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Study on potentials of triticale as an alternative of wheat in India

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Abstract

Triticale is the first man made cereal developed to combine yield potential of wheat with rye. In changing climatic conditions of North Western Plain Zone (NWPZ) of India triticale can be an alternative to wheat if certain shortcomings of this crop are corrected. In this study fourteen genotypes of wheat and triticale are evaluated for genetic variability. Significant variability was found for all the yield attributing traits among these genotypes. High heritability and genetic advance was also noticed for grain yield, biological yield and plant height. Comparison of triticale with wheat genotypes gave an idea that yield potential of triticale can be improved by modifying these genotypes for biological yield, plant height and grain yield itself.

Keywords: Genetic variability, NWPZ, triticale, wheat, yield potential

Introduction

Food is one of the basic needs of all organisms on this planet. Every organism including human depend on plants for nutritious diet. Among all crop plants, cereals and pulses have more importance in our diet. The progress of every country is based on their food production industries which are directly based on agriculture. In past century, scientist have tried and got success in development of improved varieties of cereals such as rice, maize and wheat. Among these three cereal crops, wheat (*Triticum aestivum* L. em. Thell) is the only polyploidy species which is cultivated all over the globe under different temperature and water regime conditions. The importance of this crop can be realized with the fact that around 766 million ton of wheat is produced annually (FAO, 2019) [4]. Development of fertilizer responding dwarf varieties and improved management practices are the key factors of improved wheat production. But at present the annual wheat production is increasing with a speed which is quite low than global population growth rate (Ray *et al*., 2013) [15]. The global population is expected to reach around 10 billion in just next 30 years which will lead to huge hunger (Hickey *et al*., 2019) [6]. Under such situation there is quick need of development of varieties which can tolerate the changing climatic condition and have higher yield potential. But at present wheat is facing a problem of yield stagnation due to exploration of already existing genetic variability among wheat germplasm (Ray *et al*., 2012) [14]. This stagnation barrier can be break if new source of variability is introduced in wheat breeding programme. Further North western plain zone of India is facing serious challenges of heat and drought stresses. Introduction of new species which can tolerate the changing environment condition and has a potential of higher yield than wheat can be an alternative strategy. For this, scientists have developed first man made cereal, triticale (X *triticosecale* Wittmack) by crossing wheat spikes with rye (*Secale cerale* L.) as a pollen parent (Wilson, 1876) [20]. The idea behind this was that rye has more genes for abiotic stress tolerance which can be combined with higher yield potential of wheat. Although triticale was not adopted by people for a long time but in recent years scientists have found that triticale genotypes have more diversity and stability under changing environmental conditions (Barnett *et al*. 2006; Kozak *et al*., 2007; McGoverin *et al*., 2011) [3, 9, 10]. Various studies have shown that triticale are more tolerant to biotic and abiotic stress and have better nutritional food and feed quality than wheat (Peña, 2004; Niedziela *et al*. 2014) [13, 12]. These studies have attracted the interest of breeders to improve triticale genotypes as a potential crop of coming era. It is also used in wheat breeding where triticale can be used as source of genetic variability and mapping population in gene tagging. Keeping these things in mind the present investigation was carried out to compare genotypic variability among wheat and triticale genotypes and to find out traits which can be targeted to make triticale a potential alternative of wheat.

Material and Methods

Experimental material

The first objective of this investigation was to find out genetic variability among wheat and triticale genotypes for various morphological traits including grain yield. For this seven released varieties of each group were used. Most of the selected wheat varieties are regularly grown by Indian farmers. Bread wheat genotypes included in this study were namely, WH 1080, WH 1105, WH 1142, PBW 550, HD 3086, DBW 88 and Raj 3765. Among triticale group we selected TL 3001, TL 3002, TL 3003, TL 3004, TL 3005, TL 2942 and TL 2969.

Experimental design and layout

The research was conducted at Research area of Wheat and Barley Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar. The experiment was carried out using Randomized Block Design (RBD) with three replications. All the genotypes were sown in four rows of 2.5 m length with 22 x10 cm^2 spacing. To eliminate any biasness all the genotypes were grown with recommended package of practices.

