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Research Article

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Estimation of Hetrosis in F_1 Hybrids of Bread Wheat Genotypes

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Abstract

The experiment was conducted for estimation of the heterosis in F_1 hybrids in wheat genotypes. The research was conducted at the experimental field of Seed Production Development Centre, Sindh Agriculture University Tandojam during Rabi growing season 2019-20. The experiment was laid-out in randomized complete block design (RCBD) using three replications. The performance of parents and their hybrids, and heterotic effects were measured in various aspects like earliness characters (days taken to 75% heading, days taken to 75% maturity), morphological and yield traits like plant height, tillers plant^{-1}, yield plant^{-1}, and a physiology related trait; relative water content. The study consisted of six varieties and their six F_1 hybrids. The parents used were TD-1, Benazir-2013, TJ-83, Hamal, Imdad-2005, Kiran-95 and their crosses were as TD-1 × Hamal, TD-1 × Benazir-2013, Benazir-2013 × TD-1, TJ-83 × Benazir-2013, TJ-83 × Imdad, Kiran-95 ×Benazir-2013. Results revealed that all the parents and hybrids were highly significant for all the parameters studied at P<0.01 level. The F_1 hybrids Benazir-2013 × TD-1, TD-1 × Benazir-2013, TD-1 × Hamal and Kiran -95 × Benazir-2013 had showed better response in mid parent heterosis and heterobeltiosis for most of the traits except plant height. On the basis of current findings, it could be concluded that these cross combinations may be used in bread wheat for yield improvement.

Keywords: *Triticum aestivum L*, F_1 Hybrids, Heterosis, Heterobeltiosis, Bread Wheat.

Introduction

Wheat is one of the most important cereal crops worldwide (Venskey *et a*l., 2019). It has been acknowledged as the king of cereal crops for centuries because of its consumption and utilization (Pavithira and Patel, 2013). It provides food to the 36% of world population and contributing 20% food calories. In Pakistan, wheat also occupied central position among the cereals as food consumption and preparation of wide range of the food stuff. It contributes 30% to food basket of the country. In addition, it has also great value on nutrition, food security, poverty alleviation, and improved livelihoods (Channa *et a*l., 2015). The concept of heterosis on hybrid vigour in crops was first introduced by George Harrison Shull in 1908. To take advantage of this phenomenon, it is necessary to evaluate diverse germplasm to identify the best donors with desired genes, cross elite genotypes, and select the most heterotic F1s. This allows for the obtainment of desirable segregants from various cross combinations. The selection of the potential lines as parents is a major and crucial step for superior cross combinations and for the development of the new varieties with desired characteristics (Gowda *et al.*, 2010). Furthermore, heterosis helps plant breeders eliminating less effective or less productive crosses in the F_1 generation. Elimination of poor cross combination enable plant breeders to focus on few and more productive cross combinations. The selection and choice of materials as parents in hybridization programs have not contributed significantly for developing potential varieties. The parents that are genetically superior and diverse with traits of the interest are utilized for varietal development programs in wheat (Singh *et al.*, 2015). Therefore, in views of the importance of heterosis breeding and above-discussed facts, this study was designed and conducted to estimate level of the heterosis and heterobeltiosis in hybrids of six wheat cultivars. However, findings of the current research would be useful to investigate the performance and relationship of the hybrids with their parents for development of the potential variety with desired and improved characteristics.

Materials and methods:

The present research studies were conducted at the Experimental Farm of Seed Production and Development Centre, Sindh Agriculture University, Tandojam during wheat growing season 2019-20, to determine the effects of heterosis and heterobeltiosis in F_1 hybrids. Six wheat genotypes viz., TD-1, Benazir-2013, TJ-83, Hamal, Imdad-2005 and Kiran-95 along with their six F_1 hybrids viz., TD-1 × Hamal, TD-1 × Benazir-2013, Benazir-2013 × TD-1, TJ-83 × Benazir-2013, TJ-83 × Imdad-2005 and Kiran-95 × Benazir-2013 were grown and tested under field conditions. The Randomized Complete Block Design (RCBD) was used with three replications to minimizing the experimental errors and for reliability of the experiment. Plot size of 3m×1.2m (3.6m2) having five rows of each parent and their F_1 hybrids. The data was analysed for determining the differences between the treatments, parental lines and F_1 hybrids using analysis of variance (ANOVA) (Gomez and Gomez, 1984). On the other hand, percent in increase or decrease in F_1 hybrids over mid parent and better parent (heterobeltiosis) was used to estimate heterotic effects as described by Fehr (1987).

