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DELAYED PLANTING AND GENOTYPE AFFECT GRAIN PROTEIN AND YIELD OF WHEAT

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ABSTRACT

Recently, climatic change has supported delay for some days in the previously suggested planting time of wheat in Pakistan. Delayed planting can also improve grain protein contents. Grain protein in wheat is a major source of plant protein in human food and therefore, grain quality is decided on grain protein. Grain protein and yield of wheat are affected by environmental conditions and can be regulated by planting time besides genetic factors. In this study, three wheat genotypes viz. Aas-2011, Sehar-2006 and AARI-2010 and two planting times viz. December 1 and 15, were investigated to determine the planting impact on grain protein and crop productivity. Significant increase in grain protein (19% higher) was recorded in late planted wheat than early one. Wheat genotypes also varied in protein contents. Genotypes Aas-2011and Sehar-2006 proved superior with 16% more grain protein content over AARI-2010. Thousand grain weight was significantly affected by planting date and genotype. Grain protein was found non-significantly negatively correlated (r = - 0.1789) with grain yield (n = 24). Grain yield and biomass did not vary significantly with some days delay in planting time and genotypes. It is evident from the results that optimum grain protein in wheat can be attained by considering appropriate planting time and genotypes.

Key words: Grain protein, grain yield, planting time, genotype

INTRODUCTION

Grain protein and yield are two very important traits in bread wheat which are controlled by genetic factors. Moreover environmental conditions can also significantly affect their expression (Groos *et al.*, 2003). Globally, several billions of people rely on wheat for substantial part of their diet. Despite the relatively low grain protein (8-15%) wheat still provides as much protein for human and livestock as the total soybean crop at about 60 million tones per annum (Shewry, 2000). Therefore, nutritional importance of wheat protein is very important, particularly in less-developing countries where bread, noodles and other products provide a substantial part of diet. Quality of protein is decided on protein it contains. Protein is one of the most important building blocks and takes part in metabolic processes. Wheat breeders generally select for protein content in their research programme (high protein for bread making and low protein for feed and other uses), however, the current range of protein in commercial cultivars is limited. This limited variation has led to researchers for high protein genes in more exotic germplasm. Environmental impact accounts for two-third of variation in grain protein. Therefore, genotypic and environmental impacts can greatly affect the quality of wheat grains (Shahzad *et al.*, 2007; Shewry, 2009).

Recently, some days delay in the previously suggested planting time of wheat is recommended due to climatic change in Pakistan. The delayed planting can improve grain quality due to increase in grain protein. Planting time is one of the major components of production technology which can significantly affect yield and quality of wheat in a region by affecting the environment. Generally, delay in wheat sowing after 20th November causes yield reduction. Longer duration of growth generally results in higher production. However, delayed planting can be managed by various agronomic practices such as increase in seed rate for late-sown crop usually gives good yield (Wajid *et al.* 2004). It has been found that delayed planting results in the increased grain protein contents (Yadava and Singh, 2003; Abdullah *et al.*, 2007). The understanding of planting wheat at the optimum time is, therefore, very important due to the impact of climatic change of habitats not only from agro-technical point of view but also from economical aspects (Soomro *et al.*, 2009). Yan *et al.*, (2008) reported that the highest protein content and grain yield can be produced by planting wheat crop at proper sowing time.

In Pakistan, farmers are generally cultivating wheat crop with the main emphasis on higher yield of genotypes only without caring much for grain quality. Recently, local climatic change has delayed the previously recommended planting time for some days and this delay in planting can be beneficial to improve protein contents in wheat grains. The present research work was, therefore, aimed to determine whether the delayed planting and wheat genotypes could positively influence grain quality and yield or otherwise under changing agro-climatic conditions of Faisalabad, Pakistan.

MATERIALS AND METHODS

The field experiments were conducted at the research area of Nuclear Institute for Agriculture and Biology (NIAB) during 2012-13. The experiment was laid out in a randomized complete block design (RCBD) with split plot arrangement, with planting dates as main plots and genotypes as sub plots. There were three replications having a plot size of 1.6 m x 5 m. The treatments were two planting dates (1st December and 15th December) and three genotypes (AARI 2010, Sehar 2006 and Aas 2011). Crop was sown with a tractor-driven rabi drill. Nitrogen (N) and phosphorous (P) were applied @ 120 and 100 kg N and P_2O_5 ha^{-1}, respectively. Half N and full P were applied at sowing and the remaining half N was given at first irrigation. All other agronomic practices such as hoeing, irrigation, weeding, etc. were kept uniform for all the treatments.

