Asian Journal of Agricultural Research 5 (3): 194-200, 2011
ISSN 1819-1894 / DOI: 10.3923/ajar.2011.194.200

Physiological Traits in Integration with Yield and Yield Components in Wheat (*Triticum aestivum* L.) Study of their Genetic Variability and Correlation

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ABSTRACT

The present study was aimed to determine whether physiological traits could be taken into the selection criteria in integration with yield and yield components to achieve a successful breeding programme. Analysis of variance revealed significant differences for MSS values of all 50 lines for all the traits under study. High Phenotypic Coefficient of Variation (PCV) and Genotypic Coefficient of Variation (GCV) on the basis of pooled data was obtained for grain yield per plot, tillers per m^2, harvest index and 1000-grain weight. Among the physiological traits high PCV and GCV was obtained for seed vigour index and leaf nitrogen while chlorophyll-a, b and total chlorophyll records moderate estimates of PCV and GCV. Heritability accompanied with high genetic advance as percent mean was observed highest for grain yield per plot, seed vigour index, leaf nitrogen content, harvest index, spike length, grains per spike, 1000-grain weight, chlorophyll b and chlorophyll-a, suggesting selection for these traits may be rewarding. All the physiological traits along with yield components exhibited significantly positive correlation with grain yield per plot at both phenotypic and genotypic levels. On the basis of study it is suggested there is a great need to give emphasis on physiological breeding approach to integrate with conventional breeding methods as compliment factor to break present yield ceiling and develop photosynthetically efficient and stress tolerant wheat varieties. Further the above said physiological traits which have significant correlation with yield and high heritability accompanied with genetic advance should be taken into the selection criteria for breeding methods.

Key words: *Triticum aestivum* L., genetic variability, correlation, physiological traits, yield parameters

INTRODUCTION

Wheat (*Triticum aestivum* L.) belongs to family Gramineae is one of the most important crop of the world. The world wide importance of wheat can be realized from the fact that FAO symbol is a bread wheat spike with the Latin motto *Fiat Panis* meaning let there be bread. Wheat is the dominant grain of the world commerce. It is used to produce a large variety of foods that include many kinds and types of breads, cakes, breakfast foods, biscuits and confectionary items. It is a good source of carbohydrates, protein and other important minerals and vitamins. Wheat is the second largest food crop of our county with the production of about 73 million tons from the area of about 28 million hectares.

Undoubtedly, wheat breeding programme world wide has achieved significant genetic gains in yield potential without aid of physiological selection tools (Rajaram and Van-Ginkel, 1996) but plant breeders, as well plant physiologists, generally agree that future success will be realized to a greater extent by integration of these two disciplinary research (Jackson *et al.*, 1996). Physiological selection techniques are now being evaluated for their role as complementary tools in the wheat breeding research at CIMMYT (Reynolds *et al.*, 1998).

Photosynthesis is the most important physiological event on the earth. It serves as world's largest solar battery. The most important photosynthetic pigments in the chloroplast are chlorophyll-a and chlorophyll-b. Chemically, they differ from each other and absorb light of different wave lengths to perform photosynthesis. They perform important function in the absorption and exploitation of light energy, thereby influencing photosynthetic efficiency (Pang and Dong, 1995). Increasing chlorophyll content in crops is effective way to increase biomass production and grain yield (Wang *et al.*, 2008). Leaf nitrogen concentration on the other hand is important because nitrogen is the core component of chlorophyll molecule as the structural component in porphyrin ring and thus its content in the leaf is directly proportional to chlorophyll content (Rahman *et al.*, 2007). Up to 75% of the reduced nitrogen present in photosynthetically active cells of cereal crop leaves is located in the chloroplast (Peoples and Dalling, 1988; Hortensteiner and Feller, 2002). Optimum plant population is one of the most crucial factor for obtaining higher production and profitability for any crop, which is generally influenced by vigour status of seed. Wheat breeders are continuously seeking the improvement in wheat through various ways to ensure a near perfect stand of crop, which in turn depends upon good quality seed with good germination followed by vigorous seedlings, which can help the crop to escape the hazards of water stress conditions etc., Early seedling vigour is considered an essential component of plant development under most environmental conditions (Khan *et al.*, 2002).