Results and Discussion:

The mean square for various traits in Table-1 suggested that most of the traits under study are highly significant at P<0.01). It suggests that parents and hybrids performed variably for most of the traits.

Table 1. Mean of square values obtained from analysis of variance (ANOVA) for various traits.

Source of Variance	DF	Mean Square					
		Days to heading (75%)	Days to maturity (75%)	Plant height	Tillers plant^{-1}	Yield plant^{-1}	Relative water content%
Replication	2	9.72	6.67	6.50	6.91	34.72	4.52
Genotype	11	47.13**	109.16**	296.27**	10.44**	24.35**	93.99**
Error	22	5.63	12.80	12.79	2.078	7.02	2.64
Total	35	--	--	--	--	--	--

**= highly significant at P<0.05 probability level

The mean performance of all parental lines and their hybrids is present in Table 2. The results revealed that minimum days to 75 % heading (74.33 days) were taken by the genotype TD-1 and hence it stood as the early maturing variety among others. However, the maximum days to 75% heading (88.4 days) were taken by the genotype Hamal and which indicating it as the late maturing variety. While among F_1 hybrids, TJ-83 x Imdad (86.86 days) stood as late and TD-1 × Benazir (81.13 days) stood as early heading hybrids. All the hybrids started heading later than all the parental lines except Hamal. Same results were reported by Ali et al. (2015). This Table further reveals that variety TJ-83 took maximum (128.26) days to maturity whereas TD-1 took minimum (110.8) days to maturity among the parents. The TJ-83 has taken maximum days for days for maturity than all the parental lines and all hybrids, this phenomenon was expected to be observed because TJ-83 is a well-known late maturing variety. Whereas cross TD-1 × Hamal took maximum (128.53) days to maturity and hybrid TJ-83 × Imdad recorded minimum (124.66) days to maturity among the F_1 hybrids. This phenomenon suggests that when TJ-83 was used in cross combination with Imdad, the early maturity trait from Imdad might have transferred because generally TJ-83 is late maturing variety. Similar results were also found by Arya *et al*. (2019). While for plant height concern, variety Kiran-95 produced taller plants (95.06cm) and variety TD-1 produced shortest plants (68.93cm) among the parents. Among crosses, hybrid Kiran-95 × Benazir produced tallest (87.53cm) plants and TD-1 × Hamal produced shortest (70.2cm) plants. The negative heterosis for plant height during the studies on wheat also observed by Jaiswal *et al*. (2010) and Khattab *et al*. (2010). The results for tillers plant-^{1} indicate that maximum tillers plant-^{1} were produced by TD-1 (13.33) and minimum tillers plant-^{1} were found for Hamal variety (10.2). For the F_1 hybrids, maximum tillers plant-1 were produced by hybrid TD-1 × Hamal (15.86) and minimum tillers plant-1 were recorded for the cross TJ-83 × Imdad (9.2). Similar results were also found in bread wheat genotypes and observed significant effect on wheat genotypes (Khan *et a*l., 2016). Additionally, results revealed that TD-1 produced the highest (21.92 g.) grain yield plant-1 variety among the parents and TJ-83 had minimum (18.24 g.) grain yield plant-^{1}. While among the F_1 hybrids, hybrid TD-1 × Hamal produced maximum (24.38 g.) grain yield plant-1 while cross TJ-83 × Imdad recorded minimum values (14.26 g.) for grain yield plant-^{1}. These results are also correlates with previously published results (Akbar *et a*l., 2007; Kumar *et al*., 2008). Relative Water Content (RWC) is an important physiological parameter which attributes with the drought tolerance of a variety. It was recorded that the parent Hamal has a high (94.06) relative water content percent and Kiran-95 has a lowest value (80.79) for the relative water content percent. While among the F_1 hybrids, TD-1 × Benazir (96.46) recorded had maximum relative water content percent and TJ-83 ×

Imdad (91.53) had minimum relative water content percent. similar results were found by Baloch *et al*. (2014). Overall, findings from this study suggesting that variety TD-1 stood as best performer and produced desired results for most of the traits. However, it also performed well crossed with the other varieties, the hybrids involving TD-1 as parent performed well. Further, genotype TJ-83 performed poor as parent and as well in cross combinations.

