INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 6, No. 12, p. 1-8, 2015

RESEARCH PAPER OPEN ACCESS

Effect of sowing time on quality attributes of wheat grain

Iqbal Hussain[1,2*], Hafiz Bashir Ahmad[3], Salsabeel Rauf[4], Muhammad Aslam[2], Azhar Mehmood Aulakh[5]

[1]*Deapartment of Agronomy, University College of Agriculture, Sargodha, University of Sargodha, Pakistan*

[2]*Deapartment of Agronomy, University of Agriculture, Faisalabad, Pakistan*

[3]*Pulses Research Institute AARI Faisalabad, Pakistan*

[4]*Oil Seed Research Institute AARI Faisalabad, Pakistan*

[5]*Arid Zone Research Institute, Bakhar, Pakistan*

Key words: Sowing dates, Terminal heat stress, Grain protein, Carbohydrate.

http://dx.doi.org/10.12692/ijb/6.12.1-8 Article published on June 30, 2015

Abstract

Optimum sowing time ensures adequate yield and produces grains of good quality. Under changing climate, late sown wheat faces terminal heat stress, which not only reduces grain yield but also affects the grain development process and the harvested grains are of poor quality if used as seed for next crop, do not perform well. In this, influence of sowing time on the nutritional attributes of wheat grain was investigated at University of Agriculture, Faisalabad during 2010-11 and 2011-12. Seed was obtained from the wheat crop previously sown on November 10, 25 and December 10 and 25. Sowing dates severely influenced protein and carbohydrate contents in subsequent grains of wheat crop. Wheat crop sown from the seeds obtained from the crop previously sown at November 10 and 25 showed better grain protein and carbohydrate content as compared to December 10 and 25.

* **Corresponding Author:** Iqbal Hussain ✉ iqbal1429@gmail.com

Introduction

Wheat (*Triticum aestivum* L.) is an important cereal crop of the world and more than one third of the world's population uses it as a staple food. The nutritional value of wheat is extremely important and it supplies more calories, protein, dietary fiber, B-group vitamins and minerals to the diet of world's population than any other cereal crop (Adams *et al.*, 2002; Shewry, 2007, 2009). It is the cheapest source of calories, protein and fiber in human nutrition. Wheat grain contains nearly 72% carbohydrate, 6-16% protein, considerable proportion of mineral and vitamins (Gul *et al.*, 2012; Hussain *et al.*, 2013-14). Wheat bran is also a dietary source of potassium, calcium, magnesium, phosphorus and fiber necessary for good health of people and thus wheat contains the main source of nutrients to the most of world's population.

In Punjab (Pakistan), sowing of wheat is often delayed under cotton-wheat, rice-wheat and sugarcane-wheat cropping systems because of delay in the last picking of cotton, late harvesting of the rice and sugarcane, which results in yield penalty (Din *et al.,* 2010). Delayed planting wheat crop matures a bit late during the season and prevailing high temperature at reproductive stage, causes poor grain filling that results in shrivelled grains of poor quality (Egli, 1998; Ehdaie *et al.*, 2006; Farooq *et al.*, 2009; Kaur and Behl, 2010). The environment during seed development is a major determinant of seed quality (Castillo *et al.*, 1994). Adams *et al.* (1980) observed that sowing time significantly affected soybean seed quality and it was found that hot environmental conditions were associated with lower quality of seeds. High quality seeds have more vigor, uniformity and structural soundness besides its genetic and physical purity. Seeds weight, size and protein content are an important scale in seed quality that influence germination, seed vigor and yield in various crops like wheat and oat (Ries, 1971; Ries and Everson, 1973). Daily or seasonal temperature above optimum and extreme affects critical stages of plant growth and development. Like other plant organs, seeds are also affected by environmental conditions. The sensitivity of seeds to environmental stress depends on the stage of development (Spears *et al.*, 1997; Gibson and Paulsen, 1999; Monjardino *et al.*, 2005). The effect of high temperature stress prior to physiological maturity and during endosperm cell division phase, reduced the number of endosperm cells, starch granules (Commuri and Jones, 1999), grain size and final dry weight (Monjardino *et al.*, 2005). High temperature during anthesis and crop maturity, initiated a significant decrease in the carbohydrate accumulation in developing grains of wheat as compared to crop plants sown under normal conditions (Hurkman *et al.*, 2003). Exposure to higher than optimal temperature reduces yield and decreases quality of cereals (Fokar *et al.*, 1998; Maestri *et al.*, 2002; Wardlaw *et al.*, 2002). Temperature stress during the post-anthesis grain-filling stage, affects availability and translocation of photosynthates to the developing grain, starch synthesis and deposition within the grain, thus resulting in lower grain quality (Bhullar and Jenner, 1985). Khah *et al.* (1989) found that low quality spring wheat seed produced lower yield.

