Harnessing Winter Wheat Variability for Enhancement of Yield in Spring Wheat

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Abstract

The winter wheat gene pool which possesses huge diversity for various agronomic traits it can be exploited for widening the genetic base and improving the yield of spring wheat varieties. With a view to assess the variability for various yield contributing traits in winter wheat, an experiment was conducted at Directorate of Wheat Research Karnal, Haryana. Fifty exotic winter wheat germplasm collections were evaluated for various yield contributing traits like plant height, number of tillers meter^{-1}, spike length and thousand grains weight in a paired row experiment. The results showed that large variability was present for all the agronomic traits studied. The plant height of the genotypes ranged from 56.4 to 155 cm, while the number of tillers meter^{-1} row length ranged from 67 to 305. The spike length of winter wheat genotypes varied from 7.2 to 16.4 cm. Thousand grains weight was in the range of 19.6 to 47.96 g. Plant height is very important yield trait in winter wheat. The genotypes EC 609403 and EC 609399 were found to be of dwarf stature. The winter wheat lines viz., EC 479376, EC 493712, EC 493709, EC 609395 and EC 609401 had more number of tillers meter^{-1} (>150). Longer spikes (>12 cm) were observed in EC 479375, EC 609410, EC 609405 and EC 609400 lines. EC 528127, EC 479378, EC 609410 showed high thousand grains weight (45 g). These promising lines have successfully been utilized in hybridization for transferring the desirable traits in the agronomic base of spring cultivars for the development of spring lines with high yield and resistance.

1. Introduction

Wheat is one of the leading cereal crops providing food for major portion of world population. About 330 million ha of the globe is covered by wheat. Bread wheat *T. aestivum* is most widely grown among the three cultivated species of wheat. Bread wheat has two ecotypes viz., winter and spring wheat. The winter wheat is adapted for cultivation in temperate regions while the spring wheat is mainly grown on subtropical parts of the world. In India wheat is the most important crop after rice and occupies more than 29 mha area. With the production of about 93 mt in 2011-12, India was the second largest wheat producing country next to China sharing approximately 15% of global wheat production. In India, the cultivated varieties are of the spring type grown during the *rabi* (winter) season.

There has been a gradual increase in the productivity of wheat varieties grown in the country. But there is need to enhance the yield level in order to feed the growing population. The responsibility of researchers engaged in wheat improvement is to develop elite lines and also to increase the genetic potential of the varieties to give higher productivity and production. Winter wheat presents a huge diversity for various component traits contributing to yield and resistance against biotic and abiotic stresses. During 1960s, a breeding programme for the improvement of spring wheats by utilizing winter wheats as a novel source of variability was initiated at CIMMYT, Mexico. As an outcome of this approach, a very high yielding disease resistant variety *Veery* was developed by using a Russian winter wheat variety, *Kavkaz*. This incorporation of winter wheat gene pool in spring wheat provided a quantum jump to wheat yield. *Veery* and other winter wheat derivatives like *Attila*, *Kauz*, *Pastor*, *Baviacora* now commonly occur in the pedigree of most CIMMYT lines.

So keeping in view the need for broadening the genetic base of spring cultivars, diversity present in winter wheat, there a need to access the winter wheat variability and harness it for yield improvement of spring wheat.

2. Materials and Methods

For assessing the variability for yield contributing traits in winter wheat, an experiment was conducted at the Research

Farm of Directorate of Wheat Research Karnal, Haryana. Fifty exotic winter wheat germplasm collections from Serbia, Germany and Sweden were sown during *rabi* season 2011-12 in paired row experiment of 3 meters length. In order to meet the vernalization requirement (Chilling at 5-10°C for 14-20 days) of winter wheats, the accessions were sown on 20th October. The flowering occurred in the month of second fortnight of March and the flowering time matches with the late sown spring varieties. The winter lines were free from yellow and leaf rusts. The data were recorded for various yield contributing traits like plant height, number of tillers meter^{-1}, spike length and thousand grains weight as per the standard procedure.

3. Results and Discussion

The data revealed that large variability was present for all the traits studied. The data presented in Table 1 revealed that the plant height of the genotypes averaged at 94.83 cm and ranged from 56.4 to 155 cm. There were 146 tillers meter^{-1} row length across the genotypes and value ranged from 67 to 305. The mean value for the spike length of winter wheat genotypes was 10.62 cm and it varied from 7.2 to 16.4 cm. Thousand grains weight (TGW) was in the range of 19.6 to 47.96 g. The mean value for the thousand grain weight was 28.98 g it might be due to that the short grain filling period at the sub tropical location. On the basis of variability parameters plant height showed high variability followed by tillers meter^{-1} and thousand grains weight. Lowest variability was recorded for spike length (Table 1)

On the basis of mean performance of each genotype presented in Table 3 suitable genotypes were identified for each trait. The genotypes EC 609403 and EC 609399 were found to be of dwarf stature. The winter wheat lines viz., EC 479376, EC 493712, EC 493709, EC 609395 and EC 609401 had more number of tillers meter^{-1} (>150). Longer spikes (>12 cm) were observed in EC 479375, EC 609410, EC 609405 and EC 609400 lines. High thousand grains weight (>45 g) was observed in EC

Table 1: Mean, range and parameters of variability for various traits

S. No.	Traits	Mean	Range	Standard Deviation	CV%	Standard Error
1.	Plant height	94.83	56.4-155	38.50	26.33	5.50
2.	Tillers meter^{-1}	146.24	67-305	20.91	22.05	2.99
3.	Spike length	10.62	7.2-16.4	1.96	18.45	0.28
4.	1000 Grains Weight	28.98	19.6-47.96	6.35	21.93	0.91