Table: 2. Mean performance of six varieties (Parental lines) and their F_1 hybrids for yield and yield components.

Genotypes	Days to heading (75%)	Days to maturity (75%)	Plant height (cm)	Tillers plant^{-1}	Yield per plant^{-1}	Relative water content (%)
TD-1	74.93e	110.80c	68.93e	13.33b	21.92ab	90.60d
Benazir-13	77.80de	115.27bc	89.66abc	12.20bc	21.00abc	81.53e
TJ-83	79.33d	128.27a	91.26ab	11.06bcd	18.24bcde	89.13d
Hamal	88.40a	127.00a	85.06c	10.20cd	16.25de	94.06bc
Imdad-2005	79.60d	117.93b	93.73a	10.46cd	19.93abcd	82.93e
Kiran-95	79.86d	116.00bc	95.06a	10.33cd	19.93abcd	80.73e
TD-1 × Hamal	80.13d	128.53a	70.20e	15.86a	24.38a	95.26b
TD-1 ×Benazir-13	81.46cd	125.87a	71.20de	12.46bc	21.00abc	96.86a
Benazir-13 × TD-1	84.80abc	125.20a	74.66de	10.80cd	18.55bcde	94.26ab
TJ-83 × Benazir-13	84.60abc	125.67a	76.60d	10.46cd	16.40de	93.53bc
TJ-83 × Imdad	86.86ab	124.67a	72.60de	9.20d	14.26e	91.53cd
Kiran × Benazir-13	84.26bc	127.53a	87.53bc	9.60d	16.86cde	93.60bc

Heterotic effects: The results of the heterotic effects of hybrids are present in the Table 3. The hybrids showed maximum heterosis in following traits; Benazir × TD-1 for days to 75% heading (11.48) TD-1 × Benazir for days to 75% maturity (11.35) Kiran × Benazir for plant height (-5.22), TD-1 × Hamal for tillers plant-^{1} (34.80), TD-1 × Hamal for yield plant-1 (27.74), Kiran × Benazir for relative water content % (15.32). The hybrids showed maximum heterobeltosis for following traits; TD-1 × Hamal for days 75% to heading (8.99), Kiran × Benazir-2013 for days to 75% maturity (9.93). The F_1 crosses revealed maximum heterobeltiosis for following traits; Benazir × TD-1 for days 75% to heading (8.99), Kiran × Benazir for days to 75% maturity (9.93), Kiran × Benazir for plant height (-7.92), TD-1 × Hamal for tillers plant-^{1}, TD-1 × Hamal for yield plant-^{1} (11.22) and Kiran × Benazir for relative water content % (14.8).

Table-3. Heterotic effects (mid and better parents) and percentage increase or decrease over mid parent and better parent of F_1 hybrids for various traits

Crosses	Days to 75% heading		Days to 75 % maturity		Plant height		Tillers plant^{-1}		Yield plant^{-1}		Relative water content	
	Mid parent	Hetero-beltiosis	Mid parent	Hetero-Beltiosi-s	Mid parent	Hetero-beltiosis	Mid parent	Hetero-beltiosis	Mid parent	Hetero-beltiosis	Mid paren	Hetero-beltiosi
TD-1 × Hamal	-1.51	-9.35	8.09	1.20	-8.82	-17.47	34.80	18.97	27.74	11.22	3.17	1.27
TD-1×Benazir-13	6.65	4.28	11.35	9.19	-10.20	-20.58	-2.38	-6.52	-0.69	-2.78	12.07	6.46
Benazir × TD-1	11.48	8.99	10.76	8.62	-5.84	-16.72	-15.39	-18.97	-13.56	-15.37	9.52	4.03
TJ-83 × Benazir	7.68	6.64	3.20	-2.02	-15.32	-16.064	-10.06	-14.26	-16.41	-21.90	9.60	4.93
TJ-83 × Imdad	7.77	6.79	1.27	-2.80	-21.50	-22.54	-14.49	-16.81	-25.28	-28.44	6.39	2.69
Kiran × Benazir-13	6.88	5.50	10.29	9.93	-5.22	-7.92	-18.85	-27.98	-17.61	-19.71	15.32	14.80

Conclusion: From the current study it is conducted that magnitude of heterosis and heterobeltiosis in all observed parameters showed that these inbred are useful for further breeding programme in wheat hybrids production. Talking about specifically, TD-1 could be used as potential parents in future wheat breeding performance for improved traits

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