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EFFECT OF DWARFING GENES ON YIELD AND YIELD COMPONENTS OF TALL INDIAN WHEAT VARIETIES

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ABSTRACT

The effects of 3 dwarfing genes Rht 2, Rht 3 and Rht 1, 2 obtained from Tobari 66, Tordo's, Norin 10, Olesen, D 6899 and S 948A was studied on the expression of yield and yield components of 4 commercially grown tall Indian wheat varieties K 68, Hybrid 65, NP 846 and NP 876. Though, almost all the dwarfing genes reduced the plant height and enhanced the expression of grain yield, but the contribution of Rht 1, 2 in combination, from the source D 6899 with NP 846 was observed to be the highest (28.3%) followed by Rht 3 gene from Tordo's source (20.0%) with K 68. However, the Rht 1, 2 in combination. The increase in yield of the dwarf versions of the tall Indian varieties resulted primarily from an increase in the number of spikes per plant as also from the increase in the number of grains per spike.

Key words: Dwarfing genes, near-isogenic lines, nonrecurrent parent, Norin 10, yield components.

As a result of large scale cultivation of dwarf, high yielding varieties of wheat, a number of tall Indian commercial varieties with good agronomic base and adaptability are almost going out of cultivation. This is because of their comparatively poor grain yield. This, obviously, requires that their dwarf versions are developed utilizing suitable sources of dwarfing genes. But in doing so, the precise understanding of the effect of the different dwarfing genes (specially the Rht 2, Rht 3 and Rht 1, 2) on the grain yield and its components is considered essential. In the present investigation the effect of Rht 2, Rht 3 and Rht 1, 2 dwarfing genes was studied on yield and yield components of four commercially grown tall Indian wheat varieties.

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MATERIALS AND METHODS

The experimental material comprised of nine near-isogenic lines containing three height reducing genes, namely, Rht 2, Rht 3 and Rht 1, 2. These near-isogenic lines were developed by the conventional backcross method by incorporating the dwarfing (Rht) genes obtained from the six different sources, viz., Tobari 66 (Rht 2), Tordo's (Rht 3), Olesen (Rht 1, 2), D 6899 (Rht 1, 2) and S 948A (Rht 1, 2) into four tall Indian wheat varieties, namely, K 68, Hybrid 65, NP 846, and NP 876. These tall varieties were used as the recurrent parents. Tordo's was backcrossed with all the four recurrent parents, while the remaining dwarf and semi-dwarf sources were backcrossed to only one of the recurrent parent NP 846. In developing the near- isogenic lines, two backcross dosages followed by two selfings were done to detect the recessive dwarf version. Individual plant progenies of BC_2F_2 generation were grown. Five dwarf plants were selected and bagged. The F_3 generation of the backcrossed dwarf so obtained, were utilized in this study. Individual plant progenies obtained from the homozygous dwarf/semidwarf plants along with the parents of a given backcross were planted in Nested Design [1] with four replications. The row length was kept at 3 meters. The row to row and plant to plant distance was 30 cm and 10 cm, respectively. Data were recorded on plant height, grain weight/spike, spikes/plant, grains/spike, 1000-grain weight, and grain yield/plant at maturity.

RESULTS AND DISCUSSION

The analysis of variance for all the six characters indicated significant differences among the materials studied.

Mean data on plant height, grain weight/spike, number of spikes/plant, grains/spike, 1000-grain weight and grain yield/plant for the parents and for the near-isogenic lines are presented in Table 1. As can be seen, there was marked reduction in plant height due to incorporation of the different Rht genes.

The dwarfing genes Gai/Rht 1 and Gai/Rht 2 (either together or separately) and Gai/Rht 3 increased grain yield as well as the number of spikes/plant. Yield traits like grain weight/spike, grains/spike and 1000-grain weight either slightly reduced or only marginal improved (Table 2). Several workers [2–5] have observed increased grain yield of semidwarfs over tall wheat varieties.

In the near-isogenic lines containing Rht 2 gene increased the grain yield/plant in the dwarf version upto 11.9% over the tall version. Rht 1, 2 genes in combination gave 1.39% to 28.31% more yield in dwarf version over that of the tall versions (Table 2). Near-isogenic lines with Rht 3 gene gave 7.36% to 20.0% higher yields in dwarf version as compared to

Table 1. Mean values of six quantitative characters of tall wheat varieties, dwarfing gene sources and nine near-isogenic lines

