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Designing Future Wheats with Emphasis on Sink Capacity and Crop Growth Duration

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Abstract

Sixteen wheat varieties (including nine short duration and seven long duration) were sown during last week of December 2003, 2004 and 2005 to analyze the impact of sink capacity and crop growth duration on yield potential of a wheat genotype. The grain yield superiority ranged from 4.4 to 22.8% among the short duration varieties viz. HW 2045, HD 2833, DL 788-2 and DBW 16, over the best popular variety PBW 373 while it ranged from 57.8 to 25.9% in longer duration varieties i.e. DL 803-3, DL 153-2, HD 2824, DL 784-3 and HD 2733, over best control variety HD 2687. The results indicated that varieties of longer crop duration might perform well under late sown conditions also. Out of sixteen varieties, long duration variety DL 803-3 exhibited 29.3% yield superiority over late sown check PBW 373. The wide range of yield component traits like 1, 000-grain weight that was 45 g (HW 2045), 43 g (Dl 788-2, HD 2781), 40 g, (HD 2824, HD 2733) and 39 g (HD 2833, DL 153-2) indicated the importance of sink capacity over crop growth duration which might help in the promotion of longer duration varieties under late sown conditions. Thus, it may be suggested that varities of longer crop duration having bold grains with high grain number could be used for planting under late sown conditions for genetic diversification in Indo-gangetic plains zone. Thus there is an urgent need to establish criteria for the formulation of future wheat ideotype having increased sink capacity with adjustable crop growth duration. Thus, present investigation defined the optimum characterization of traits that will be of help to researchers in designing future wheats.
Key words : Crop duration, Plant type, Future wheats, Sink capacity.

In India, wheat is generally sown in November as timely sown and in December under late sown conditions. For timely sown conditions, varieties having longer crop durartion (130—135 days) are preferred for cultivation, whereas under late sown conditions, shorter crop duration genotypes (105–110 days) are preferred for cultivation. Long duration varieties though are exposed to low temperature at tillering stage but grain filling is almost complete before the temperature shoots up, whereas short duration varieties are exposed to terminal heat under delayed sowing conditions. Generally, grain weight and grain number in short duration varieties compensate the yield reduction occurred due to less tillering compared to long duration genotypes. Therefore, a study was conducted to access the impact of crop growth duration and sink capacity on grain yield and its contributing traits by sowing long duration varieties in late sown conditions.

Methods

Nine short duration and seven long duration varieties were grown at krishi Vigyan Kendra, Nagina (Bijnor) in last week of December, 2003, 2004 and 2005. Popular variety HD 2687 for timely sown and PBW 373 for late sown conditions were used as check varieties. Data for grain yield, days to flowering and maturity, plant height, 1,000-grain weight, threshability, grain color and texture were recorded in all the three years and pooled data were used for analysis of findings.

Results and Discussion

Among the long duration varieties namely, DL-803-3, DL 153-2, HD 2824, DL 784-3 and HD 2733, yield superiority was recorded between 57.8 to 25.9% over the longer duration check variety HD 2687, while

Table 1. Phenological and yield components data of long duration wheat varieties.

Varieties	Grain yield (q/ha)	Percent superiority over HD 2687	Percent superiority over PBW 373	Days to flowering	Days to maturity	Plant height (cm)	Threshability	Grain color	Grain texture	1000 grain weight (g)
DL 153-2	32.2	57.8	29.3	71	110	84	Easy	Amber	hard	38
HD 2824	29.5	44.6	18.5	72	111	86	„	„	semi-hard to hard	39
DL 784-3	28.0	37.2	12.5	77	114	89	Medium	„	semi-hard	40
DL 803-3	26.4	29.4	6.0	70	114	81	Easy	„	semi-hard to hard	38
HD 2733	25.7	25.9	3.2	76	115	86	Medium	„	semi-hard	40
HD 2781	18.8	–	–	70	113	70	Easy-Medium	„	hard	43
HD 2687 (Check)	20.4	–	–	75	115	90	Medium	„	„	33
PBW 373 (Check)	24.9	–	–	74	110	86	Easy	„	semi-hard to hard	35

these varieties also observed 29.3 to 3.2% yield superiority over the short duration check variety PBW 373 (Table 1 and Fig 1). In short duration varieties HW 2045, HD 2833, DL 788-2 and DBW 16 reported 22.8, 20.5, 16.0 and 4.4% grain yield superiority over PBW 373, respectively. However, longer duration variety DL 803-3 occupied first position in yield and was found to be superior over PBW 373 by 29.3% increment in yield. Table 2 shows that among the 16 varieties were almost one week late in flowering and in maturity compared to short duration varieties that indicated the wider adaptability of longer duration varieties under delayed planting conditions. Yield potential of a genotype depends upon the source and sink relationship. Researchers emphasized that highest increases in genetic yield potential have been achieved by inducing genetic changes in source capacity while in the traits of sink capacity have not been much changed (Austin et al. 1980, Ladent and Stoy 1988). Therefore, taking into consideration the role of yield contributing traits with phenological behavior, the present study was an attempt to find out the yield defining traits which might provide preliminary information for designing a desirable plant type for future wheats.