At crop maturity, area of one square meter was harvested from each plot. Spikes were threshed to separate the grains which were then weighed. Grain yield was converted into kilogram hectare^{-1}. Other traits measured were plant height, spike length, number of spiklets per spike. The quality characters examined were protein and total N contents. Grain protein was determined using Micro kjeldahls' apparatus (Jackson, 1960). Data collected were analyzed using Statistix 8.1 software and means were compared using Least Significant Difference (LSD) test (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Mean values of different growth, yield and quality traits of different wheat genotypes were compared under varying planting times (Table I). Significant ($p < 0.01$) increase in grain protein was recorded for wheat genotypes planted on December 15 with 15 days delay in sowing than December 1. Although higher grain weight, biomass and grain yield was recorded in early but the difference was non-significant. It may be due to the better environmental conditions for optimum crop growth and development but non-significant differences might be attributed to the reason that both the plating times were late as compared to the previously recommended plating time (1 November to 20 November) under Faisalabad, Pakistan conditions. An overall grain yield decline of 409 kg ha^{-1} was recorded in late planting (3855kg ha^{-1}) than early one (4264kg ha^{-1}), resulting in a daily yield loss of 27 kg ha^{-1} over the early harvest (Table 2). The reduction in yield may be more severe when there is delay in planting as compared to normal planting time as reported by Sial *et al.*, 2005 and Arain *et al.*, 1999. Genotypes did not vary regarding grain yield (3776-4361 kg ha^{-1}) which means that genotypes behaved in a similar pattern at different planting dates. Similar trend was recorded for total biomass production. It ranged 951-1127 and 1017-1057 kg ha^{-1} for planting time and genotypes, respectively. Grain yield of wheat reduced with delay in planting as the duration of crop growth and development becomes shorter. Early planting gave higher grains than late planting. Similar results were reported by Wajid *et al.*, (2004).

Total number of productive tillers m^{-2} did not vary for different genotypes at varying planting dates (Table I). It ranged 382 to 391 m^{-2} for planting dates and 340-458 m^{-2} for different wheat genotypes (Table II). However, grain weight tiller^{-1} and thousand grain weight differed significantly with varying planting dates and genotypes. Higher grain weight tiller^{-1} (1.15 g) and thousand grain weight (38.2 g) was recorded in early planting than late harvest (1.0 and 33.1 g, respectively). Among genotypes, maximum grain weight and thousand grain weight was produced by Sehar-2006 (1.21 and 39.86 g) followed by Aas-2011 (1.13 and 35.9 g) and AARI-2010 (0.9 and 31.1 g). The only interaction between planting date and genotype was found significant for thousand grain weight (Fig. 1). The interaction early planting x Sehar-2006 (44.14 g) and early planting x Aas-2011 resulted in higher thousand grain weight. Minimum thousand grain weight was found in the interaction late planting x AARI-2010. This may be attributed to the production of more number of grains with lighter weight. Thousand grain weight was positively and linearly correlated ($r = 0.3770$, $p < 0.10$) with grain yield, however, it was non-significant (Fig. 2). Early planting resulted in improved grain development due to longer growing period. These findings are in agreement with supported by those of Shahzad *et al.*, (2007). The response of genotypes to planting dates varied for thousand grain weight and grain weight tiller^{-1} because the growth span reduced under late planting. This reduction was even higher in the genotypes which required higher number of days for heading under normal planting. The time to heading shortens when temperatures increases (Slafer and Whitechurch, 2001). Similarly, the genotypes results in 4-10 days earlier maturity when planted late, indicating forced maturity owing to high temperature (Wajid *et al.*, 2004). Hence, the grain filling period is shortened under stress of late planting which result in low grain weight. However, the genotypes which possessed inherent earliness showed the ability to produce higher grain weight in late planting.

Table 1. Analysis of variance based on mean squares for grain yield, yield components and protein contents.