Data collection and analysis

Data related to grain yield and component traits were collected from all the genotypes. Only middle two rows were used for data collection to avoid the border row effect. For this, five plants were selected randomly from each genotype per replication. In this study, data was collected for major ten morphological traits i.e. days to heading (DH), days to maturity (DM), plant height (PH), number of effective tillers per plant (TP), spike length (SL), grains per spike (GS), grain yield per plant (GY), biological yield per plant (BY), harvest index (HI) and thousand grain weight (TGW). The data collected from five plants was averaged to make it more valuable. Data was analyzed using standard statistical programmes to find out analysis of variance (ANOVA), genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV).

Results and discussion

Analysis of variance (ANOVA) revealed that the mean sum of squares of various traits *viz*. days to heading, days to maturity, tillers per plant, spike length, grain yield per plant, biological yield, harvest index, number of grains per spike and thousand grain are significant for these genotypes which indicated the presence of genetic variability among these wheat and triticale genotypes (Table 1).

Data presented in table 2 revealed that under both the environments phenotypic coefficient of variation (PCV) is higher than genotypic coefficient of variation (GCV) which means there is significant environment variations also present. Highest GCV and PCV were recorded for grain yield itself which represented maximum variability for this trait. Among the remaining traits, biological yield per plant, spike length, effective tillers and harvest index were also possessing high genotypic and phenotypic variability. Days to heading and days to maturity had minimum GCV and PCV. Similar results for genetic variability were also found by Thapa *et al*. (2018) and Kaur *et al*. (2019) [17, 8]. Both wheat and triticale genotypes have significant genetic variability for yield and attributing morphological traits (Upadhyay *et al*., 2019; Balážová *et al*., 2014) [19, 2]. This variability can be used in further improvement of wheat and triticale genotypes. This variability can be utilized in development of superior hybrids as triticale has shown significant heterosis (Tripathi *et al*., 2011; Yildirim *et al*., 2014; Ferrari *et al*., 2018) [18, 21, 5].

In the present study it was noted that phenotypic variability is higher than genotypic variability which represented environmental influence on these traits. Selection of genotypes is productive only if the concerned trait has a high heritability and genetic advance (Johnson *et al*., 1955) [7]. The general trend of heritability in broad sense and genetic advance is also calculated in this study. Although maximum variability was recorded for grain yield but maximum heritability (93.39%) along with highest genetic advance (20.92%) was noticed in biological yield per plant. Plant height and grains per spike also had high heritability than grain yield. Minimum heritability was reported for spike length (67.83%). Similar studies in past reveals that selection for grain yield is effective when we use these traits as selection criteria (Naik *et al*., 2015; Azimi *et al*., 2017; Sharma *et al*, 2018; Upadhyay *et al*., 2019) [11, 1, 16, 19].

Mean value of different traits is used to get an idea of the traits which are lacking in triticale due to which yield potential of triticale is lower than wheat (Figure 1). It is clear from this figure that average grain yield of triticale (20.2 g) is quite lower than wheat (31.4 g). Lower biological yield, harvest index, thousand grain weight and spike length are the main cause of this difference. Other than these traits, triticale genotypes are tall in nature due to which these are less responding to fertilizer and water applications. Introduction of dwarfing gene can overcome this problem.

Table 1: Analysis of variance for yield and component traits for wheat and triticale genotypes

Source of Variations	Degree of freedom	Mean Sum of Squares									
		DH	DM	TP	PH	SL	GY	BY	HI	GS	TGW
Replication	**2**	2.05	1.27	0.33	11.12	0.85	1.85	1.43	7.42	10.85	1.21
Treatment	**13**	25.94*	48.89*	7.01*	343.74*	4.39*	114.92*	339.23*	65.75*	276.94*	24.97*
Error	**26**	1.28	3.40	0.99	9.63	0.60	4.74	7.82	5.99	9.78	2.09

