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RESEARCH ARTICLE :

Character association of wheat varieties under different degree of shades

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SUMMARY : Morphological, Physiological characters and yield components were studied in five wheat varieties in order to find out the genetic association of different characters towards grain yield under different degree of shades. The experiments were laid out in split-plot design with three main plot consisting three levels of light exposures *i.e.* full sunlight, 2/3 and 1/3 of full sunlight and five sub-plot treatments consisted of five varieties of wheat at GBPUA and T, Pantnagar during 2010-11 and 2011-12. The character association analysis revealed that grain weight/spike and 1000 grain weight had strong positive and significant correlation with gain yield during both the growing season. Fertile spikelets had a significant positive correlation with potential shoots m^{-2} during both years. Number of grains $spike^{-1}$ was positively associated with grain weight $spike^{-1}$, 1000 grain weight and days to 50 per cent heading in 2010-11 but it was negatively correlated with days to 80 per cent maturity in 2011-12.

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KEY WORDS :
Correlation Co-efficient, Wheat, Spikelet, Sunlight, Yield

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BACKGROUND AND OBJECTIVES

India harvested 93.82 million tonnes of wheat from 29 million hectare with the average yield of 3.07 tonnes per hectare (Economic Survey, 2015-16). Besides due to ever increasing population, the land resources are not capable of fulfilling the associated demands for food, fodder, timber, fuel etc and hence, increased pressure on the world's resources and natural ecosystems were inevitable, predictable and will become more severe in future. Wheat production needs to be augmented to meet food and nutritional security of the burgeoning population largely through enhanced productivity.

Dimming or shading not only reduce radiation but also increase the fraction of diffused light and alter the spectral quality. Diffuse light is more efficiently utilized by plants and can offset small decrease in direct radiation and actually enhance the CO_2 uptake, photosynthesis and plant growth. Mean while, with increasing intensity of shading, the fraction of blue light (400-500 nm) increases while of red light (600-700 nm) decreases, which might affect both physiological parameters as well as plant morphology (e.g. main culm development, tillers appearance and stomatal conductance) (Li *et al*., 2010).

In addition, light fractions distributed differently within the plant canopy as the upper sunlight leaves usually receive both diffuse and direct radiation while the lower shaded leaves receive more diffuse light. Thus, low light level is common for lower leaves, which are more shade tolerant and can use diffuse light more efficiently than direct irradiance (Gu *et al*., 2002).

In any agroforestry system, tree-crop interaction for solar radiation, moisture and mineral nutrients results in changed micro-climates, which in turn affect the productivity of component crops. While moisture and nutrient management could be agronomically manipulated, the crop/varietal selection is more important for shade tolerance in agroforestry. Yield reductions in various vegetative and grain crops have been reported due to such interactions but the crop yield loss may well be compensated bio-economically through growth/yield of tree component. Agroforestry is very specially stated to be a sustainable land management system (King and Chandler, 1978).

Genotypic variations exist in their performance with respect to agro-climatic conditions in general and availability of radiation in particular. The process of yield formation begins with seed sowing. The number of seedlings established, their assimilatory capacity in terms of leaf area and duration decide potential sink size in terms of number and size of wheat spikes. The environmental conditions prevailing during vegetative crop growth period determine the establishment of sink potential.

Hence, the efforts are required to identify crops and their varieties suitable for sub-optimal growth conditions (particularly the light) in agroforestry like situations and develop alternate production technologies to minimize the yield losses. Good vegetative growth is prerequisite for economic yield in any grain crop as it determines the ultimate sink size. In most important *Rabi* cereal crop *i.e.* wheat, the yield is determined by the number of spikes per unit area, number of grains per spike and 1000 grain weight. Character association reveals the measure of positive and negative influence of one independent variable upon the other dependent one. The value assigned to correlation is termed as Correlation co-efficient and is defined as the ratio of standard deviation in the independent variable and the present study carried was out by taking grain yield as the dependent variable and rest of the characters (yield attributes) as independent variables.

RESOURCES AND METHODS

The field experiments were conducted at the Norman Borlaug Crop Research Centre, G.B Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand during the winter season of 2010–2011 and 2011-12. Pantnagar is located at 29^{o}N latitude, 79.3^{o}E longitude and an altitude of 243.8 m above mean sea level in the Tarai belt of Shiwalik range of the Himalayan foothills. It falls under the sub-humid and sub-tropical climatic zone. The experiment was laid out in a split plot design with three replications. The main plot treatments comprised of three different levels of sunlight viz. full sunlight as control, and 66 % (using muslin cloth) and 33 % (using poplin cloth)of full sunlight as shade treatments while the sub-plot treatments consisted of five varieties of wheat*viz*.UP 2684, UP 2526, UP 2565, UP 2113 and PDW 233. The gross plot size was 1.61 x 5.0 m while the net plot size was 1.15 x 4.0 m. A row spacing of 0.23 m was maintained and the seed rate was 100 kg ha^{-1}.

Character association :

To find the association between two characters, the correlation co-efficients were worked out with the help of computer programme (STPR 5), designed and developed by department of mathematics and statistics of college of basic science and humanities (CBSH), Pantnagar.

OBSERVATIONS AND ANALYSIS

The correlation co-efficients between yields and its different attributes both during 2010-11 and 2011-12 are presented in Table 1 and 2. In the present study, grain yield exhibited a highly significant positive correlation with fertile spikelets spike-1 (0.9545) in 2010-11, but exhibited a significant negative correlation (-0.7398) in 2011-12. A significant positive correlation also occurred between grain yield and 1000 grain weight both during 2010-11(0.8923) and 2011-12 (0.7273).