Parent/isogenic line	Dwarfing gene (s)	Character means					
		plant height (cm)	spikes/ plant	grain weight/ spike (g)	grains/ spike	1000-grain weight (g)	grain yield (g)
K 68	—	110.2	8.9	0.8	24.6	36.1	8.0
Hybrid 65	—	104.1	9.6	0.9	25.8	35.1	8.8
NP 846	—	108.6	9.6	0.8	25.7	31.4	7.9
NP 876	—	104.0	7.0	1.1	34.7	31.1	7.6
Tobari 66	Rht 2	83.9	8.7	0.8	33.7	25.8	7.6
Tordo's	Rht 3	48.6	6.2	0.9	36.7	25.6	5.9
Norin 10	Rht 1,2	57.6	6.7	0.9	39.5	23.0	6.1
Olesen	Rht 1, 2	40.3	9.8	0.6	29.4	24.9	6.1
D 6899	Rht 1, 2	41.4	8.9	0.8	38.9	22.1	7.8
S 948A_1	Rht 1, 2	35.3	7.2	1.0	47.8	21.3	7.3
(Tobari 66 x NP 846) x NP 846^2	Rht 2	81.7	13.1	0.7	25.6	26.1	8.8
(Tordo's x NP 846) x NP 846^2	Rht 3	64.8	12.2	0.7	27.5	26.8	9.0
(Tordo's x NP 876) x NP 876^2	Rht 3	60.3	7.7	1.1	37.8	30.3	8.8
(Tordo's x Hybrid 65) x Hybrid 65^2	Rht 3	64.0	7.8	1.2	37.6	32.2	9.4
(Tordo's x K 68) x K 68^2	Rht 3	66.2	7.8	1.2	35.9	34.0	9.6
(Norin 10 x NP 846) x NP 846^2	Rht 1, 2	58.0	14.6	0.5	18.7	28.7	8.0
(Olesen x NP 846) NP 846^2	Rht 1, 2	61.4	11.6	0.7	24.5	30.1	8.6
(D 6899 x NP 846) x NP 846^2	Rht 1, 2	56.9	12.3	0.8	27.7	29.5	10.1
(S 948A_1 x NP 846) x NP 846^2	Rht 1, 2	71.7	13.1	0.6	21.0	28.9	8.0

their tall versions. This shows that almost all the dwarfing genes have increasing effect on grain yield. But the contribution of Rht 1, 2 (in combination) was numerically the highest. The contribution of Rht 3 gene was, however, relatively more than that of Rht 2. The highest increase of grain yield (28.3%) was observed in the case of Rht 1, 2, i.e., (D 6899 x NP 846) x NP 846^2 and the lowest (1.4%) was in the case of Rht 1, 2 itself, i.e., in the isogenic line from (Norin 10 x NP 846) x NP 846^2. Only difference being the source of material from which the dwarfing gene was taken. It indicates that the agronomic background of sources of dwarfism are of considerable importance in expressing the important agronomic attribute like grain yield. More or less, similar situation was observed in case of the different yield components.

Table 2. Expected effect of dwarfing genes on yield and yield components of near-isogenic lines over the tall parents

Near-isogenic line	Dwarfing genes	Effect on various character means (%)					
		plant height (cm)	spikes per plant	grain weight per spike (g)	grains per spike	1000-grain weight (g)	grain yield (g)
(Tobari 66 xNP 846) x NP 846^2	Rht 2	–24.7	35.4	–17.2	–0.5	–16.8	11.8
(Norin 10 x NP 846) x NP 846^2	Rht 1, 2	–46.5	50.9	–33.3	–27.0	–8.5	1.4
(Olesen x NP 846) x NP 846^2	Rht 1, 2	–43.4	20.0	–8.6	–4.5	–4.2	8.9
(D 6899 x NP 846) x NP 846^2	Rht 1, 2	–47.6	27.4	1.2	7.6	–6.0	28.3
(S 948A$_1$ x NP 846) x NP 846^2	Rht 1, 2	–33.9	35.3	–24.6	–18.2	–7.8	2.0
(Tordo's xNP 846) x NP 846^2	Rht 3	–40.2	25.5	–8.6	6.9	–14.5	14.0
(Tordo's x NP 876) x NP 876^2	Rht 3	–42.0	9.3	6.4	9.0	–2.4	15.5
(Tordo's x Hybrid 65) x Hybrid 65^2	Rht 3	–38.4	–18.9	32.9	45.3	–8.3	7.3
(Tordo's x K 68) x K 68^2	Rht 3	–39.9	–12.1	37.0	45.6	–5.8	20.0
Mean		–39.6	24.5	–2.9	12.8	–8.2	12.1

Overall, it appears that the incorporation of combination of dwarfing genes Rht 1, 2 in the genetic background of the isogenic line from the backcross (D 6899 x NP 846) x NP 846 appears to be promising. This is mainly because along with increasing the grain yield, it also reduced the plant height of variety NP 846. For further study, it is suggested that the desirable characteristics of both the tall and dwarf versions of these crosses may be further studied so that it could be possible to develop dwarf versions of the NP 846 or K 68 for the commercial cultivation with their desirable grain characteristics for which these varieties have been much liked and grown by the Indian farmers over years.

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