164-195
	81A hybrids	224	±6.2	158-255	200	±5.81	158-223
Days to 50% bloom	5141A hybrids	49.0	±0.62	45-54	44.6	±0.78	41-47
	81A hybrids	51.4	±1.05	47-55	48.4	±0.28	46-51
Head length (cm)	5141A hybrids	23.3	±1.07	20-27	22.1	±0.73	20-25
	81A hybrids	25.0	±1.37	22-29	24.1	±0.98	22-29
Tillers/plant	5141A hybrids	2.3	±0.48	1.5-3.6	2.2	±0.30	1.4- 3.2
	81A hybrids	2.2	±0.49	1.3-4.9	2.0	±0.24	1.1- 2.8
1000-seed weight (g)	5141A hybrids	7.6	±0.34	5.8-9.5	7.2	±0.34	5.8- 8.2
	81A hybrids	8.3	±0.31	7.0-9.6	8.6	±0.36	7.0-10.2

hybrids (Fig. 2). The mean yield of 81A hybrids was significantly more than that of 5141A hybrids at both locations ($P<0.01$), with the 81A hybrids showing greater superiority over the 5141A hybrids at Bhavanisagar than at ICRISAT Centre (Table 2). The two highest yielding hybrids on 81A and 5141A at Bhavanisagar involved the same common pollinator and some of the highest yielding 81A and 5141A hybrids at ICRISAT Centre were also based on common pollinator (Fig. 2). Yield performance of 81A hybrids and 5141A hybrids was correlated in this trial at both the locations ($r=0.37^*$ at ICRISAT Centre and $r=0.46^{**}$ at Bhavanisagar).

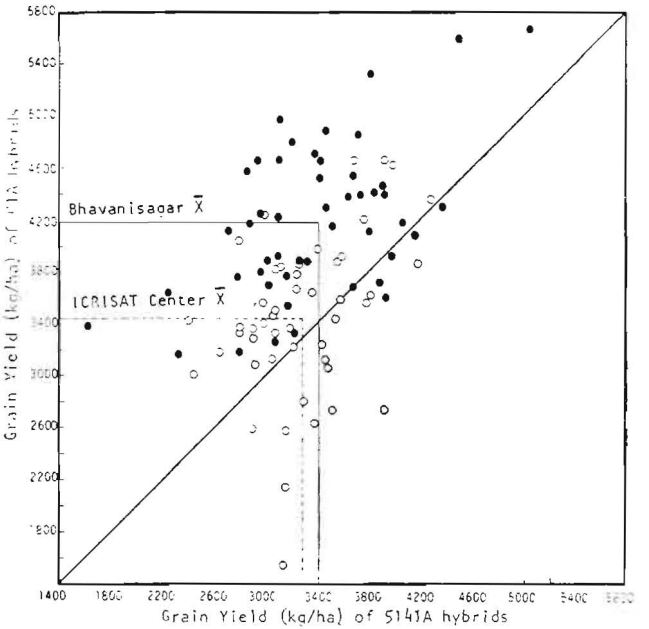

Fig. 2. Relationship between the yielding ability of 5141A and 81A hybrids at ICRISAT Centre (o) and Bhavanisagar (●) in Trial II.

Based on the nature of the relationship between 81A hybrids and 5141A hybrids in Trial II, we anticipate that a number of restorers producing high yielding hybrids on 5141A are likely to produce high yielding hybrids on 81A also. Therefore, the restorers of high yielding hybrids on 5141A should be evaluated straight away for their performance in hybrids with 81A. At the same time, there is need to further evaluate this relationship. Since the 81A hybrids were relatively more superior to 5141A hybrids in grain yield at Bhavanisagar,

Table 2. Mean, standard error (SE) and range for grain yield and other characters of 5141A and 81A hybrids in Trial II

Character	Hybrid group	ICRISAT Centre			Bhavanisagar		
		mean	SE	range	mean	SE	range
Grain yield (kg/ha)	5141A hybrids	3280	±287.2	2400-4280	3409	±368.79	1613-5066
	81A hybrids	3450	±336.2	1540-4660	4175	±542.66	2510-6070
Plant height (cm)	5141A hybrids	214	±6.85	178-250	175	± 5.3	152-201
	81A hybrids	223	±7.57	176-261	200	± 6.13	160-231
Days to 50% bloom	5141A hybrids	47.3	±3.37	30-55	44.8	± 0.86	42-48
	81A hybrids	49.1	±2.48	33-54	48.6	± 0.63	46-52
Head length (cm)	5141A hybrids	23.2	±1.26	19-28	21.7	± 0.94	18-26
	81A hybrids	25.3	±1.36	22-31	23.6	± 0.90	19-28
Tillers/plant	5141A hybrids	3.3	±0.55	2.0-4.8	2.1	± 0.32	1.6-2.9
	81A hybrids	2.9	±0.41	1.7-4.6	2.0	± 0.31	1.4-2.5
1000-seed weight (g)	5141A hybrids	8.0	±0.38	5.3-11.2	7.4	± 0.30	5.4-10.9
	81A hybrids	8.7	±0.30	6.8-13.0	8.7	± 0.40	6.7-12.3