It is evident from previous studies that sowing time affected seed size, weight carbohydrate and protein content. Crops sown at optimum sowing time produced grains of high quality. Nonetheless, to best of our knowledge, limited informations are available that If once crop is sown at various sowing time then what will be the performance of subsequent seeds under normal field condition and whether that quality is retained for the subsequent crop or not. Keeping this in view, the present study was under taken to asses and compares the quality of subsequent grains obtained from crop previously sown at four different dates.

Materials and methods

Seed source, experimental site, soil and design

Seeds of wheat cultivar seher-2006 used in this study, were obtained from Wheat Research Institute, Faisalabad, Pakistan. Crop was sown at four different sowing dates viz. November 10, 25, December 10 and 25 during 2009 and 2010 under field condition at

Agronomic research Area, University of Agriculture, Faisalabad (31.25° N, 73.06° E and 184 MSL). For seed bed preparation and better germination of wheat seed, soil was cultivated 2 times with tractor mounted cultivator followed by planking each time. A pre-sowing irrigation was applied and when soil reached at field capacity, again soil was cultivated 2 times with tractor mounted cultivator followed by planking each time. The experimental soil texture was sandy loam with pH 8.1, total exchangeable salts 0.29 dS m^{-1}, 0.81% of organic matter, total nitrogen 0.049%, available phosphorus 8 mg kg^{-1}, exchangeable potassium 110 mg kg^{-1} and exchangeable sodium 0.4 me 100 g^{-1}. At maturity, crop was harvested and seeds were stored for following year experimental trial. During 2010 and 2011, seeds from previous harvest (in year 2009 and 2010) sown at November 10, 25, December 10 and 25 were sown on 08 and 17 November in 2010 and 2011 respectively. Randomized complete block design having four replications was used. The crop was hand drilled keeping 22.5 cm space between rows using seed rate of 125 kg ha^{-1}. Recommended fertilizer dose of nitrogen and phosphorus @ 100 and 90 kg ha^{-1} was applied. Sources of fertilizer were Urea (46% N) and Diammonium phosphate (46% P and 18% N). All the dose of phosphorus and one third of the nitrogen were used as basal while rest of nitrogen was applied in two equal splits at 1st and 2nd irrigation. Crop took three irrigations to reach maturity.

Weather data

Meteorological data for maximum, minimum temperature, relative humidity and rainfall for the whole crop season was collected from Agricultural Meteorology Cell, Department of Crop Physiology, University of Agriculture, Faisalabad, Pakistan.

Grain protein and carbohydrates content (%)

At maturity, crop was harvested and plants were allowed to sun-dry for a week. After sundring, plants of each plot were threshed and grains were separated and packed in jute bags. Grains samples of each treatment were analyzed using near infrared (NIR) technology (Omega Analyzer G™ Bruins Instruments, Germany). NIR Omega G Analyzer is a tool designed for precise and accurate measurements of parameters of whole grain of cereal (wheat, rice, corn, soybeans and oats). It is a fast and efficient solution for non-destructive analysis of samples which can be analyzed without the reagents or sample preparation in advance (Moroi *et al.*, 2011). For protein and carbohydrate, the wheat grain samples (500 g per sample) were collected from each plot of each replication. The weighed sample were inserted into an infrared (NIR) and reflectance values obtained from samples were noted.

Statistical analysis

The data collected were analyzed statistically by applying a computer package program MSTATC and treatments means were compared by employing least significant test at 5% probability level. Graphical presentation of data were made in micro soft excel sheet.

Results

Grain protein and carbohydrate show the quality and dietary value of the grains. Higher the protein and carbohydrate more will be the dietary value and vice versa.

Table 1. Analysis of variance for the effect of previous sowing dates on grain protein and carbohydrate content of progeny seed.