*Significant at P≤0.05

Table 2: Range, coefficient of variability, heritability and genetic advance of different traits

Trait	Range	GCV	PCV	H^2	GA	GA (%) of mean
DH	89.0-98.0	3.08	3.31	86.56	5.49	5.92
DM	137.0-150.0	2.71	2.99	81.69	7.25	5.04
TP	12.0-17.0	10.50	12.83	67.01	2.39	17.71
PH	86.7-121.1	9.79	10.20	92.04	20.85	19.34
SL	11.6-15.9	8.62	10.46	67.83	1.91	14.62
GY	18.5-35.1	23.49	24.96	88.56	11.74	45.54
BY	46.0-78.8	16.22	16.78	93.39	20.92	32.28

HI	31.9-46.1	11.29	12.88	76.88	8.06	20.39
GS	52.1-82.7	13.83	14.57	90.10	18.45	27.05
TGW	32.9-41.9	7.38	8.33	78.47	5.04	13.47

DH: days to heading; DM: days to maturity; PH: plant height (cm), TP: number of effective tillers per plant, SL: spike length (cm); GY: grain yield per plant (g); BY: biological yield per plant (g), HI: harvest index (%); GS: grains per spike; TGW: thousand grain weight (g); GCV: genotypic coefficient of variability; PCV: phenotypic coefficient of variability; H^2: Heritability in broad sense (%); GA: genetic advance

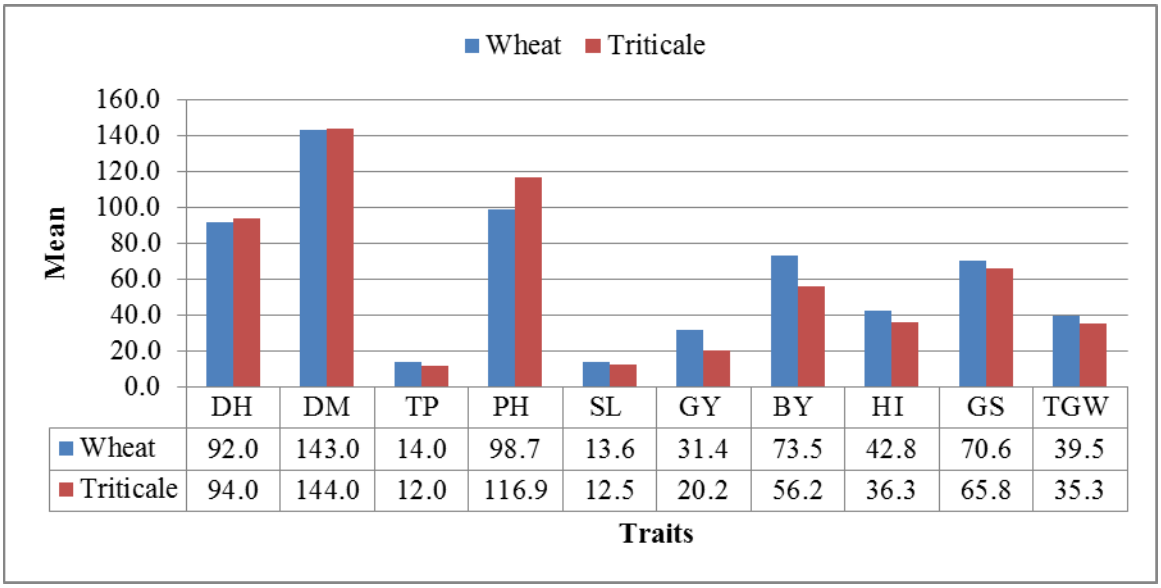

Fig 1: Comparison of wheat and triticale genotypes based on mean values of different traits

Conclusion

It is clear from this study that there is significant genetic variability among wheat and triticale genotypes for yield and its attributing traits which can be utilized by breeders. Further under the changing climate it will be more rewarding if the breeders try to improve triticale genotypes as it is more tolerant to biotic and abiotic stresses. Plant height, biological yield, spike length and thousand grain weight are the main yield attributing traits which require breeders' attention.

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