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Short Communication

Effect of wheat and maize genotypes for wheat haploid production in wheat x maize crosses

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The hybridization of wheat x maize has emerged as the most efficient technique for wheat polyhaploid production, having several advantages over other methods of wheat haploid production [1]. Despite considerable research in the area of wheat x maize system of haploid production, there is, however, still controversy surrounding the differential effect of wheat and maize genotypes on the success of haploid plant production. Whereas some groups reported a significant influence of maize genotype on the success of haploid plant production [2, 3], others report differences in crossability dependent only on wheat genotypes [4, 5].

To test whether or not there is effect of wheat and maize genotypes on haploid embryo generation and to select best wheat and maize genotypes in this context, we took ten F_1s derived from crosses between five cold tolerant (90 Zhong 65, VL 829, Druchamp, VL 738 and HS 240) and two cold susceptible (UP 2590 and UP 2425) wheat varieties. These F_1s (crosses are shown in Table 1) were crossed with five maize genotypes [Pragati, Hybrid, Inbred 1 (YHP Pant ⊗ 10-1-3-2-2-1-1-1), Inbred 2 (YHP Pant ⊗ 45-2-1-3-2-1-2-1), Inbred 3 (YHP Pant ⊗ 42-1-3-1-4-2-1-3)]. The complete parentage list can be obtained from first author. Wheat and maize plants were grown under field conditions and in glass house under artificial conditions simultaneously. Wheat x maize crossing and embryo culture was done by the method given by Laurie and Bennet [6] with certain modifications.

The ten wheat F_1s were planted in the field in RBD (Randomized Block Design) with three replications. Three spikes of each wheat genotypes were pollinated with each of the five maize genotypes in three replications. The following parameters were recorded in percentage for each replication, two-way tables were obtained and method given by Kempthorne [7] was used for analysis.

$$(1)\ \text{CFF} = \frac{\text{No. of caryopsis formed}}{\text{Total florets pollinated}} \times 100$$

$$(2)\ \text{EFF} = \frac{\text{No. of embryo carrying caryopsis}}{\text{No. of caryopsis obtained}} \times 100$$

$$(3)\ \text{HRF} = \frac{\text{Total embryos germinated}}{\text{Total embryos obtained}} \times 100$$

$$(4)\ \text{HFE} = \frac{\text{Total plants regenerated}}{\text{Total florets pollinated}} \times 100$$

where CFF, EFF, HRF and HFF denote Caryopsis Formation Frequency, Embryo Formation Frequency, Haploid Regeneration Frequency and Haploid Formation Efficiency, respectively.

To study genotypic influence of wheat and maize genotypes on production of wheat haploids, ten wheat F_1s (W_1 – W_{10}) were pollinated with five maize genotypes. This yielded seed like structures (caryopsis) and haploid embryos in all 50 wheat-mize combinations (Table 1). Analysis of variance, showed significant effects of genotypes of wheat parents (13.71*, 21.50**, 29.24**), maize pollinators (228.63**, 143.71*, 287.68**) and their interaction (9.89*, 3.10*, 3.07*) on CFF, EFF and HRF. (**significant at 1% level of significance, *significant at 5% level of significance)

The general combining ability (GCA) i.e., the average ability of a parent to induce caryopsis formation and embryo formation in a series of wheat-maize crosses was estimated for these wheat and maize genotypes. The present study used a full set of 10 wheat F_1s and 5 maize genotypes crossed in a line × tester fashion and allowed estimations of GCA effects that identified the value of each parent clearly by depicting it as deviation from the overall mean. Significant influence of genotypic differences on haploid production was observed. The wheat genotypes W_4 and W_5 were good combiners with all five maize genotypes for these parameters. Although all wheat varieties produced embryos, the wheat $F_{1,}$ W_5 (Druchamp/UP 2425) showed the highest GCA for CFF and EFF parameters (Fig. 1A).

The GCA effect seems to have greater relevance in identifying the efficient maize pollinator in our experiment. For effect of maize genotypes on plant regeneration studies, W_5 (Druchamp × UP 2425) was crossed with all 5 maize pollinators (Fig. 1B). Maize genotypes showed significant influence on EFF as it varied from 5.6 to 11.10 in different genotypes of maize. Genotypic differences in maize pollinators for the induction of haploid embryos seem to be independent

