RESEARCH PAPER *International Journal of Agricultural Sciences, June to December, 2009, Vol. 5 Issue 2 : 399-402*

Relationship of durum wheat yield to agronomical and physiological growth parameters

B.A. MONPARA
Department of Agricultural Botany, Junagadh Agricultural University, JUNAGADH (GUJARAT) INDIA

ABSTRACT

A set of 21 elite genotypes of durum wheat selected based on maturity time were evaluated for grain yield and some agronomical and physiological growth parameters. Variability and association analysis for 13 traits were carried out. Wide range of variation was observed for all the characters. The genotypic coefficient of variation was moderate for all the characters, except days to maturity, vegetative period and grain filling period, for which, the low magnitude was noted. High heritability coupled with high genetic advance was observed for days to ear emergence, plant height, flag leaf area, spike length, spikelets per spike, grains per spike and 100-grain weight. However, low heritability along with moderate genetic advance was observed for grain yield per plant, indicating that direct selection for grain yield would not be effective. Grain yield per plant was correlated in desired direction only with effective tillers per plant, therefore, this character should be considered as an important component of grain yield and emphasis should be given to this trait during selection programme. However, altering in relationships of days to ear emergence, days to maturity and vegetative period with grain yield through breeding programmes utilizing genetic variation, like Kiwi's' identified in this study, was suggested.

Key words : *Triticum durum*, Grain filling period, Vegetative period, Yield traits

INTRODUCTION

Grain weight is a component of grain yield and duration of grain filling is a component of maturity. Both are important traits in applied plant breeding and both depend upon the grain filling process. Further, Bingham (1969) reported that not only grain filling period but duration of vegetative growth is also important for achieving high yield in wheat. He noted that the yield of grain is directly dependent on sink size, which is largely determined during the vegetative period and on the photosynthetic capacity of the crop during the grain filling period. This suggests that it could be possible to increase yield in grain crops by achieving an optimal duration for the vegetative and the grain filling periods of growth. On the other hand, Nass and Reiser (1975) found no correlation between yield and days to anthesis, days to maturity and days from anthesis to maturity. While working with durum wheat, Amar (1999) have suggested that number of grains per spike, number of spike per meter^2, length of vegetative period, plant height and days to heading were major contributors to grain yield in semi-arid regions. The present study was attempted to know the variation for vegetative and grain filling periods and other agronomic traits as well as the relationship among them and with grain yield in elite genotypes of durum wheat for being utilized in breeding programmes.

MATERIALS AND METHODS

The material of the present study comprised of a set of 21 elite genotypes of varying maturity time derived from different origin. Six from Gujarat (JD 98-16, JD 98-50, JU 72, GW1139, GW 1151 and Bansi), four from Madhya Pradesh (HI 8112, HI 8356, HI 8381 and HI 8498), four from Mexico (Kiwi's', Kranich, CPAN 6153 and Altar 84), two from Rajasthan (RD 469 and Raj 1555), two from Maharashtra (NIDW 83 and MACS 2846) and one each from New Delhi (HD 4530), Punjab (PBW 34) and Utter Pradesh (UPD 64) were included and evaluated for yield and certain agronomical and physiological growth parameters. The experiment was laid out in randomized block design with four replications during *rabi* season under normal sown condition at the Wheat Research Station, Junagadh Agricultural University Junagadh. Each genotype was relegated to the plot of three rows of 3 meter length with the spacing of 22.5 cm and 10 cm between two rows and between two plants within the row, respectively. All recommended practices were followed to raise the good crop.

The measurements were made on ten plants selected randomly prior to ear emergence from the middle row of each plot. The data were collected on individual plant for 13 characters. Days to ear emergence were determined as days from date of sowing to the date on which the ear was emerged beyond the auricles of flag leaf. Physiological maturity was judged as approximately 75% of glumes of main spike turned yellow. Vegetative period was calculated as days from date of sowing to the date of anther extrusion from central florets (date of anthesis)

*** Author for correspondence.** Present Address : Agricultural Research Station, Junagadh Agricultural University, Keriya Road, AMRELI (GUJARAT) INDIA

of main spike. Duration between anthesis and physiological maturity was considered as grain filling period. Flag leaf area (cm^2) was calculated by multiplying length into breadth by the factor 0.75 (Stickler *et al*., 1961). Plant height (cm), effective tillers per plant, spike length (cm), spikelets per spike, grains per spike, 100-grain weight (g), harvest index (%) and grain yield per plant (g) were also recorded on plant basis. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation(PCV) following Burton (1952), broad sense heritability and genetic advance as percentage of mean as per the formula described by Allard (1960) and genotypic correlation coefficient according to Al-jibouri *et al*. (1958) were calculated.