The findings revealed that plant height of promising varieties ranged from 81 to 89 cm which is, in general, short plant stature due to shorter growth duration instead of required longer duration. The short duration varieties possess the plant stature in full extent because of favorable conditions. It was remarked that sink capacity limits the genetic yield potential to a much larger degree than sources capacity (Dencic and Borojevic 1992). Therefore, crop growth duration with shorter plant stature has less impact with shorter plant stature has been impact on yield potential than the spike productivity via increase in spike length , number of spikelets, number of grains per spike, grain mass/spike (Borojevic 1982 , Smocek 1988). Promising varieties of longer duration viz DL 803-3, DL 153-2, HD 2824, DL 784-3 and HD 2733 possess 38 to 40 g weight of thousand grains. Variety

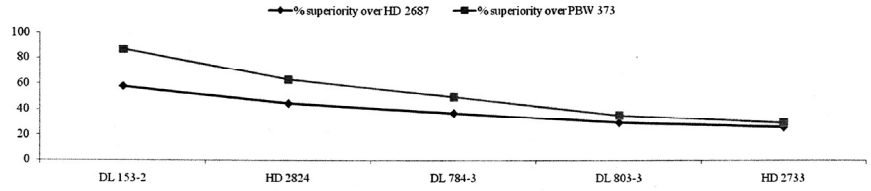

Figure 1. Performance of long duration varieties over both the Checks.

Table 2. Phenological and yield components data of short duration wheat varieties.

Varieties	Grain yield (q/ha)	Percent superiority over PBW 373	Days to flowering	Days to maturity	Plant height (cm)	Threshability	Grain color	Grain texture	1000 grain weight (g)
HW 2045	30.6	22.8	62	101	97	Easy	Amber	hard	45
HD 2833	30.0	20.5	60	102	80	Medium	,,	semi-hard to hard	39
DL 788-2	28.9	16.0	64	105	75	Easy-Medium	,,	,,	43
DBW 16	26.0	4.4	73	107	86	,,	,,	,,	38
HD 2643	25.0	–	68	108	78	,,	,,	semi-hard	41
WR 544	22.7	–	69	105	91	Easy	,,	semi-hard to hard	34
DBW 14	21.1	–	65	103	80	,,	,,	semi-hard	37
HDR 77	16.7	–	71	108	90	,,	,,	,,	33
PBW 373 (check)	24.9	–	74	110	86	,,	,,	semi-hard to hard	35

llike HD 2781 though had high thousand grain weight (43 g) but had comparatively low yield potential. Varieties viz. HW 2045, HD 2833, DL 788-2 and DBW 16 ranged from 45 to 38 g for short duration genotypes indicate the contribution of grain weight in grain yield. However, low yielding varieties like HD 2781 and HD 2643 even though have high thousand grain weight *per se* but are not capable for exposure of grain yield potential of a genotype to a great extent (Fig. 2).

Conclusion

To promote the promising varieties for a specific agro-climatic region (i e. longer duration genotypes under late sown conditions) to another region, it becomes important to restructure the present wheat plant into model plant type i e. ideotype which can fit well under different agro-climatic and sowing situations. In wheat, Donald (1968) proposed a ideotype which having short, firm, uniculm stem with small erect leaves and a large spike with long awns. Researchers at IARI, New Delhi designed a new plant type (NPT) wheat lines in 2001, having 274–541 tillers/m^2, 41–56 grains per spike and 45—52 g weight of thousand grains with 15—20% more yield potential than popular varieties having 446–514 tillers/m^2, 36–42 grains/spike and 36—39g weight of thousand kernels (Singh et al. 2001). They also concluded that negative correlation between the yield components have been broken leading to positive correlation between grain weight and grain number per ear resulting into high grain yield potential. The probable reason for bold and more grain number in NPT lines may be to increased availability of photosynthate for proper filling of sink leading to high grain weight and proper filling of all the grains in all spikelets resulting in higher number of grains per ear. NPT lines possess high 1,000-grain weight, higher number of grains per ear, higher biomass, long spike, dark green and broad leaves, thick stem with plant height 85 to 100 cm and

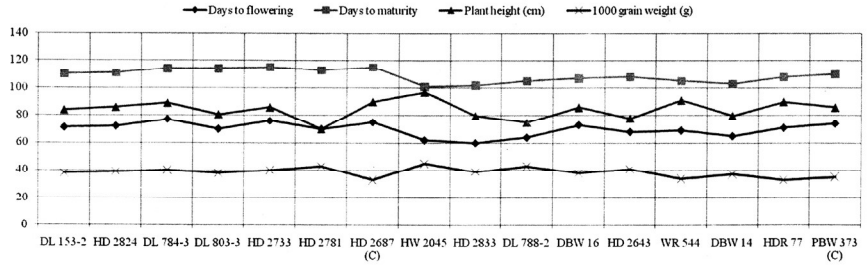

Figure 2. Graphical representation of important traits of 16 Wheat Varieties

good root system. While Dencic (1994) defined desired characteristics of spike as normal form, 10–15 cm length, 20—25 spikelets per spike, 1,000-grain weight about 40 g and an average of 2.5—3.0 grains per spikelet. In this context, our findings also provide a direction to classify the important yield components and their importance over phenological traits. In addition, our findings also suggest that short plant stature having amber color grain with semi-hard to hard texture might be considered at the time of designing a wheat ideotype suitable for cultivation across the agro-climatic regions.

By analyzing the concepts, findings of various researchers with present investigation, an ideotype of future wheat may be defined as : short plant stature highly resistant to lodging and tolerant to low and high temperature; dark green and broad leaves and thick stem ; optimum tillers, to decrease the competition for nutrient within the plant; long spike of normal form ; higher grains per spike ; bold grains (>40 g 1,000-grain weight) ; amber color grains with semi-hard to hard texture; and field resistance to major diseases.

It is not simple to realize an ideotype combines a larger number of positive traits. Therefore, by optimizing the positive traits in a manner and by strengthening the sink capacity with adjustable crop growth duration, efforts should be made by multidisciplinary team of scientists including breeders, physiologist, pathologist, agronomist for constructing the future wheat ideotype. The present investigation is an idea based on preliminary information which needs repeated efforts in future.

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