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Garin filling duratio on grain yield enhancement in wheat (*Triticum aestivum* L)

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Abstract

Grain filling duration, the period between heading date and physiological maturity, plays an important role in determining the final grain yield in spring wheat. The variability for grain filling duration and selected agronomic traits were studied in 29 wheat genotypes. Wide genetic variation was observed among the wheat genotypes for all the traits studied. It was observed that earlier heading lines tended to have longer grain filling duration as compared to later heading genotype. Genotypes having shorter grain filling duration were significantly correlated with grain yield and its components 1000- seed weight, Bio- logical yield and plant heights. The results suggested that increasing grain yield in winter wheat was possible through breeding for grain filling parameters.

Key words: Grain filling duration, kernel mass, physiological maturity and wheat.

Introduction

Wheat is the main crop during rabi season in most parts of the hills and foothills of the Shivalik and Pirpanjal mountain ranges in subtropical rain-fed area of Jammu region which is sown especially after the harvest of rice and maize crops. As the temperature rises slowly during grain filling period under these areas it provides sufficient duration for grain development. But due to many agro-climatic regions this grain filling duration varies area to area. The grain filling duration is most important phase in wheat plant's life cycle as it is responsible for producing healthy and well- filled kernels that lead to total harvested grain yield. In the present scenario of environmental changes which are leading to squeezing of the duration of the cold season, the grain filling period in wheat is greatly affected by the prevailing temperature conditions. It has been observed that any changes in day night temperature or early onset of desiccating winds at the time of grain filling becomes a limiting factor affecting grain yield to a great extent through reduction in kernel mass. It is also worth mentioning that grain yield in winter wheat is closely associated with variation in temperature. Wheat production, particularly in India, is a gamble with temperature. This fact becomes evident from the variations recorded from various wheat producing zones in India.

Grain yield in wheat is mainly contributed by three yield components, *viz* tillers per unit area, kernels per spike and kernel mass (weight). Kernel mass is determined by grain filling duration and grain filling rate of the photo – assimilates. Grain filling duration in wheat is regarded as period between headings to physiological maturity of spikes. The duration of grain filling, rather than the rate of grain filling, has been regarded as an important determinant of grain yield. The converse opinion, that grain filling rate rather than grain filling period is closely associated with grain yield, has also been reported. Terminal heat stress caused by early onset of hot desiccating winds at the time of maturity of wheat necessitates development of varieties having shorter grain filling duration (with coexisting faster grain filling rate) for reducing losses in grain yield. Grain filling duration is also very important in breeding cultivars, suitable for fitting into various crop rotations. The present study was conducted to screen germplasm lines for variability in grain filling duration and study the relationship with other agronomic traits for being utilized in breeding programmes.

Methods

Twenty nine spring wheat germplasm lines, which included cultivars and strains belonging to early, medium and late maturity groups, were utilized to study their grain filling behaviour**.** The material was grown in 6 rows plots of 4 m length, spaced 23 cm apart in three replications. The middle rows of the plots were used

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for recording data on days to heading, days to physiological maturity, plant height at maturity (cm), spike length (cm), Kernels per spike, 1000- seed weight, biological yield (g), grain yield per plot (g) and harvest index (%). Days to heading was recorded as the number of days after sowing, when 50% of the spike in the plot was completely emerged from the flag leaf sheath. Days to physiological maturity estimated as the number of days after, till the glumes lost completely their green colour in 75% of the plot. The grain filling duration was estimated as the difference between days heading to and days to physiological maturity. The yield attributing traits were recorded from 5 individual plants and these were utilized in statistical analysis.

The germplasm lines used in this study formed a part of the working collection. These lines were screened for flowering characteristics over a number of years and they sowed very little variation in itself as far as their heading and other morphological attributes were concerned, care was taken to raise a good crop and minimize variation due to environmental and cultural conditions on the present study, pooling of two years data was done so as to eliminate or minimize any variation in heading and other characteristics. Pooling of data recorded over years also enhances the accuracy and efficiency of the estimates. The pooled data of two years were statistically analyzed. Board sense heritability was calculated following Fehr (1987) and correlation coefficients were computed among yield traits and grain filling duration following Johnson *et a*l (1955).

Results and Discussion

A wide range of variability in the material was recorded. The vegetative period in the material screened in the present study ranged from 145 to 159 days whereas grain filling duration of the reproductive phase varied from 20-42 days. It was observed that the grain filling duration in early heading lines (145-153 days) ranged from 20-40 days while in later heading liner (156-200 days), it was 22-38. Two genotypes were found to exhibit marked variation for grain filing duration. "VL-870" was the genotype with shortest grain filling duration of 20 days with vegetative phase 153 days, while Raj-3765 had the largest grain filling duration of 42 days with 145. days vegetative period. The germplasm material screened revealed that early heading lines tended to have longer grain filling duration as compared to later heading genotypes.