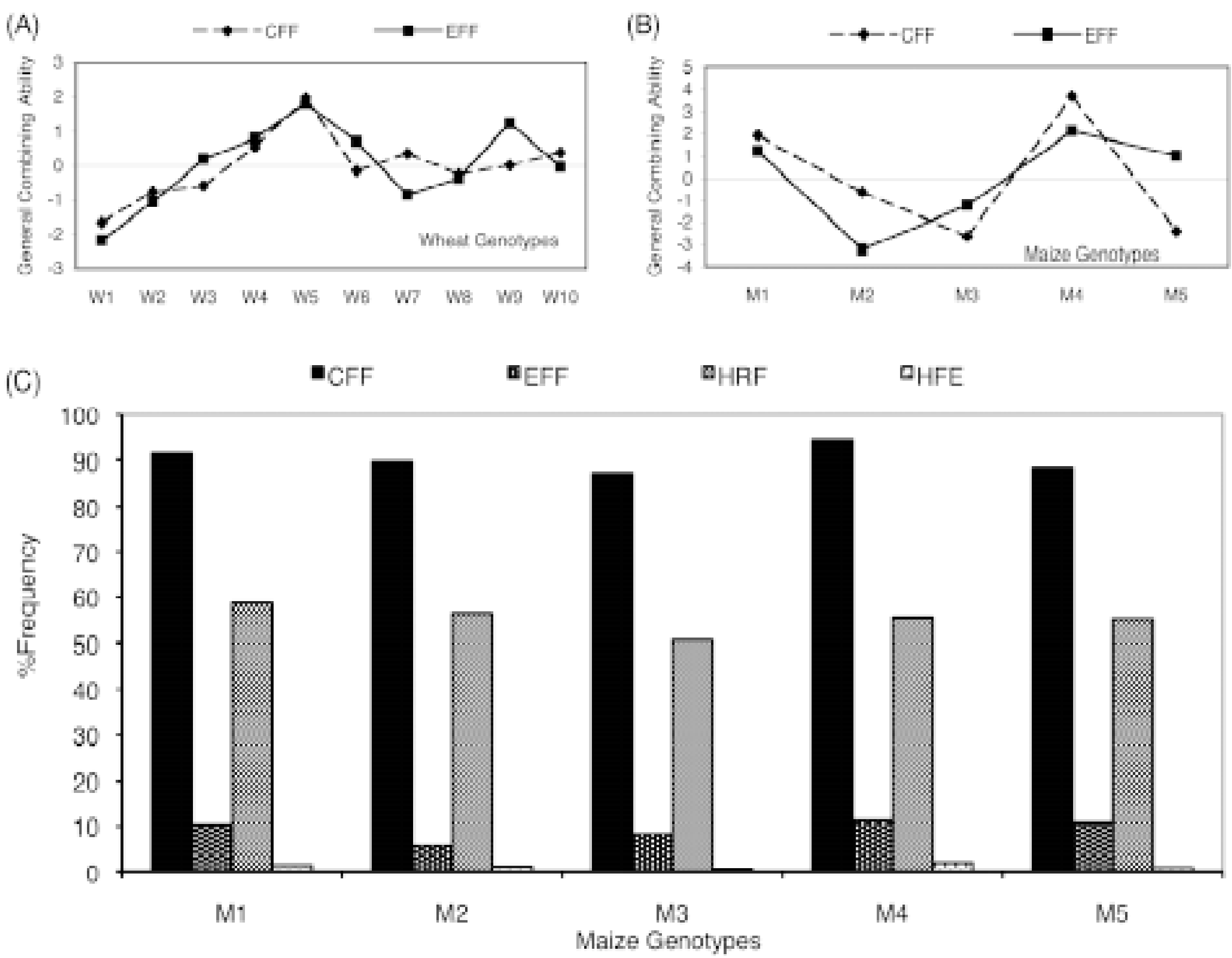

Fig. 1. (A-B) General combining ability (GCA) effects of wheat and maize genotypes on caryopsis formation frequency (CFF) and embryo formation frequency (EFF), (C) Influence of maize genotypes on CFF, EFF, haploid regeneration frequency (HRF) and haploid formation efficiency (HFE) of wheat genotype W_5 (Druchamp x UP 2425) with five different maize genotypes

Table 1. Percent mean values of CFF, EFF and HRF for all the ten F_1s of wheat (averaged over replications and maize genotypes) and five genotypes of maize (averaged over replications and wheat genotypes)

Genotypes		CFF	EFF	HRF
F_1	Cross			
W_1	90 Zhong 65 x UP 2425	86.67	5.17	51.09
W_2	90 Zhong 65 x UP 2590	87.58	6.30	51.80
W_3	VL 738 x UP 2425	87.77	7.13	53.08
W_4	VL 829 x UP 2425	88.89	8.15	54.10
W_5	Druchamp x UP 2425	90.30	9.20	55.39
W_6	VL 829 x UP 2590	88.21	8.07	52.51
W_7	HS 240 x UP 2425	88.71	6.50	52.29
W_8	HS 240 x UP 2590	88.09	7.01	52.37
W_9	Druchamp x UP 2425	88.36	8.61	54.41
W_{10}	VL 738 x UP 2590	88.74	7.32	54.65
Maize	cultivars			
M_1	Pragati	90.28	8.60	56.44
M_2	Hybrid (DEH 10503)	87.71	4.12	54.97
M_3	I Inbred 1	85.69	6.11	48.29
M_4	I Inbred 2	92.03	9.49	53.62
M_5	I Inbred 3	85.95	8.40	52.52

of differences observed for embryo regeneration. The maize genotypes that induced high embryo formation frequency did not induce a corresponding high haploid regeneration. Combining these two parameters together to obtain the proportion of florets giving haploid plantlets i.e. HFE, could serve as an appropriate index for the confirmed efficiency of maize pollinator. Based on this index, the maize genotype M_4 (Hybrid DEH 10503) ranked as the best pollinator with highest HFE of 2.05 per cent (Fig. 1C).

Thus, both wheat and maize genotypes affected different parameters in our study. Further, Hybrid DEH 10503, served as the most convenient maize cultivar in our intergeneric crossing investigations. The cross between wheat F_1 Druchamp (cold tolerant genotype) x UP 2425 with hybrid maize (DEH 10503) turned out to be the best combination to produce high number of haploid embryos capable of producing haploid plantlets. These results will facilitate further plant breeding experiments and generation of doubled haploid populations for QTL mapping of genes responsible for cold tolerance in wheat.

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