In any crop improvement programme evaluation of germplasm for identification of genetic variability in various traits is very important, mostly when considering the adoption of new traits (like some physiological traits in present study) to create further variability through hybridization is of vital importance. The extent of possible improvement for a particular character mainly depends upon the extent of genetic variability and its heritable portion. On the other hand correlation coefficient gives us an idea about the various associations existing with yield and yield components, therefore to bring a change in yield or other yield related traits to a desired level, proper understanding of association between yield, yield component traits or new traits which are being introduced in breeding programme is must (Malik and Malik, 2005). Keeping in view above concept, chlorophyll-a, b, leaf nitrogen and seed vigour index were taken as physiological traits in the present study to integrate them into the conventional breeding methods as selection criteria to evolve photosynthetically efficient and moisture stress wheat lines in future.

MATERIALS AND METHODS

The experiment was conducted in the Department of Genetics and Plant breeding/Seed Science and Tech., Sam Higginbottom Institute of Agriculture, Technology and Sciences (formerly AAI-DU) Deemed University, Allahabad; India during rabi season in two years (2007-08 and 2008-09) for both laboratory and field experiments. The experimental material consists of 50 elite spring wheat lines from CIMMYT, Mexico. Physiological traits viz. Seed vigour index was calculated from procedure given by Abdul-Baki and Anderson (1973), Chlorophyll content (a and b) was estimated from flag leaf at flowering stage by the method given by Arnon and Stout (1939) and Leaf nitrogen was estimated by Micro-Kjeidahl method (Horwitz, 1970) from flag leaf too. The field experiment was laid down in Randomized Block Design with three replications during two consecutive years (2007-08 and 2008-09). The observations were recorded on five randomly selected plants from each line in each replication for Spike length, Grains per spike and 1000-grain weight except Harvest Index and Grain yield per plot which were calculated from plot basis of 6 m^2 size and Tillers per m^2 which was calculated from an area of one meter square from each plot.

Statistical analysis: The pooled data obtained from two years (2007-08 and 2008-09) were subjected to analysis of variance by Fisher (1936), phenotypic and genotypic coefficient of variance (PCV and GCV) by Burton and Devane (1953), Heritability (broad scence) by Burton and Devane (1953), Genetic advance by Johnson *et al.* (1955) and correlation coefficient (phenotypic and genotypic) by Al-Jibouri *et al.* (1958).

RESULTS AND DISCUSSION

Estimation of variability is one of the most important factors in any crop for identification of lines, which can generate further variability so that artificial selection of desirable genotype could be made. Analysis of variance of two years data revealed significant differences for both physiological as well as yield and yield component traits, indicating relatively high magnitude of genetic diversity in these lines under study. Analysis of variance on the basis of mean sum of squares of two years (2007-08 and 2008-09) was observed highest for grains per spike (104.21 and 107.631), seed vigour index (53.32 and 58.37), 1000-grain weight (52.24 and 55.54) and tillers/m^2 (43.22 and 50.98). while lowest analysis of variance on the basis of mean sum of squares was observed in chlorophyll-a (0.525 and 1.21), total chlorophyll (0.822 and 2.11), chlorophyll-b (1.26 and 1.99) and grain yield per plant (2.45 and 3.72). Two years pooled mean performances and range of different traits is given in the Table 1. The magnitude of genetic and environmental effects involved in the expression of different characters were determined by phenotypic and genotypic coefficient of variation. Table 2 reveals that, the magnitude of Phenotypic Coefficient of Variation (PCV) was found higher than the Genotypic Coefficient of Variation (GCV) for all the characters. High coefficient of variation (GCV and PCV) among yield and yield

Table 1: Analysis of variance, Range and Mean of 11 Physiological, yield and yield component traits in 50 elite spring lines of wheat

	Mean sum of square (treatments)				
Traits	(2007-08)	(2008-09)	Range (pooled)	Grand mean (pooled)	Standard error
Seed vigour index	53.324**	58.379**	817.17-1184.17	949.23	0.318
Leaf nitrogen (mg g^{-1})	1.428**	1.373**	2.22-5.09	3.47	0.104
Chlorophyll-a (mg g^{-1})	0.525**	1.212**	0.70-1.87	0.974	0.241
Chlorophyll-b (mg g^{-1})	1.260**	1.992**	0.30-0.91	0.507	0.149
Total chlorophyll (mg g^{-1})	0.822**	2.110**	1.17-2.84	1.812	0.37
Tillers (m^2)	43.22**	50.986**	360-543	458.12	0.173
Spike length (cm)	5.424**	3.528**	8.93-12.68	10.82	0.30
Grains per spike	104.21**	107.631**	40.67-56.31	48.38	0.182
1000-grain weight (g)	52.24**	55.545**	28.81-47.48	39.29	0.127
Harvest index (%)	30.549**	32.837**	29.83-49.67	41.33	0.18
Grain yield/plot (kg)	2.451**	3.721**	1.80-3.20	2.52	0.128

