

Cytosterile diversification and downy mildew resistance in pearl millet [*Pennisetum glaucum* (L.) R. Br]

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Abstract

An investigation with line x tester mating design was carried out in pearl millet with five male sterile lines ICMA 91666, ICMA 92333, ICMA 92777, ICMA 93111 with A₁ cytoplasm and ICMA 99666 carrying A₄ cytoplasm and 11 improved promising inbreds viz., PT 5591, PT 6010, PT 6017, PT 6037, PT 6063, PT 6064, PT 6065, PT 6243, PT 6251, PT 6252, PT 6254 to study the gene action, fertility restoration and to identify the best cross combinations for high yield and its component traits and downy mildew resistance. Variance due to SCA was higher than those due to GCA variance for all the characters indicating the significance of non-additive gene action in their inheritance. Based on the *per se* performance and *gca*, the lines ICMA 91666 and ICMA 92333 and the testers PT 6065, PT 6063 and PT 6243 were adjudged as best general combiners for grain yield and its component traits, while the hybrids, namely, ICMA 92333 x PT 6063 ICMA 92333 x PT 6254 and ICMA 99666 x PT 6065 were identified as best heterotic hybrids. A₁ cytoplasm expressed good restoration with most of the pollinators as compared to A₄ cytoplasm. The two male sterile lines ICMA 92777 and ICMA 99666 contributed genes for downy mildew resistance in hybrids. Hybrids, ICMA 92333 x PT 6063 and ICMA 99666 x PT 6065 exhibited high yield, good fertility restoration percentage and downy mildew resistance.

Key words: Pearl millet, gene action, fertility restoration, heterosis, downy mildew

Pearl millet (*Pennisetum glaucum* (L.) R.Br) by virtue of its protogynous nature of floral mechanism is naturally cross fertilized and hence, this phenomenon has been successfully exploited by means of developing new hybrids and composites through heterosis breeding. In spite of its overall success, the

pearl millet hybrid programs have had occasional setbacks due to many major disease epidemics. This was due to the fact that the male sterile line Tift 23A with its Georgia cytoplasm was found to be susceptible to a few major diseases resulting in complete yield loss. One such disease epidemics occurred in the year 1971 incited by the downy mildew pathogen, *Sclerospora graminicola*, causing a severe yield loss. The utilization of diverse sources of male sterility was then felt necessary and work in this direction led to the identification of several alternatives like, A₁, A₂, A₃, A₄, A₅ cytoplasmic sources. However, the availability of suitable restorer for these sources is a limiting factor in the development of hybrids [1]. Though the A₄ and A₅ sources were found to be highly stable, their utility is restricted due to non-availability of suitable restorers. Hence, the work in this direction is attempted to make use of diverse sterile sources in the development of new pearl millet hybrids.

An experiment was carried out in pearl millet during *summer* 2010 at Department of Millets, Tamil Nadu Agricultural University, Coimbatore with five male sterile lines viz., ICMA 91666, ICMA 92333, ICMA 92777, ICMA 93111 (A₁ cytoplasmic source) and ICMA 99666 (A₄ cytoplasmic source) and eleven improved promising inbreds, PT 5591, PT 6010, PT 6017, PT 6037, PT 6063, PT 6064, PT 6065, PT 6243, PT 6251, PT 6252, PT 6254 in line x tester mating design. The resulted fifty five cross combinations synthesized, were raised along with their sixteen

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parents and the check X7 in RBD with two replications during *kharif* 2010 and evaluated for fertility restoration and downy mildew resistance. Each progeny was raised in two rows of 4 m length with the row spacing of 45 cm and plant to plant spacing of 15 cm.

Fertility restoration studies

Fertility restoration is a key factor deciding the fitness of a hybrid combination for exploitation of heterosis. Fertility restoration and seed set nature of the hybrids were observed to identify good maintainer and restorer lines. Selfing of earhead was carried out in ten plants of 55 hybrids in both the replications and seed set of each selfed earhead was scored at the time of maturity using the standard rating scale [2]. Based on seed set per cent the 55 hybrids were grouped into different restoration classes [3] (Table 1). Three hybrids viz., ICMA 92333 x PT 6063, ICMA 92777 x PT 6065 and ICMA 92777 x PT 6037 showed high fertility restoration per cent of more than 90 per cent which was grouped under strong restoration. Six hybrids viz., ICMA 91666 x PT 6254, ICMA 92333 x PT 6017, ICMA 93111 x PT 6010, ICMA 92333 x PT 6065, ICMA 99666 x PT 6037 and ICMA 99666 x PT 6251 registered more than 80-90 per cent and nine hybrids viz., ICMA 92777 x PT 6254, ICMA 92777 x PT 6063, ICMA 91666 x PT 6017, ICMA 99666 x PT 6065, ICMA 92777 x PT 6252, ICMA 99666 x PT 6063, ICMA 93111 x PT 6064, ICMA 93111 x PT 6017 and ICMA 93111 x PT 5591 recorded more than 60-80 per cent of seed set per cent and were grouped under high and moderate restoration respectively. The pollinators involved in these hybrids