it is suggested that there is more likelihood of developing high yielding hybrids on 81A for the South Indian locations in the State of Tamil Nadu. The higher relative yield superiority of 81A hybrids over 5141A hybrids at Bhavanisagar may be because of the more appropriate maturity of 81A hybrids than 5141A hybrids, which becomes too early there. Although 81A hybrids flower significantly later to 5141A hybrids at both the locations ($P<0.01$), the difference between the two groups of hybrids was about four days at Bhavanisagar and two days at ICRISAT Centre (Tables 1 and 2). Line 81A flowers about 10 days later than line 5141A, but the difference in maturity of the two groups of hybrids is much smaller. The relative yield superiority of 81A hybrids over 5141A hybrids may not be associated only with appropriate maturity but also with a higher general combining ability shown by 81A. Nagarajan et al. [5] compared the relative yield potential of 81A, 111A and PT 732A and although 111A flowers 6 days later than 81A at Bhavanisagar, hybrids on 81A yielded more than those made on 111A. The relative yield potential of 81A and 5141A hybrids has not been compared in the north. However, the identification of 3 promising hybrids on 81A in the first year of evaluation of 81A hybrids (R. L. Kapoor, personal communication) at Hisar shows that it holds promise in the north as well.

Head length and seed weight, on an average, measured significantly more ($P<0.01$) in the 81A hybrids than in 5141A hybrids across the trials and locations (Tables 1 and 2). Although data were not recorded, the 81A hybrids have, in general, been observed to have a larger head girth than the 5141A hybrids. These three characters perhaps made direct positive contributions to yield increases in the 81A hybrids. Though 81A hybrids tillered well, 5141A hybrids produced a higher number of effective tillers. It was observed that the 81A hybrids were significantly taller, measuring about 10-20 cm taller than the 5141A hybrids across trials and locations (Tables 1 and 2). Our observations indicate that though the 81A hybrids are taller, they tend to lodge less as compared to 5141A hybrids because 81A has a stronger stem which resists bending, and this character is also expressed in its hybrids. The short height of 81A caused by a major d_2 dwarfing gene permits the production of dwarf hybrids in combination with the d_2 dwarf pollen parents, which is impossible with hybrids made on 5141A.

The 81A hybrids were also superior to 5141A hybrids in grain protein content. In about two-thirds of the 39 comparisons, the 81A hybrids had higher protein percentage than 5141A hybrids with the average protein of the former group of hybrids being 13.2% against 12.3% for the latter group of hybrids

(Fig. 3). Many of the high protein lines combined very differently with 81A and 5141A. Consequently, there was no correlation between the protein content of 81A hybrids and 5141A hybrids (r=0.03).

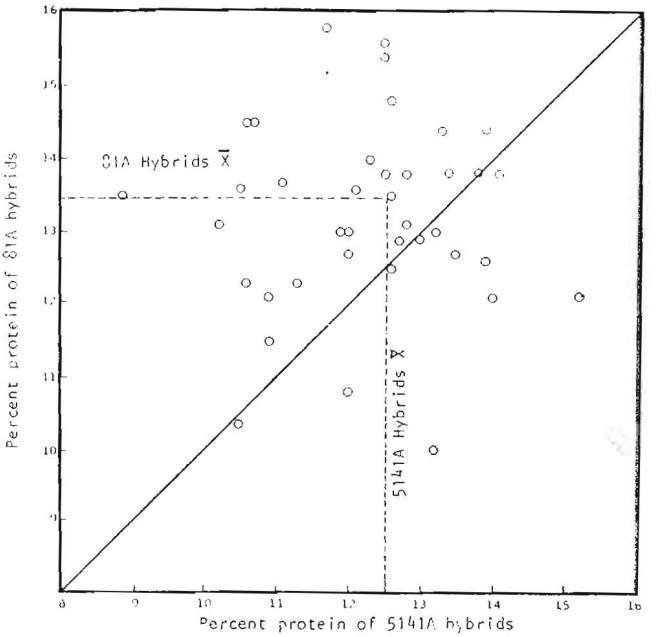

Fig. 3. Relationship between protein content of 81A and 5141A hybrids.

In crossing blocks at Bhavanisagar, ICRISAT Centre and Hisar, downy mildew incidence levels varied from 65% to above 80% in 5141A, whereas 81A was found to be free of downy mildew at all locations.

Male sterile line 81A provides opportunities both for diversifyng the genetic base of pearl millet hybrids in India, and of raising hybrid yield levels. It has remained resistant to downy mildew while 5141A has become susceptible. Furthermore, it is possible to produce dwarf hybrids with 81A which are highly resistant to lodging, by crossing with appropriate dwarf pollinators. Besides higher grain yields, 81A hybrids can also be expected to yield more grain protein than 5141A hybrids.

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