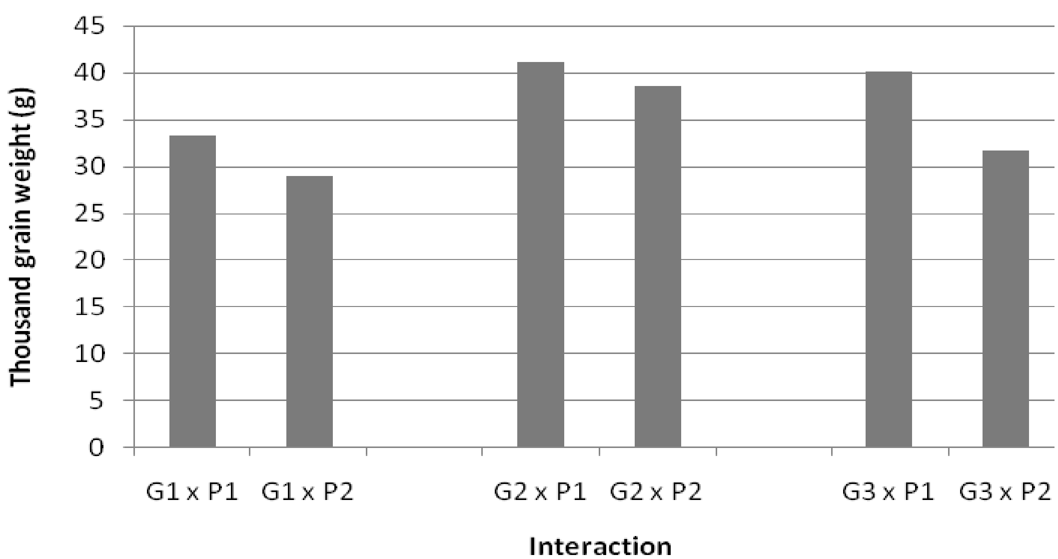
Source	d.f.	Number of productive tillers m^{-2}	Thousand grain weight	Biological yield	Grain yield	Total nitrogen	Protein contents
Planting time (PT)	1	504.2ns	157.5**	186032ns	10057.3ns	0.471**	18.41**
Genotype (G)	2	31781.8**	153.0**	3333ns	6863.5ns	0.144**	5.63**
PT x G	2	2488.0ns	18.2*	1141ns	126.6ns	0.0005ns	0.023ns
Error	12	3293.5	3.82	18176	4254.1	0.0058	0.2272

*, ** = Significant at 0.05 and 0.01 levels, respectively, ns = Non-significant.

Table 2. Effect of planting time and genotypes on grain yield, yield components and protein contents.

Treatment	Number of productive tillers m^{-2}	Thousand grain weight (g)	Biological yield (Mg ha^{-1})	Grain yield (Mg ha^{-1})	Total nitrogen	Protein contents (%)
Planting time (PT)						
December 1	382	38.2 a	11.28	4.26	1.48 b	9.23 b
December 15	391	33.1 b	9.51	3.85	1.76 a	10.99 a
LSD	NS	0.884	NS	NS	0.080	0.504
Genotypes (G)						
AARI-2010	456	31.13 c	10.44	4.04	1.46 b	9.14 b
Sehar-2006	361	39.86 a	10.57	4.36	1.69 a	10.54 a
Aas-2011	340	35.93 b	10.17	3.78	1.70 a	10.65 a
LSD	NS	2.13	NS	NS	0.083	0.519
Interaction	NS	*	NS	NS	NS	NS

LSD (0.05) = Least Significant at 5% probability.



G1 = AARI-2010, G2 = Sehar-2006, G3 = Aas-2010; P1 = 1st December planting time and P2 = 15th December planting time

Fig. 1. Interaction between genotype and planting time affecting thousand grain weight.