SOV	Mean Sum of Squares of quality attributes of grain	
	Protein	Carbohydrate
	2010-2011	2010-11
Year	0.24675**	15.6380**
D	0.48812**	10.9226**
Year × D	0.00073ns	1.2290**

** Significant at 0.01 probability level, D = Previous sowing dates, SOV = Sources of variations, DF = Degree of freedom.

Effect of previous sowing dates on the grain protein was significant during both years of study (Table 1). During both years of study, higher grain protein was recorded from the progeny of the seeds harvested from the crop previously sown on November 10, 2009-2010, which was statistically similar to grain protein content of progeny of seeds obtained from the crop previously sown on November 25, 2009-2010. Lower grain protein was recorded from the progeny of the seeds harvested from the crop previously sown on December 25, 2009-2010 (Table 1). The grains of progeny of the seeds harvested from the crop previously sown on December 25, 2009-2010 showed 4.5% reduction in protein content.

Table 2. Mean comparison of quality attributes of progeny grain.

	Protein		Carbohydrate
Year	1st	11.263 b	65.342 a
	2nd	11.439 a	63.944 b
Previous sowing dates	D1	11.544 a	65.629 a
	D2	11.539 a	65.609 a
	D3	11.299 b	64.045 b
	D4	11.023 c	63.289 c
Year × Previous sowing dates	Y1×D1	11.468	66.508 a
	Y2× D1	11.455	64.750 b
	Y1× D2	11.620	66.468 a
	Y2× D2	11.623	64.750 b
	Y1× D3	11.203	64.990 b
	Y2 × D3	11.395	63.100 c
	Y1 × D4	10.927	63.402 c
	Y2 × D4	11.117	63.175 c
LSD at 5%	Protein	Year = 0.0440, Previous sowing dates = 0.0622, Interaction (Year × Previous sowing dates) = Non-significant	
	Carbohydrate	Year = 0.2851, Previous sowing dates= 0.4031, Interaction (Year × Previous sowing dates) = 0.5701	

Means sharing same case letter for interaction and main effects, do not differ significantly at P 0.05. D1 = Seed harvested from the crop previously sown on November 10, D2 = Seed harvested from the crop previously sown on November 15, D3 = Seed harvested from the crop previously sown on December 10, D4 = Seed harvested from the crop previously sown on December 25. Y = Year. LSD = Least significant difference.

Grain carbohydrate (%)

Effect of previous sowing dates on the grain carbohydrate content of subsequent (progeny) wheat crop was significant during both years of study (Table 1). During both experimental years of study, maximum grain carbohydrate was recorded from the progeny of the seeds harvested from the crop previously sown on November 10, 2009-2010, which was also statistically similar to grain carbohydrate content of progeny of seeds taken from the crop previously sown on November 25, 2009-2010. Minimum grain carbohydrate was recorded from the progeny of the seeds harvested from the crop previously sown on December 25, 2009-2010 (Table 2). The grains of progeny of the seeds harvested from the crop previously sown on December 25, 2009-2010 showed 3.69% reduction in carbohydrate content.

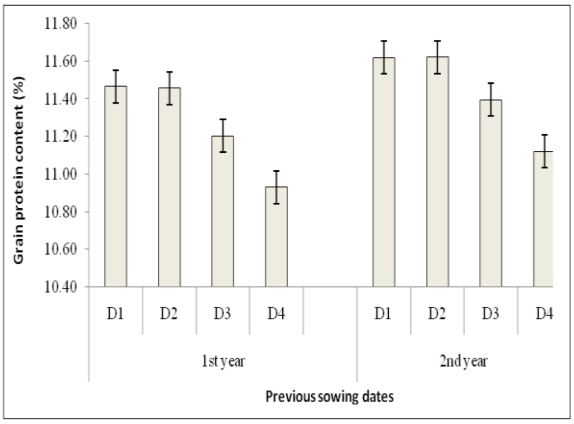

Fig. 1. Effect of previous sowing dates on grain protein content of wheat.

Discussion

Previous sowing dates significantly affected grain quality in subsequent wheat crop. Progeny of seeds harvested from the crop previously sown on November 10 and 25 produced more grain protein and carbohydrate compared to progeny of seeds harvested from the crops previously sown on December 10 and 25 (Table).