The heritability values (Table-1) were high for Kernels per spike, grain filling duration, physiological maturity and were intermediate for harvest index, biological yield per plot, plant height and low heritability values on days to 50 per cent heading, 100 seed weight, spike length and grain yield per plot. Grain yield was significantly and positively correlated with grain filling duration and 100-seed weight (Table-2). Among the yield components, Days to 50 per cent heading was significantly correlated with physiological maturity and spike length while association of 1000 seed weight was significant and positive with both grain yield per plot and harvest index but significant and negative with biological yield.

The grain filling duration was observed to be significantly and positively correlated with its components *viz*. Plant height, biological yield, grain yield per plot and 1000-seed weight (Table-2). Increasing yield *per se* has been and shall always be the prime goal of breeders. In wheat where improvement in yield has been a subject of intense selection pressure any further grains in yield enhancement has to come through manipulation of crop trait relationship to high grain yield. The traits which have been consistently modified during the process of breeding can be used as a selection criterion as it greatly affects productivity and production. Good genetic variation was observed in the material screened for all the character that were studied which showed that they may be utilized for the specific traits required in the development of cultivars.

The range of vegetative phase accounted for the major portion (145 to 159 days) of the total crop duration (189 to 204 days) and in fact it determines the quantum of harvested grain yield. Therefore the range in duration of vegetative phase is equally important as the grain filling duration for determining grain yield in wheat (Bingham, 1969). The period before anthesis has been largely recognized as being critical for grain yield (Slafer *et al* 1996).

It was observed that early heading liner tended to have longer grain filling duration as compared to later heading genotypes. The early lines, by having a prolonged or more favourable grain filling period, were thus able to accumulate more photosynthates which was reflected through their Kernel mass, on the other hand the late heading genotypes generally getting lesser time for grain filling were at risk to exposure influence by environmental factors, particularly temperature, during grain filling period It has been suggested that short grain filling duration in some late heading genotypes which maintains grain yield despite of short duration grain filling period, contributed to stress tolerance Sadallah and Ghandorah (2000) which gives an opportunity for its further exploitation by introducing shorter grain filling duration in late genotypes and also or a likely source for incorporating stress tolerance in late heading genotypes.

The grain filling duration has a great importance for kernel weight which is related to kernel size. According to Rajaram and McNab (2003) the maximum kernel size is determined by the size of lemma and palea of the spikelets. Similarly, Milka *et all* 2008) observed a positive correlation between kernel weight and volume of the floral cavity. Hence, it can be deduced from the above statements that spikes bearing lemma and palea of larger size would produce grains of higher mass but in fact, the actual size and weight is determined by competition for resources and environmental factors**.** In the present study spike length showed significant and positive correlation with grain yield (r= 0.26) but it has no significant correlation with 1000-kernel mass (Table-2). This means that genotypes with longer spikes may not necessarily produce bold kernels. The potential kernel weight is mostly dependent on genotype, but it may be limited to some extent by post anthesis assimilate supply. It is known that after the grain number in the spike becomes fixed, kernel mass has a major influence on the final grain yield in wheat.

Kernel mass is dependent on the duration and rate of grain filling. An extended grain filling duration would increase the availability of photo-assimilates leading to higher grain yield. However, high temperature during grain filling period causes reduction in kernel weight by imposing drought and heat stress leading to reduced grain filling duration. In the early heading genotypes grain yield was increased with corresponding enhancement in the grain filling duration (figure 1) up to certain level but it tends to decrease beyond that level (34 days). In the late heading genotypes the trend was different. The enhancement in grain yield with corresponding increase in grain filling duration was genotype dependent. All late heading genotypes excluding (Sonalica, VL-849 and HPW-255) showed yield enhancement with corresponding increase in grain filling duration (Przuli and Mladenov 1999) .

The grain yield has significant and positive correlation with its major components, 100- seed weight, spike length, grain filling duration and seeds per spike, thus improvement in yield is possible through improvement in the yield component traits .Grain filling duration show significant positive correlation with plant height and biological yield along with grain yield. A positive correlation of these two yield traits with grain filling duration reflects its importance with respect to the final grain yield. This observation opens up the avenue that improvement in higher grain yield is possible via improvement in grain filling parameter.

In general there is agreement that higher the temperature shorter will be the grain filling period. Manipulation of temperature response in genotypes is thus essential for increasing the grain filling duration to obtain higher grain yield. It has been observed that a faster grain filling rate is required in the late heading genotypes, particularly in areas experiencing heat stress due to high temperature at the time of heading and grain filling. The high association between grain filling rate and kernel weight shows that simultaneous selection for grain filling rate is possible through selection for kernel weight Kamaluddin, *et all* (2007). A breeding strategy involving selection for early heading (longer grain filling duration) in early segregating generations followed by selection for grain yield and medium grain filling duration in later heading genotypes followed by selection for grain yield and grain filling duration in later generations utilizing multilocation testing of genetic material like VL- 870, HS-295, TL-2943, UP-2964 and VL-738 screened in this study would be very effective in manipulation of grain filling duration for obtaining higher yielding genotypes.

