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Short Communication

Heterotic hexaploid wheat hybrids using genic male-sterility

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Wheat is world's second most important cereal. For over 50 years many attempts have been made to develop a suitable system for producing hybrid seeds in this self-pollinated crop [1]. Main stimulus had come from the success of cytoplasmic-genetic male sterility system used in developing sorghum hybrids. In wheat too several sources of cytoplasmic male sterility (CMS) are now known but not as successful as sorghum mainly because of adverse effects of the cytoplasm and problem in fertility restoration. There was intense research on chemical gametocides too, also known as chemical hybridizing agents (CHA). But these suffer from disadvantages, like different dose rate for different parents, inconsistency of timing and rate of chemical application, cost of application, etc. Thus the useful knowledge remained as a proprietary right and is not accessible in general. Inspired by these challenges, the authors tested a homeotic partial male sterile, rust free (score of 5R compared with land race Agra local), medium tall (110 cm) mutant (p-mst) for wheat hybrid seed production and its performance, using it as a female. The purpose of this present study was to demonstrate that the mutant (used as a female), can produce normal heterotic wheat hybrids and may serve as an accepted economical method of wheat hybrid seed production.

The material consisted of two types of seeds. The female parent was a homeotic mutant and the two pollinators used were PBW 343 and Agra local. PBW 343 was also used as a control in the hybrid evaluation experiment.

The female parent was a male non-functional mutant of hexaploid wheat. It was isolated from F_3 generation of a cross, involving female Sel 212 (a wheat and rye recombinant rust resistant wheat) [2], and HD 2009 as a pollen donor. The three anthers in each floret got converted into fully fertile ovaries (Fig. 1), others were of intermediate types paralyzing the normal function of the anther. Some florets had almost normal anthers. The net result was a plant with spikes in which 5-6 seeds could set themselves under bagged conditions. In this mutant detectable anther modifications could take place even upto 100% of the florets. But in majority of cases anther modification was not full. As a result in some florets, functional anther and its viable pollens were produced with a low frequency and hence observed low rate of selfed seeds, which is enough for its maintenance. Thus, this mutant was named as homeotic partial genic male sterile genotype (p-mst). The mutant was tested for its stability of the characters for over 8 generations and found stable.

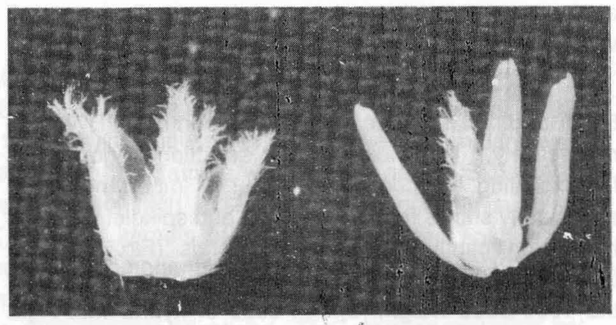

Fig. 1.

The first pollinator was PBS 343, which is a short, medium duration, has some rust resistance and amber seeds. The second pollinator was Agra local, red seeded land race with rust susceptibility.

Hand pollination was followed to make hybrid seeds between p-mst and var. PBW 343 and crossed seeds were obtained from natural cross-pollination involving p-mst and variety Agra local in rabi season of 1999-2000. There was no need for female emasculation. Top 1/3rd of the spikelets were cut and pollinated with fresh pollen of var. PBW 343. Many female spikes could be pollinated in a day.

Hybrid seeds were germinated on moistened filter papers in petri plates kept in the room at 25°C. Upon germination the coleoptiles were exposed to soft rays of the sun for a day or two. The colour of the coleoptile turned to red if the seed was a hybrid. That is red coleoptile colour was used as a marker for hybrid seedling. Few seeds, which were non-pigmented were of female type.