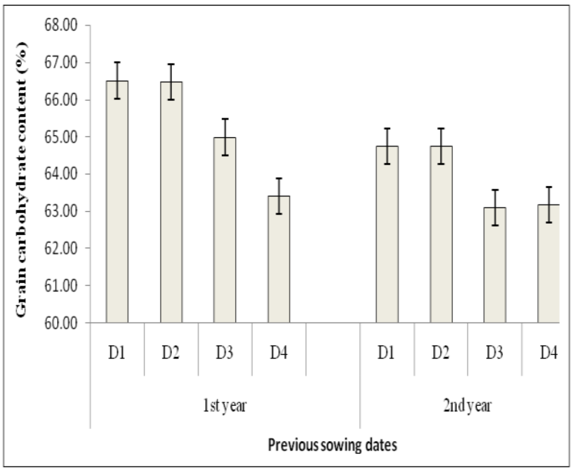

Fig. 2. Effect of previous sowing dates on grain carbohydrate content of wheat.

D1 = Seed harvested from the crop previously sown on November 10, D2 = Seed harvested from the crop previously sown on November 15, D3 = Seed harvested from the crop previously sown on December 10, D4 = Seed harvested from the crop previously sown on December 25.

The improvement in grain protein and carbohydrate in progeny seeds might be due to that wheat plants grown from the seeds harvested from the crop previously sown on November 10 and 25 were more vigorous and healthy. They might have more root biomass and more availability and contribution of nitrogen to grains and improved net assimilation rate that resulted in more photo-assimilation and its translocation towards the grains. Previous studies showed that plants grown from bold seed had faster growth and more grain protein content (Lowe and Ries, 1972). Choudhry and Imtiaz (2001) reported that the highest protein percentage was recorded when large seeds were used for sowing.

Lower grain protein and carbohydrate content taken from the progeny of the seeds harvested from the crop previously sown on December 25, 2009-2010 might be due to poor seed vigor and quality. It can be assumed that high temperature during grain development resulted in small and poor quality seed (McDonald *et al.*, 1983; Tewolde *et al.*, 2006; Hasan *et al.*, 2013). Seed exhibited low germination when parent plant was exposed to medium or high temperature stress during grain development (Grass and Burris, 1995). As a consequence, smaller and poor quality grains are of low vigor produced, if used as seed for next crop, do not perform well. Our results also showed that progeny of seeds obtained from the crop previously sown at December 25 exhibited lower grain protein and carbohydrate content. Sowing of wheat at optimum sowing time has longer growing period and results in better growth, development and dry matter accumulation (Spink *et al.*, 2000; Shahzad *et al.*, 2002), and crop produces good quality grain ensuring better crop performance during following season.

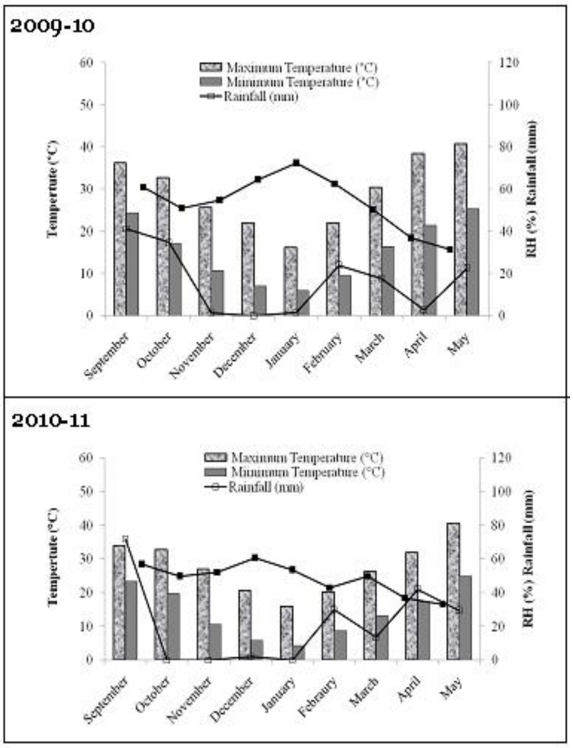

Fig. 3. Meteorological data for growing season of crop during the years 2009-10, 2010-2011.

In conclusion, delay in sowing influences the grain development resulting in grains of poor quality, if use as seeds for next crop, suppress the performance of crop and grain quality.