The significant positive correlation occurred between grain yield and grain weight spike-1 (0.6157 and 0.7089) both during 2010-11 and 2011-12, respectively. A significant positive correlation also occurred between grain yield and spike length (0.5440) in 2010-11, but it was an exhibited a significant negative correlation (-0.7123) in 2011-12. Potential shoots m^{-2} (0.5310)

exhibited significant positive correlation in 2010-11, but it was not significant in 2011-12.

Fertile spikelets spike-1 had a significant positive (0.6173 and 0.5506) correlation with potential shoots m^{-2} both during 2010-11 and 2011-12. The thousand grain weight exhibited a significant positive correlation (0.8984) with fertile spikelets spike-1 in 2010-11 and it was significant negative correlation (-0.6231) in 2011-12. Thousand grain weight, 50 per cent heading and number of grain spike-1 exhibited a significant positive correlation with potential shoots (0.7306, 0.5955 and 0.6251, respectively) in only during 2010-11.

Grain yield is a complex character resulting from multiplicative interaction of yield components. Improvement in this trait by selection based on component characters appears to be more useful as compared to selection of yield per se, as has also been advocated by Graffius (1956). Since all these characters are correlated, the change in one of the character brings about a series of changes in other characters. Thus, to bring a change in yield or other characters to a desired level, proper understanding of association among the yield and yield attributing characters is must.

Grain yield exhibited a highly significant positive correlation with number of grains $spike^{-1}$ in 2010-11. These results are in accordance with the findings of Tiwari and Rawat (1993) and Subhani (2000). A significant positive correlation also occurred between grain yield and 1000 grain weight both during 2010-11 and 2011-12.

Grain yield had a significant positive correlation with . . . . . $^{-1}$ during both the years *i.e.* 2010-11

Table 1 : Correlation co-efficients between different yield attributes in wheat during 2010-11

Characters	Potential shoots m^{-2}	Spike length (cm)	Fertile spikelets $spike^{-1}$	Sterile spikelets $spike^{-1}$	Number of grains $spike^{-1}$	Grain weight $spike^{-1}$ (g)	1000 grain weight (g)	50% Heading	80 % Maturity	Grain yield q ha^{-1}
Potential shoots m^{-2}	1.0000	0.4042	0.6173*	0.3121	0.6251*	0.3863	0.7306**	0.5955*	0.0057	0.5310*
Spike length (cm)		1.0000	0.5851*	0.3236	0.3807	0.5274*	0.5122	0.3692	-0.0336	0.5440*
Fertile spikelets $spike^{-1}$			1.0000	0.3288	0.7711**	0.6667**	0.8984**	0.4538	-0.1033	0.9545**
Sterile spikelets $spike^{-1}$				1.0000	0.6464**	0.5507*	0.2304	0.4801	0.8210**	0.1182
Number of grains $spike^{-1}$					1.0000	0.7115**	0.7110**	0.5273*	0.3559	0.6333*
Grain weight $spike^{-1}$ (g)						1.0000	0.5104	0.0723	0.2969	0.6157*
1000 grain weight (g)							1.0000	0.4672	-0.2722	0.8923**
50% Heading								1.0000	0.3066	0.2560
80 % Maturity									1.0000	-0.3421
Grain yield q ha^{-1}										1.0000

Table 2 : Correlation co-efficients between different yield attributes in wheat during 2011-12

Characters	Potential shoots m^{-2}	Spike length (cm)	Fertile spikelets $spike^{-1}$	Sterile spikelets $spike^{-1}$	Number of grains $spike^{-1}$	Grain weight $spike^{-1}$ (g)	1000 grain weight (g)	50% Heading	80 % Maturity	Grain yield q ha^{-1}
Potential shoots m^{-2}	1.0000	0.0614	0.5506*	0.0984	-0.1021	-0.1969	-0.0357	0.4358	0.2972	-0.3818
Spike length (cm)		1.0000	0.4191	0.8117**	0.3035	-0.4782	-0.8029**	-0.0174	-0.5543*	-0.7123**
Fertile spikelets $spike^{-1}$			1.0000	0.6742**	0.1480	-0.3855	-0.6231	0.3486	0.1996	-0.7398**
Sterile spikelets $spike^{-1}$				1.0000	0.3375	-0.3557	-0.9223**	0.0313	-0.3068	-0.7246**
Number of grains $spike^{-1}$					1.0000	0.4634	-0.2513	-0.4986	-0.6955**	-0.0940
Grain weight $spike^{-1}$ (g)						1.0000	0.3366	-0.5199*	-0.3061	0.7089**
1000 grain weight (g)							1.0000	0.0335	0.3594	0.7273**
50% Heading								1.0000	0.7255**	-0.3790
80 % Maturity									1.0000	-0.0003
Grain yield q ha^{-1}										1.0000

and 2011-12. Fertile spikelets spike-1 had a significant positive (0.617 and 0.551) correlation with potential shoots m^{-2} during both the years *i.e.* 2010-11 and 2011-12 and significant positive correlation also occurred between fertile spikelets $spike^{-1}$ and spike length but only during 2010-11.

The correlation co-efficient simply indicates the degree of association among the characters contributing towards economic (grain) yield. It helps in evaluating the relative influence of yield attributes on grain yield and permits the separation of correlation co-efficient into the measure of direct and indirect effect.

Conclusion:

The character association analysis revealed that grain weight/spike and 1000 grain weight had strong positive and significant correlation with gain yield during both the growing season (Table 1 and 2). Fertile spikelets had a significant positive correlation with potential shoots m^{-2} during both years. Number of grains $spike^{-1}$ was positively associated with grain weight $spike^{-1}$, 1000 grain weight and days to 50 per cent heading in 2010-11 but it was negatively correlated with days to 80 per cent maturity in 2011-12.

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