RESULTS AND DISCUSSION

The variation is the basic requirement for crop improvement as it provides wider scope for selection. Wider range of variation was observed in the present study for the characters under consideration (Table 1). Days to maturity ranged from 87.1 to 106.3 days with the mean of 100.9 days. Vegetative period showed the variation from 54.0 to 76.9 days with mean of 70.8 days, while grain filling period varied from 20.6 to 35.5 days with the mean of 30.1 days. This indicates that of the total life span, durum wheat allocates, on an average, 70% to vegetative phase and 30% to grain filling phase. Thus, vegetative phase accounted major portion of crop duration. In fact, certain minimum vegetative growth is essential to support the bigger ear. Moreover, the length of vegetative phase within the range allowed the plant to develop sufficient floral structures to provide adequate sink capacity for good yields and therefore, it is an important character for achieving high grain yield in durum wheat (Bingham, 1969). Grain yield per plant ranged from 7.7 to 13.5 g with the mean manifestation of 10.2 g. There was a wider range for other characters too. Tiwari (2007) also reported wider range of variation in his materials of spring wheat.

Among the cultivars studied, early genotypes, Kiwi's' had the shortest vegetative (54.0 days) with the longest grain filling (35.5 days) periods and the shortest plant stature (47.3cm), while JD 98-16 had the highest harvest index (43.8%) and the largest 100-grain weight (4.5g). HI 8498 recorded the highest grain yield per plant (13.5g), whereas CPAN 6153 exhibited the longest spike (9.8 cm) and the highest number of grain per spike (76.8). Both of these were medium early genotypes. Identification of these genotypes gives an opportunity to allow them in developing breeding populations from which selection for desirable types could be possible.

The values of GCV and PCV were as low as 5.19% and 5.94% for days to maturity to as high as 17.37% and 19.40% for grains per spike, respectively. The wider difference between GCV and PCV for grain filing period, effective tillers per plant and grain yield per plant indicated that these characters were highly under the influence of environmental conditions. The magnitude of GCV was moderate for all the characters, except days to maturity, vegetative period and grain filling period, for which low magnitude was observed.

The heritability estimates ranged from as low value of 26.91% for grain filling period to high value of 86.52% for days to ear emergence. The high magnitude of heritability was also shown by remaining traits under study, except harvest index and grain yield per plant. The magnitude was moderate for harvest index and low for grain yield per plant. The genetic advance, expressed as

Table 1 : Mean, range and genetic parameters for grain yield and some agronomical and physiological growth parameters in durum wheat

Characters	Mean	Range	GCV (%)	PCV (%)	Heritability (%)	GA as(%) mean
Days to ear emergence	68.0	48.1 - 73.9	11.76	12.65	86.52	22.54
Days to maturity	100.9	87.1 - 106.3	5.19	5.94	76.39	9.35
Vegetative period	70.8	54.0 - 76.9	8.26	9.47	76.00	14.82
Grain filling period	30.1	20.6 - 35.5	9.15	17.66	26.91	9.77
Plant height(cm)	73.1	47.3 - 93.6	14.27	16.36	76.09	25.65
Effective tillers/plant	7.4	5.2 - 8.6	10.65	16.98	39.30	13.76
Flag leaf area(cm^2)	28.0	18.4 - 34.3	15.63	18.29	73.12	27.72
Spike length	7.9	5.6 - 9.8	12.33	14.41	73.22	21.71
Spikelets/ spike	18.2	11.9 - 19.4	12.73	14.02	82.43	23.84
Grains/spike	54.2	36.6 - 76.8	17.37	19.40	80.17	32.04
100-grain weight(g)	3.8	2.8 - 4.5	11.01	12.05	83.38	20.66
Harvest index (%)	29.5	25.3 - 43.8	14.57	18.14	64.58	24.13
Grain yield/plant(g)	10.2	7.7 - 13.5	12.94	19.51	43.92	17.63

percentage of mean, varied from as low as 9.35% for days to maturity to as high as 32.04% for grains per spike. High magnitude of genetic advance was also noted for flag leaf area, plant height, spikelets per spike, days to ear emergence, spike length and 100-grain weight, while grain yield per plant and vegetative period had moderate and grain filling period had low value of genetic advance. High heritability for heading date and test weight (Talbert *et al*., 2001; Tiwari, 2007) and low heritability for grain filling period (Talbert *et al*., 2001; Chavada and Monpara, 2007) were reported earlier in wheat.