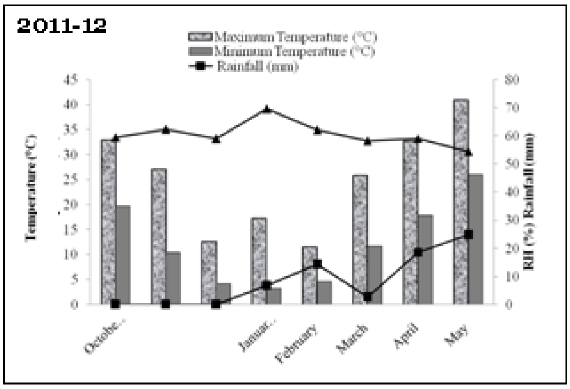

Fig. 4. Meteorological data for growing season of crop during the years 2011-12.

References

Adams ML, Lombi E, Zhao FJ, McGrath SP. 2002. Evidence of low selenium concentrations in UK bread-making wheat grain. Journal of the Science of Food and Agriculture **82,** 1160-1165. http://dx.doi.org/10.1002/jsfa.1167.

Bhullar SS, Jenner CF. 1985. Differential responses to high temperatures of starch and nitrogen accumulation in the grain of four cultivars of wheat. Australian Journal of Plant Physiology **12,** 363-375.

Castillo AG, Hampton JG, Coolbear P. 1994. Effect of sowing date and harvest timing on seed vigor in garden pea (*Pisum sativum* L.). New Zealand Journal of Crop and Horticultural Science **22,** 91-95. http://dx.doi.org/10.1080/01140671.1994.9513810

Choudhry AU, Imtiaz H. 2001. Influence of seed size and seed rate on the phenology, yield and quality of wheat. Pakistan Journal of Biological Sciences **4,** 414-416.

Commuri PD, Jones RJ. 1999. Ultra-structural characterization of maize (*Zea mays* L.) kernels exposed to high temperature during endosperm cell division. Plant Cell Environment **22,** 375-385.

Din R, Subhani GM, Ahmad N, Hussain M, Rehman N. 2010. Effect of temperature on development and grain formation in spring wheat. Pakistan Journal of Botany **42,** 899-906.

Egli DB. 1998. Seed growth and development. In: Egli DB. (ed.), seed biology and the yield of grain crops. CAB International, New York, PP: 184.

Ehdaie B, Alloush GA, Madore MA, Waines JG. 2006. Genotypic variation for stem reserves and mobilization in wheat: I. Post-anthesis changes in inter node dry matter. Crop Science **46,** 735-746. http://dx.doi.org/10.2135/cropsci2005.04-0033.

Farooq M, Wahid A, Ito O, Lee DJ, Siddique KHM. 2009. Advances in drought resistance of rice. Critical Review in Plant Sciences, **28**, 199-217. http://dx.doi.org/10.1080/07352680902952173.

Fokar M, NguyanT, Blum A. 1998. Heat tolerance in spring wheat. II. Grain filling. Euphytica **104,** 9-15. http://dx.doi.org/10.1023/A:101832250227.

Gibson LR, Paulsen GM. 1999. Yield component of wheat yield grown under high temperature stress during reproductive growth. Crop Science **39,** 1841-1846.

Grass L, Burris JS. 1995. Effect of heat stress during seed development and maturation on wheat seed quality. I. Seed germination and seedling vigor. Canadian Journal of Plant Science **75,** 821-829. http://dx.doi.org/10.4141/cjps95-138.

Gul H, Khan AZ, Saeed B, Nigar S, Saeed A, Khalil SK. 2012. Determination of seed quality tests of wheat varieties under the response of different sowing dates and nitrogen fertilization. Pakistan Journal of Nutrition **11,** 34-37.

Hasan MA, Ahmed JU, Hossain T, Mian MAK, Haque MM. 2013. Evaluation of the physiological quality of wheat seed as influenced by high parent plant growth temperature. Journal of Crop Science and Biotechnology **16,** 69-74.

Hurkman WJ, McCue KF, Altenbach SB. 2003. Effect of temperature on expression of genes encoding enzymes for starch biosynthesis in developing wheat endosperm. Plant Science **164,** 873-881. http://dx.doi.org/10.1016/j.jcs.2015.01.004

Hussain I, Ahmad R, Farooq M, Wahid A. 2013. Seed priming improves the performance of poor quality wheat seed. International Journal of Agriculture and Biology **15,** 1343-1348.

Hussain I, Ahmad R, Farooq M, Rehman A, Amin M. 2014a. Seed priming improves the performance of poor quality wheat seed under drought stress. Applied. Science Reports **3,** 12-18.