can be considered as good restorer lines and those lines can be utilized to restore the fertility in different CMS lines. The lines ICMA 92333 of A₁ cytoplasm and ICMA 99666 of A₄ cytoplasm exhibited complete sterility with four testers. The former expressed sterility with PT 5591, PT 6037, PT 6243 and PT 6254 and the later expressed sterility with PT 5591, PT 6010, PT 6017 and PT 6254. These inbreds could be utilized for development of maintainer line by back crossing with the respective inbred lines.

Screening for downy mildew resistance

Fifty five hybrids along with sixteen parents were raised under sick plot conditions and screened for downy mildew resistance. The infector-row technique was adopted with 7042 (S), a universally susceptible pearl millet genotype to downy mildew disease. The susceptible genotype was raised in two rows for every six rows of the test entries in the ratio of 2:6 which served as the infector row by supplying the sufficient inoculum load. Infector rows were sown 20 days prior to sowing of the test entries for the disease build up and the disease incidence was recorded at 15th, 30th, 45th and 65th days after sowing test entries. The entries were scored as highly resistant (= 5% incidence), resistant (6-10% incidence), susceptible (> 10% incidence) [4].

The results inferred that the lines, ICMA 92777 and ICMA 99666 and the testers PT 6254, PT 6065, PT 6063, PT 6252, PT 5591 and PT 6251 recorded resistance to downy mildew. Of the lines used, ICMA

Table 1. Fertility restoration based on mean seed set percentage in pearl millet.

	ICMA 91666		ICMA 92333		ICMA 92777		ICMA 93111		ICMA 99666	
	Seed setting(%)	FR	Seed setting(%)	FR	Seed setting(%)	FR	Seed setting(%)	FR	Seed setting(%)	FR
PT 5591	5.66	LR	0.00	M	25.24	PR	60.44	MR	0.00	M
PT 6010	31.45	PR	22.92	PR	33.70	PR	85.21	HR	0.00	M
PT 6017	76.81	MR	85.54	HR	0.00	M	64.72	MR	0.00	M
PT 6037	1.62	LR	0.00	M	90.90	SR	31.97	PR	82.76	HR
PT 6063	32.01	PR	93.34	SR	78.05	MR	0.00	M	65.89	MR
PT 6064	4.20	LR	30.12	PR	7.51	LR	64.88	MR	8.49	LR
PT 6065	2.71	LR	82.92	HR	92.24	SR	0.33	LR	74.92	MR
PT 6243	18.44	PR	0.00	M	0.00	M	0.00	M	2.19	LR
PT 6251	13.59	PR	37.81	PR	38.08	PR	26.46	PR	80.56	HR
PT 6252	16.72	PR	56.55	PR	67.44	MR	58.87	PR	51.67	PR
PT 6254	87.01	HR	0.00	M	78.92	MR	6.19	LR	0.00	M

FR - Fertility restoration; M - Maintainers (0%); LR - Low restoration (< 10%); PR - Partial restoration (10-60%); MR - Moderate restoration (> 60-80%); HR - High restoration (> 80-90%) and SR - Strong restoration (> 90%)

92777 and ICMA 99666 contributed its resistance capacity to six (ICMA 92777 x PT 6037, ICMA 92777 x PT 6063, ICMA 92777 x PT 5591, ICMA 92777 x PT 6064, ICMA 92777 x PT 6065, ICMA 92777 x PT 6243) and four hybrids (ICMA 99666 x PT 6064, ICMA 99666 x PT 5591, ICMA 99666 x PT 6037 and ICMA 99666 x PT 6243) respectively, while the other hybrids which showed resistance to downy mildew includes ICMA 92333 x PT 6010, ICMA 92333 x PT 6063, ICMA 92333 x PT 6065 and ICMA 91666 x PT 6251. It could be inferred from this study that the two male sterile lines ICMA 92777 (A₁ cytoplasm) and ICMA 99666 (A₄ cytoplasm) had contributed its resistance capacity for evolving higher number of downy mildew resistant hybrids that can be utilized as parents in pearl millet breeding program. The hybrids ICMA 92333 x PT 6063, ICMA 92777 x PT 6065 (A₁ cytoplasm) and ICMA 99666 x PT 6037 (A₄ cytoplasm) exhibited good fertility restoration percentage and downy mildew resistance which indicated the scope of developing hybrids either

with the A₁ or A₄ cytoplasmic sources. This would certainly reduce the risk associated with the use of single cytoplasmic source in the development of hybrids.

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