The magnitude of high heritability accompanied with high genetic advance for days to ear emergence, plant height, flag leaf area, spike length, spikelets per spike, grains per spike and 100-grain weight indicated that most likely the heritability was due to additive gene effects and selection for these characters may be effective. Days to maturity and vegetative period expressed high heritability coupled with low genetic advance. It was indicative of non-additive gene effects and manifestation of high heritability was due to favourable influence of environment rather than genotype. Selection for such traits may not be rewarding. Harvest index recorded low heritability along with high genetic advance, revealed that character was controlled by additive gene effects and low heritability being exhibited due to high environmental effects. Low heritability accompanied by moderate genetic advance for grain yield per plant indicated that this character was highly influenced by environmental effects and selection would be ineffective.

Heritability estimates for grain yield per plant lower than other traits as observed in the present study indicated that selection on the basis of grain yield *per se* would usually not effective and efficient, whereas selection along with its component characters could be more efficient and reliable. Consequently, information on the association between yield and yield components and among the component character themselves can improve the efficiency of selection in plant breeding programmes (Shimelis, 2006).

The values of genotypic correlation coefficients for 13 characters are given in Table 2. The perusal of the table revealed that grain yield per plant was positively and significantly correlated with days to ear emergence, days to maturity, vegetative period and effective tillers per plant. Days to maturity was associated with vegetative period but not with grain filling period. Association of grain filling period was non-significant with all the characters studied. This indicated that grain filling period may not be yield limiting factor in durum wheat.

Since the vegetative period plus the grain filling period make up the days to maturity, they are expected to be correlated with it, but grain filling was not found associated in our case. When the filling period tended to be shortened, its correlation coefficient would be smaller and some times may result into non-significant values. In fact, because of the effects of late-season stress as occurring frequently in the region, this might have restricted the length of growing period. Thus, if a line had a long vegetative period, it was forced to fill its kernels in short period, whereas if it had a short vegetative period, then a longer period was available for kernel filling. Chavada and Monpara (2007) also found non-significant correlation between grain yield and grain filling period while working with eight durum wheat crosses. Significant positive association was observed by Gebeyehou *et al*. (1982) in durum wheat and Tiwari (2007) in spring wheat, whereas Knott and Gebeyehou (1987) reported the association as negative in one year and positive in another year. Thus, results indicated that it occurs only under certain environmental conditions.

The association of effective tillers per plant was relatively strong and positive with grain yield. Its positive association with days to ear emergence and days to maturity was moderate and undesirable since our objective is to develop early varieties with higher grain yield. Quisenberry (1967) suggested that timing of tiller production, its number and final size of tillers have critical effects on final grain weight, whereas Jarrah and Gerg (1997) reported that under temperate conditions, grain yield was strongly correlated with tillering capacity, spike fertility and test weight.

Spike length, spikelets per spike and grains per spike were associated among themselves and with longer vegetative period. They are known to be the components of sink capacity and largely determined during the vegetative period, but were not correlated with grain yield per plant. Shorter vegetative period and earliness (days to ear emergence and maturity) was associated with low grain yield. Grain filling period was independent of these characters as it had shown non significant correlations. Similar results were obtained by Rasmusson *et al*. (1979) in barley and opined that improvement of yield may be possible through manipulation of these growth periods in a breeding programme.

Plant breeders are always tended to develop early varieties. In fact, the yield of such early maturing plants is generally low on per plant basis. One of the reasons of decrease in per plant yield is shortening in the duration of the reproductive phase that is, flowering to physiological maturity, together with reduction in their vegetative phase. Our effort should be to cut down the vegetative phase

Table 2 : Genotypic correlation coefficient between grain yield and some agronomical and physiological growth parameters in durum wheat