The seedlings with pigmented coleoptile were transplanted in the field when 7-10 days old. Two hybrids and PBW 343 (as control) were planted in randomized block design with three replications. In each block 75 cm x 3m area with three rows were considered as a plot. In each row 25 plants were transplanted. Plant to plant spacing was 12 cm and 25 cm as row spacing. Fertilizer @ N 50 kg: P 20 Kg : K 15 Kg per acre with 4 irrigations. Data were collected at maturity on all the plants. Plant biomass and seed weights were taken after drying the plants under hot peak summer sun for a week. Data was analyzed statistically and tested for significance of F value.

Data in Table 1 shows that hybrid seed yield is 50% and 80% more than the control PBW 343 respectively. This indicates that selection of genotypes for exploiting the combining ability is important. Data also clearly shows that spike length and spikelet numbers have significantly increased in hybrids (Fig. 2). But increase in the yield is also due to the increase in the 1000 seed weight [3]. In case of hybrid with Agra local tiller numbers per plant also contributes to the grain yield. Increase in plant height is reflected in the increase in the biomass of the hybrid plants.

This experiment clearly demonstrates that the homeotic mutant plant (p-mst) can be used as a female plant for producing hybrid seeds like other crops. The only criteria are that the pollinators should have good anther extrusion as well as pollen dispersal capability. The flowering should synchronise and plant height should be comparable. This mutant does not have any adverse effect of cytoplasm as compared to the CMS of wheat which in spite of longest period of investigation and use, still suffers from versatility in methods of fertility restoration [4]. CHA allows speedy hybrid development but accompanied with plant toxicity and lack of specificity. Unlike CHA, here the hybrid seed production is very convenient, effective and much economical.

Genic male sterility has enjoyed the least success due to lack of cost effective methods of maintenance [5, 6]. But here maintenance is the easiest, since it produces 6-7 selfed seeds per spike under bagged conditions. And also some percentage of selfed seeds among the hybrid seeds is not a problem at all, since the plants arising from the selfed seeds are easily distinguishable and hence spikes should be bagged to produce the pure p-mst seeds for the next cycle of hybrid seed production.

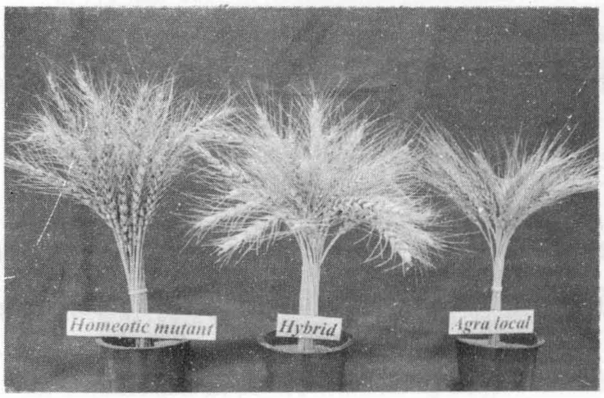

Fig. 2.

Backcross conversion experiment has shown that the mutant character of the female is easily transferable to different genotypic background with different heights. Some added advantages of the female are that the glumes remain open continuously for a few days after anthesis, which facilitates natural cross-pollination. This will permit the use of alternate rows of females and pollinators as conventionally followed to produce hybrid seeds in other crop. Its natural crossability with different pollen donors is currently being tested.

Table 1. Performance of wheat hybrids compared with PBW 343

Entries	Plant height (cm)	Tiller Nos.	Spikelet Nos.	Spike length (cm)	Total Biomass yield/plot (g)	Grain yield/plot (g)	1000 grain wt. (g)
PBW 343 (Control)	75.95	7.57	21.31	10.41	1848.7	779.0	35.5
Hybrid with PBW 343	97.73**	8.42	23.67**	13.04**	2648.7**	1166.7**	42.2**
Hybrid with Agra local	122.64**	12.70**	22.22**	12.36**	3526.0**	1383.5**	46.1**

** is significance at 1% probability leve

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