Table 2: Suitable parents for various yield traits

S. No.	Traits	Winter wheat
1.	Plant height	EC 609403, EC 609399
2.	Tillers meter^{-1}	EC 479376, EC 493712, EC 493709, EC 609395, EC 609401
3.	Spike length	EC 479375, EC 609410, EC 609405, EC 609400
4.	1000 Grains Weight	EC 528127, EC 479378, EC 609410

Table 3: Performance of all the genotypes for various traits studied

S. No.	Name	Tillers meter^{-1}	Plant height (cm)	Spike Length (cm)	TGW (g)
1	EC 429374	145.0	117.8	13.6	31.40
2	EC 439779	147.0	113.2	9.6	31.40
3	EC 479375	159.0	139.0	16.4	35.60
4	EC 479375-1	132.0	105.0	9.6	35.40
5	EC 479375-2	135.0	100.4	11.8	35.20
6	EC 479375-8	136.5	90.0	8.0	33.28
7	EC 479376	305.0	139.0	11.8	27.20
8	EC 479378	167.5	120.0	10.6	45.40
9	EC 479379	179.0	129.8	8.0	32.00
10	EC 493707	134.0	100.0	11.4	34.60
11	EC 493709	245.0	130.0	11.0	30.20
12	EC 493712	226.0	139.0	12.0	31.00
13	EC 528127	169.0	103.6	12.8	47.96
14	EC 528128	139.0	84.0	11.2	30.80
15	EC 609395	178.0	81.0	9.7	22.84
16	EC 609397	176.5	83.6	10.0	21.32
17	EC 609398	150.0	65.8	11.8	25.48
18	EC 609399	132.5	56.4	9.0	19.60
19	EC 609400	155.0	91.6	14.2	22.60
20	EC 609401	157.5	96.0	9.8	23.92
21	EC 609402	106.5	70.8	9.4	27.64
22	EC 609403	140.0	59.0	8.2	27.20
23	EC 609404	125.5	78.2	8.8	24.68
24	EC 609405	150.0	84.4	14.8	22.68
25	EC 609406	112.5	94.4	10.8	22.64
26	EC 609407	138.5	90.6	10.2	21.24
27	EC 609408	130.0	94.0	10.0	22.88
28	EC 609409	110.0	83.0	8.8	25.40
29	EC 609410	163.0	95.0	14.4	41.76
30	EC 609411	134.5	95.0	11.6	36.96
31	EC 609412	138.5	76.8	10.0	27.68
32	EC 609413	115.5	84.0	10.2	24.00

Continue

33	EC 609415	121.5	88.0	8.2	25.00
34	EC609396	127.5	102.8	9.3	23.08
35	FAWWON-IR33	119.5	89.2	11.2	19.60
36	FAWWON-IR-61	114.0	82.8	7.2	21.96
37	HLWSN 5032	220.0	155.0	12.8	31.20
38	HLWSN 5047	132.5	98.4	9.6	28.24
39	HLWSN 5048	138.0	92.0	12.2	35.12
40	HLWSN 5051	133.5	94.0	11.6	28.95
41	HLWSN 5069	124.0	100.4	8.4	35.16
42	HLWSN 5264	144.0	88.0	12.4	30.96
43	HLWSN5041	117.5	81.6	10.4	24.16
44	IRTN 46	128.5	66.6	10.2	22.15
45	Marton Vasur 9	67.0	82.2	10.2	30.72
46	Mv Emese	132.5	75.8	7.8	28.16
47	Mv Emma	142.5	88.8	10.8	27.28
48	Mv Magdalema	180.0	88.8	11.4	26.48
49	Mv Megavasu	134.0	94.8	8.6	34.40
50	Mv Platos	102.5	82.0	9.0	34.08

528127, EC 479378, EC 609410 (Table 2) Spring×winter gene pool recombination has transmitted a higher number of grains through either a higher number of spikes m^{-2} or through bigger spikes (Villareal et al., 1994, 1995). Winter wheats have successfully been utilized in hybridization for transferring the desirable traits in the agronomic base of spring cultivars for the development of spring lines with high yield and resistance to biotic and abiotic stresses.

For harnessing the winter wheat potential Directorate of Wheat Research is successfully running the spring×winter wheat hybridization programme which is the a novel approach for enhancing the genetic variability to raise the yield levels of spring wheat. For the past 10 years, around 50 F_2 crosses are shared with the centres located in NWPZ (North Western Plains Zone), NEPZ (North eastern Plains Zone) and CZ (Central Zone) for exposing the segregating materials under biotic and abiotic stresses to make individual plant selections so as to harness the variability generated in spring×winter wheat hybridization. During the year 2011-12,% utilization of spring×winter crosses varied from 22 to 100% for yield components and disease resistance (Tiwari et al., 2012).

4. Conclusion

The genotypes EC 609403 and EC 609399 were found to be of dwarf stature. The winter wheat lines viz., EC 479376, EC 493712, EC 493709, EC 609395 and EC 609401 had more number of tillers $meter^{-1}$ (>150). Longer spikes (>12 cm) were observed in EC 479375, EC 609410, EC 609405 and EC 609400 lines. EC 528127, EC 479378, EC 609410 showed high thousand grains weight (45 g). These promising lines have successfully been utilized in hybridization for transferring the desirable traits in the agronomic base of spring cultivars for the development of spring lines with high yield and resistance.

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