**Significant at 5% level and *Significant at 1%, respectively

Table 2: GCV, PCV, Heritability and genetic advance (as percentage of mean) for 11 physiological, yield and yield component traits in wheat

Traits	GCV	PCV	Heritability (%) (Broad scence)	Genetic advance	Genetic advance as (%) of mean (Genetic gain)
Seed vigour index	11.24	12.66	78.80	5.54	20.56
Leaf nitrogen (mg g^{-1})	10.04	11.32	79.05	0.64	18.44
Chlorophyll "a" (mg g^{-1})	7.74	8.39	70.10	0.10	11.44
Chlorophyll "b" (mg g^{-1})	8.95	10.31	78.40	0.08	15.77
Total chlorophyll (mg g^{-1})	9.25	10.37	74.00	0.14	9.91
Tillers per m^2	10.61	12.46	68.20	5.18	18.59
Spike length (cm)	6.62	8.32	71.50	1.85	17.09
Grains/spike	8.95	11.09	65.20	7.21	14.90
1000-grain weight (g)	10.66	12.05	71.90	7.63	19.41
Harvest index (%)	10.31	12.10	72.60	8.93	21.60
Seed yield per plot	12.42	14.87	82.05	0.85	21.32

component traits were observed for grain yield per plot (12.42 and 14.87), tillers per m^2 (10.61 and 12.46), harvest index (10.30 and 12.10) and 1000-grain weight (10.66 and 12.05). GCV and PCV for yield attributing traits in wheat were also reported by Walia and Garg (1996). Among the physiological traits high GCV and PCV were observed for seed vigour index (11.24 and 12.66) and leaf nitrogen (10.04 and 11.32). While chlorophyll-a (7.74 and 8.39), chlorophyll-b (8.95 and 10.31) and total chlorophyll (9.25 and 10.37) recorded moderate coefficient of GCV and PCV. Coefficient of variation for seed vigour traits also reported by Khan *et al.* (2002). Munir *et al.* (2007) reported genetic variability for chlorophyll content in wheat. The estimate of genotypic coefficient of variation reflects the total amount of genotypic variability present in the material. However, the proportion of this genotypic variability which is transmitted from parents to the progeny is reflected by heritability. In the present investigation, all the 11 characters i.e., Physiological as well as yield and yield components scored high to moderate heritability. High heritability among physiological traits scored by leaf nitrogen (79.05) followed by seed vigour index (78.80), chlorophyll-b (78.40), chlorophyll-a (70.10) and total chlorophyll (74.00). These findings are supported by Ghai *et al.* (1969) who reported high heritability for chlorophyll content. Among yield and yield component traits, highest heritability was estimated for grain yield (82.05) followed by harvest index (72.60). Whereas, moderate heritability was recorded for 1000-grain weight (71.90), spike length (71.50), tillers per m^2 (68.20). These findings are in conformity with Sexana *et al.* (2007). From the present investigation it was observed that all the physiological traits with some other important yield component traits show highest heritability indicating these traits are controlled by additive gene action. Hence, these physiological traits along with other yield attributes have great opportunity to be adopted as selection criteria in future wheat breeding programmes to enhance yield. According to Johnson *et al.* (1955), a heritable estimates along with genetic advance as percent mean is more meaningful than the heritability alone in predicting the ultimate effect of solution. Our findings on grain yield per plot, seed vigour, leaf nitrogen content, harvest index and spike length are quite encouraging since these characters exhibited high heritability estimates along with high genetic advance and these traits were least influenced by the environment and might show least genotype x environment interaction. Similar findings were observed by Raha and Ramgiri (1998).