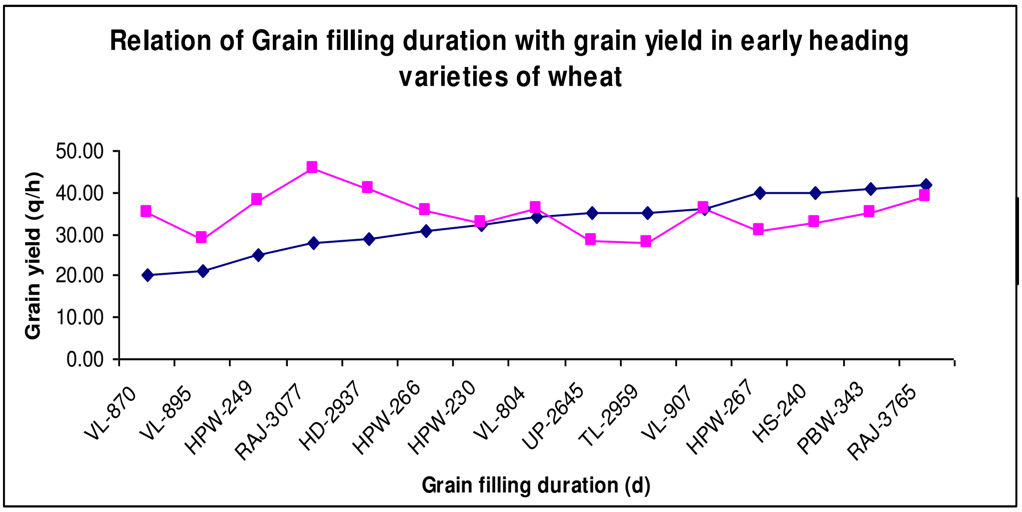

Figure 1

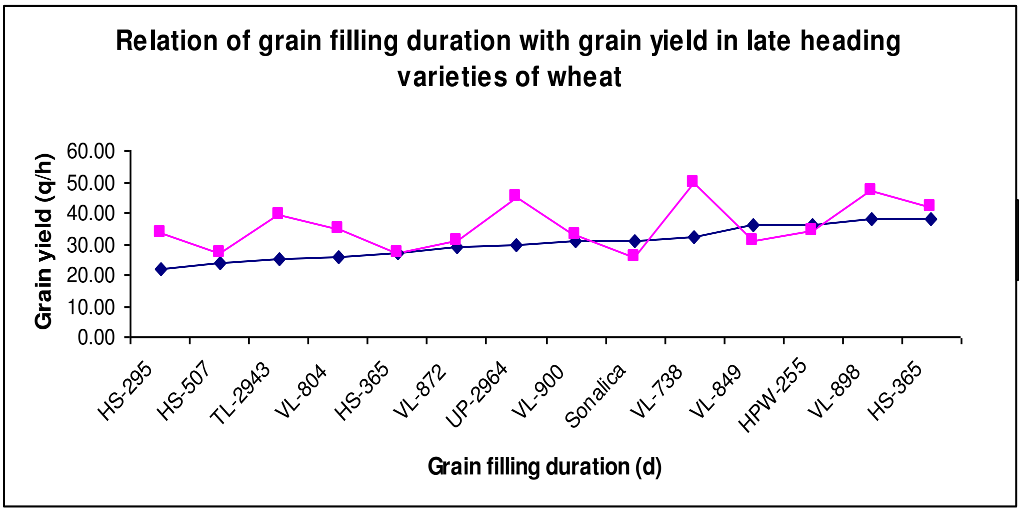

Figure 2

Table : 1 Range, mean and heritability estimate for 10 characters in wheat

Character	**Range**	**Mean**	h^2
Days to 50% heading	145-159	153.45	0.49
Physiological maturity	189-204.3	195.25	0.79
Grain filling duration	20-42	31.51	0.92
Plant height (cm)	70.11-106.16	89.95	0.59
Spike length (cm)	8.11-11.5	9.61	0.31
Kernels per spike	36.6-75.3	56.16	0.96
1000-seed weight (g)	4.12-6.8	5.46	0.48
Biological yield per plot (kg)	3.71-7.23	5.64	0.61
Grain yield per plot (kg)	1.43-2.60	1.95	0.21
Harvest index (%)	20.83-45.55	34.19	0.62

Table: 2 Phenotypic correlation coefficient between grain filling duration and selected agronomic traits in wheat

Traits	Physio-logical maturity	Grain filling duration	Plant height	Spike length	Seeds per spike	100-seed weight	Biolo-gical yield per plot	Grain Yield per plot	Harvest index
Days to 50% heading	0.76**	0.05	0.17	0.26*	0.05	0.21	-0.06	-0.03	0.08
Physiological maturity		0.41**	0.08	0.16	0.06	-0.07	0.12	0.14	-0.03
Grain filling duration			0.24*	-0.13	0.09	0.32**	0.26*	0.27*	0.06
Plant height				-0.15	0.02	0.26*	0.23*	-0.21	-0.07
Spike length					0.08	0.07	0.07	0.26*	0.32**
Seeds per spike						0.15	0.06	0.35**	0.27*
100- seed weight							-0.39*	0.54**	0.38**
Biological yield per plot								-0.15*	-0.27**
Grain yield per plot									-0.28*
	*,** significant at 5% and 1%, respectively								

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