Characters	Days to maturity	Vegetative period	Grain filling period	Plant height (cm)	Effective tillers/ plant	Flag leaf area (cm^2)	Spike length	Spikelets/ spike	Grains/ spike	100-grain weight (g)	Harvest index (%)	Grain yield/ plant (g)
Days to ear emergence	0.91**	0.93**	-0.20	0.54*	0.47*	0.64**	0.69**	0.93**	0.51*	-0.40	0.82**	0.44*
Days to maturity		0.87**	0.10	0.60**	0.46*	0.66**	0.71**	0.94**	0.56**	-0.33	-0.76**	0.55**
Vegetative period			-0.42	0.53*	0.33	0.65**	0.73**	0.96**	0.60**	-0.42	-0.73**	0.47*
Grain filling period				0.03	0.18	-0.09	-0.15	-0.20	-0.18	0.24	0.08	0.07
Plant height(cm)					-0.15	0.73**	0.66**	0.73**	0.24	-0.17	-0.65**	0.06
Effective tillers/plant						0.38	-0.18	0.21	-0.12	-0.34	0.32	0.69**
Flag leaf area(cm^2)							0.81**	0.81**	0.52*	-0.38	-0.73**	0.17
Spike length								0.88**	0.70**	-0.38	-0.61**	-0.09
Spikelets/ spike									0.62**	-0.45*	-0.84**	0.37
Grains/spike										-0.73**	-0.45*	0.08
100-grain weight(g)											0.69**	0.04
Harvest index (%)												-0.06

* and ** indicates significance of values at P=0.05 and 0.01, respectively

with no reduction in the grain filling period for maximum partitioning and grain filling. On the other hand length of two growth period depends upon the environmental factors, particularly temperature. However, it was suggested that increase in yield of wheat may be possible by achieving optimal duration for the vegetative and grain filling periods of growth (Gupta, 1992).

The utilization of genetic variation like Kiwi's' identified in this study would be very useful in manipulation of physiological growth parameters for obtaining higher yielding genotypes.

REFERENCES

Al-jibouri, H.A., Miller, P.A. and Robinson, H.F. (1958). Genotypic and environmental variance and covariance in an upland cotton of interspecific origin. *Agron. J.*, **50** : 633-636.

Allard, R.W. (1960). *Principles of Plant Breeding*. John Wiley and Sons. Inc., New York,

Amar, F.B. (1999). Genetic advance in grain yield of durum wheat under low rainfall condition. *Rachis*, **18** : 31-33.

Bingham, J. (1969). The physiological determinants of grain in cereals. *Agric. Prog.*, **44** : 30-42.

Burton, G.W. (1952). Quantitative inheritance in grasses. *Proc. 6th Intrn. Grasslands Cong.*, **1** : 277-283.

Chavada, S.K. and Monpara, B.A. (2007). Heritability and interrelations of maturity components and grain yield in eight durum wheat crosses. *Natnl. J. Pl. Improv.*, **9** : 19-22.

Gebeyehou, G., Knott, O.R. and Baker, R.J. (1982). Relationship among duration of vegetative and grain filling phases, yield components and grain yield in durum wheat cultivars. *Crop Sci.*, **22** : 287-290.

Gupta, U.S. (1992). Crop improvement for earliness. In: *Crop Improvement*. Vol. 1. *Physiological attributes*. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, pp109-130.

Jarrah, M. and Gerg, I. (1997). Variability of morpho-physiological traits of Menditerranean durum wheat cultivars. *Rachis*, **16** : 52-57.

Knott, D.R. and Gebeyehou, G. (1987). Relationships between the length of the vegetative and grain filling periods and agronomic characters in three durum wheat crosses. *Crop Sci.*, **27** : 857-866.

Nass, H.G. and Reiser, B. (1975). Grain filling period and grain yield relationships in spring wheat. *Canadian J. Pl. Sci.*, **55** : 673-678.

Quisenberry, K.S. (1967). *Wheat and wheat improvement*. American Society of Agronomy. Wisconsion, USA.

Rasmusson, D.C., Mclean, I. and Tew, T.L. (1979). Vegetative and grain filling periods of growth in barley. *Crop Sci.*, **19** : 5-9.

Shimelis, H.A. (2006). Associations of yield and yield components among selected durum wheats (*T. turgidum* L.). *S. Afr. J. Plant Soil*, **23** : 305- 310.

Stickler, F.C., Wearden, S. and Pauli, A.W. (1961). Leaf area determination in grain sorghum. *Agron. J.*, **53** : 187-188.

Talbert, L.E., Lanning, S.P., Murphy, R.L. and Martin, J.M. (2001). Grain filling duration in twelve hard red spring wheat crosses: Genetic variation and association with other agronomic traits. *Crop Sci.*, **41** : 1390-1395.

Tiwari, V. (2007). Grain filling duration as a means for increasing yield in spring wheat. *Indian J. Genet.*, **67** : 365-368.

Received : January, 2009; Accepted : March, 2009