To bring a change in yield or other yield related traits to a desired level, proper understanding of association between yield, yield component traits or new traits which are being introduced in breeding programme is must. This approach might be useful in selection of traits associated with highest expression of yield and improvement of the character without sacrificing much in other traits. The genotypic and phenotypic correlation coefficients were worked out on the basis of pooled data of two years. In general, genotypic correlation coefficients were higher in magnitude than the phenotypic correlations. This indicates that there was high genetic relationship between the traits under study and environment has not much influencing in reducing their actual association. The data illustrated in Table 3, indicates that all the traits viz. seed vigour index (0.814 and 0.671), chlorophyll-a (0.713 and 0556), chlorophyll-b (0.574 and 0.503), total chlorophyll (0.714 and 0.683), leaf nitrogen (0.624 and 0.512), tillers per m^2 (0.412 and 0.362), spike length (525 and 0.443), grains per spike (0.712 and 0.632), harvest index (0.797 and 0.599) and 1000-grain weight (0.903 and 0.812) had significantly positive correlation with grain yield per plot at both genotypic and phenotypic levels. Positive and significant correlation of above physiological traits with yield and yield components indicates strong association of these traits with yield. Therefore, by increasing the value of these traits by breeding and selection, yield may be easily pushed up. Suggesting that selection for these traits will be useful in improving grain yield. It has also been proved that physiological traits like chlorophyll (a, b and total), leaf nitrogen and seed vigour index taken in the present study along with other yield traits have showed strong positive correlation with grain yield. Hence, these physiological traits could be integrated with conventional

Table 3: Genotypic and phenotypic correlation coefficient among different genotypic wheat (Pooled)

Traits		SV	LN	Chl-a	Chl-b	T.Chl.	T/m2	SL	G/S	GW	HI	GY
SV	Rg	1.000	0.464**	0.452**	0.398**	0.695**	0.429**	0.302	0.485**	0.733**	0.693**	0.814**
	Rp	1.000	0.400**	0.400**	0.327	0.549**	0.384**	0.209	0.380**	0.560**	0.532**	0.671**
LN	Rg		1.000	0.503**	0.517**	0.600**	0.178	0.259	0.467**	0.607**	0.562**	0.624**
	Rp		1.000	0.482**	0.482**	0.570**	0.142	0.193	0.335**	0.541**	0.497**	0.512**
Chl-a	Rg			1.000	0.577**	0.744**	0.327	0.372**	0.375**	0.679**	0.569**	0.713**
	Rp			1.000	0.501**	0.600**	0.225	0.351**	0.288	0.537**	0.571**	0.556**
Chl-b	Rg				1.000	0.524**	0.175	0.342**	0.194	0.595**	0.412**	0.574**
	Rp				1.000	0.491**	0.105	0.332*	0.132	0.444**	0.450**	0.503**
T.Chl	Rg					1.000	0.321	0.392**	0.404**	0.723**	0.447**	0.714**
	Rp					1.000	0.284	0.342**	0.345**	0.642**	0.392**	0.683**
T/m^2	Rg						1.000	-0.422**	0.279	0.172	0.335	0.412**
	Rp						1.000	-0.352**	0.212	0.133	0.287	0.362**
SL	Rg							1.000	0.524**	0.471**	0.423**	0.525**
	Rp							1.000	0.475**	0.302	0.338*	0.443**
G/S	Rg								1.000	-0.421**	0.492**	0.712**
	Rp								1.000	-0.384**	0.420**	0.632**
GW	Rg									1.000	0.666**	0.903**
	Rp									1.000	0.497**	0.812**
HI	Rg										1.000	0.797**
	Rp										1.000	0.599**
GY	Rg											1.000
	Rp											1.000

**Significant at 5% level and *Significant at 1%, respectively., S.V: Seed Vigour, L.N: Leaf nitrogen Chl-a: Chlorophyll-a, Chl-b: Chlorophyll-b, T.Chl: Total chlorophyll, T/m 2: Tillers/m2, SL: Spike length, G/S: Grains/spike, G.W: Grain weight, H.I: Harvest index, G.Y: Grain yield breeding techniques as new selection criteria to enhance the yield *per se*. Our findings are supported by Singh *et al.* (2007) who reported significant positive association of seed vigour with yield. Iimulwar *et al.* (2003) reported significant positive correlation of chlorophyll with yield. Saleem *et al.* (2006) observed positive and significant correlation of tillers per plant, spike length and 1000-grain weight with grain yield and Sexana *et al.* (2007) who reported strong positive and significant association of harvest index and tillers per plant with grain yield.

CONCLUSION

Because of limited knowledge of the physiological processes involved in harnessing maximum grain yield, the identification of traits related to grain yield is most formidable task by the plant breeders. It is envisioned that selection for appropriate physiological traits may be quite helpful in enhancing the yield than by selecting for grain yield itself. The information derived from this study established the fact that physiologic breeding approach is right approach to increase the yield *per se* by integrating the important physiological traits with conventional breeding methods as selection criteria.

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