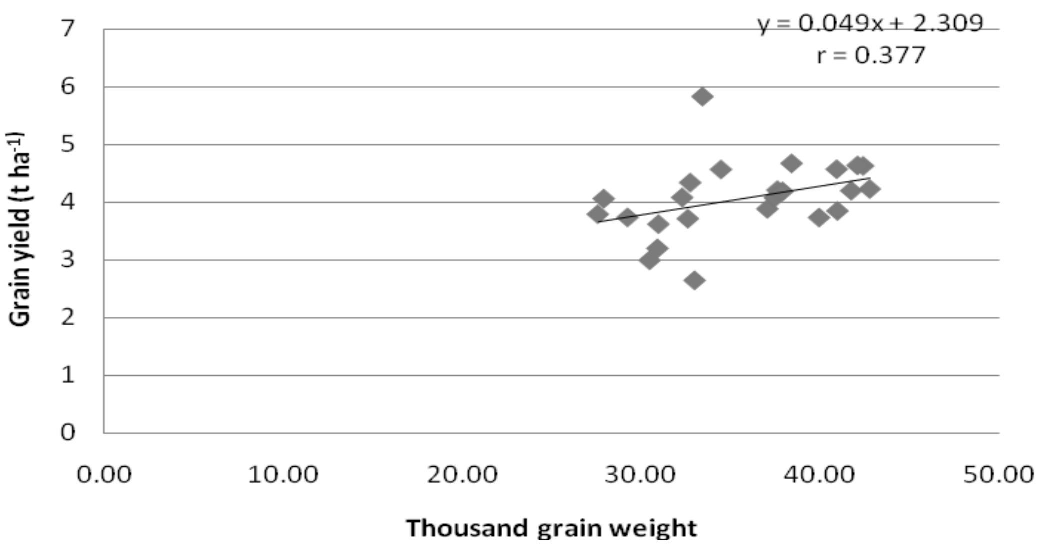


Fig. 2. Relationship between thousand grain weight and grain yield (n = 24).

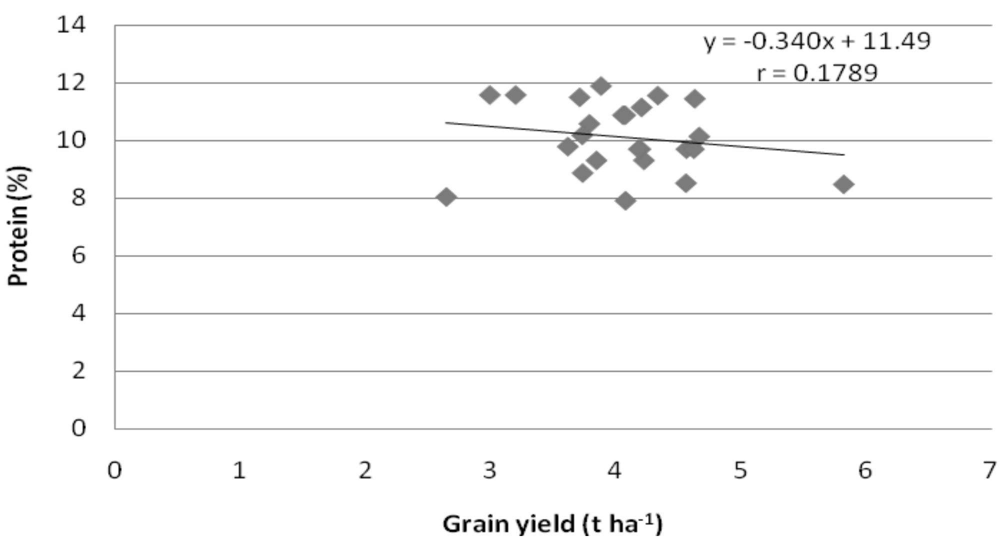


Fig. 3. Relationship between grain yield and protein (n = 24).

Grain quality is decided on proteins basis because proteins are most important building materials which build the cells of our bodies. Planting date and genotype significantly ($p < 0.01$) altered the grain protein contents (Table1). Late planting (15 December) produced grains with higher protein contents (11.0%) than 9.2% in early planting (1 December) (Table 2). Among genotypes, Sehar-2006 and Aas-2011 produced grains with more protein contents (10.54 and 10.65%, respectively) than AARI-2010 (9.1%). Genetic factor is, therefore, also responsible for varying grain proteins. Genotypes with higher proteins may be given much consideration to promote quality food. The results are in conformity with earlier studies. However, Shahzad *et al.*, (2007) obtained contradictory results that early planting resulted in higher grain proteins. A non-significant negative linear relationship was, however, found between grain yield and grain protein (Fig. 3) and grain yield could account for only 3.2% variation in protein.

In conclusion, grain yield declined with delayed planting of 15 days. Meanwhile, grain protein was improved by late planting. Genotypes also varied in grain protein contents. Genotypes Sehar-2006 and Aas-2011 produced more protein-enriched grains than AARI-2010. Recently, the impact of local climatic change has resulted in delay of few days in planting time. The results of present studies suggest that there is a tremendous potential to produce quality wheat by judicious manipulations of environmental conditions particularly planting time along with the genetic factors by selecting appropriate wheat genotypes under the changing climatic scenario of Faisalabad, Pakistan.

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