Hussain I, Ahmad R, Farooq M, Rehman A, Amin M, Bakar MA. 2014b. Seed priming: a tool to invigorate the seeds. scientia agriculturae, **3**, 122-128.

Kaur V, Behl RK. 2010. Grain yield in wheat as affected by short periods of high temperature, drought and their interaction during pre and post anthesis stages. Cereal Research Communications, **38,** 514-520.

Kelley, KW. 1995. Rate and time of N application for wheat following different crops. Journal of Production and Agriculture, 8, 339-45.

Lowe LB, Ries SK. 1972. Effect of environment on the relation between seed protein and seedling vigor in wheat. Canadian journal of Plant Science **52,** 157-164. http://dx.doi.org/10.4141/cjps72-026.

Maestri E, Natalya K, Perrotta C, Gulli M, Nguyen H, Marmiroli N. 2002. Molecular genetics of heat tolerance and heat shock proteins in cereals. Plant Molecular Biology **48,** 667-81. http://dx.doi.org/10.1186/s12864-015-1282-1.

McDonald GK, Sutton BG, Ellsion FW. 1983. The effect of time of sowing on the grain yield of irrigated wheat in namoi valley, New South Wales. Australian Journal of Agriculture Research **34,** 224-229.

Monjardino P, Smith AG, Jones RJ. 2005. Heat stress effects on protein accumulation of maize endosperm. Crop Science **45,** 1203-1210. http://dx.doi.org/10.2135/cropsci2003.0122

Moroi A, Nicoleta V, Alisa VA, Ilena DN, Iuliana MA. 2011. Prediction of the ash content of wheat flours using spectral and chemometric methods. The Ann. Uni. Dunarea de Jos of Galati Fascicle VI. Food Technolgy **35,** 33-45.

Phadnawis BN, Saini AD. 1992. Yield models in wheat based on sowing time and phenological developments. Annals of Plants Physiology **6,** 52-59.

Ries SK. 1971. The relationship of protein content and size of bean seed with growth and yield. Journal of American Society of Horticultural Sciences **96,** 557-60.

Ries SK, Everson EH. 1973. Protein content and seed size relationships with seedling vigour of wheat cultivars. Agronomy Journal **65**, 884-886.

Ries SK, Moreno O, Meggitt WF, Schweizer CJ Ashkar SA. 1970. Wheat seed protein: Chemical influence on and relationship to subsequent growth and yield in Michigan and Mexico. Agronomy Journal **62,** 746-48.

Robertson AI, Lenanton RCJ. 1984. Fish community structure and food chain dynamics in the surf-zone of sandy beaches: The role of detached macrophyte detritus; Journal of Experimental Marine Biology and Ecology **84,** 265-283.

Schweizer CJ, Ries SK. 1969. Protein content of seed: increase improves growth and yield. Science, **125,** 73-75.

Shahzad K, Bakht J, Shah WA, Shafi M, Jabeen N. 2002. Yield and yield components of various wheat cultivars as affected by different sowing dates. Asian Journal of Plant Science **1,** 522-525.

Shewry PR. 2007. Improving the protein content and composition of cereal grain. J. Cereal Science, **46,** 239-250.

Shewry PR. 2009. Wheat: mini review. Journal of Experimental Botany **60,** 537-1553.

Spears, JF, Tekrony DM, Egli DB. 1997. Temperature during seed filling and soybean seed germination and vigour. Seed Science and Technology **25,** 233-244.

Spinks JH, Semere T, Sparkes DL, Wahley JM, Foulkes MJ, Calre RW, Scatt RK. 2000. Effect of sowing dates n planting density of winter wheat. Annals of Applied Biology **2,** 179-188.

Tewolde H, Fernandez CJ, Erickson CA. 2006. Wheat cultivars adapted to post-heading high temperature stress. Journal of Agronomy and Crop Science **192,** 111-120.

Wardlaw, IF, Blumenthal C, Larroque O, Wrigley CW. 2002. Contrasting effects of chronic heat stress and heat shock on grain weight and flour quality in wheat. Functional Plant Biology **29,** 25-34.

Warraich EA, Basra SMA, Ahmad N, Ahmed R, Aftab M. 2002. Effect of nitrogen on grain quality and vigour in wheat (*Triticum aestivum* L.). Intentional Journal of Agriculture and Biology **4,** 517-520.