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Short Communication

Pathways of height reduction in induced mutants of barley

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In barley, reduced height mutants belong to the most frequently arising category. The reduction in culm length in several cases is associated with an improved straw stiffness resulting in increased lodging resistance [1]. The efficiency of a breeding program for the height of a crop can be improved if the various pathways by which final manifestation of this character can be reached are clearly understood.

The material consisted of six induced, true breeding morphological mutants in M_6 generation of barley isolated from gamma irradiated populations of cv. K-169. Yield trials were conducted at two locations during rabi 1997-98. The mutants along with their control (K-169) were grown in adjacent plots in three replications. Data were collected on main tiller of individual plants from 10 random plants per replication for culm length (from lowest node of the culm to the basal node of the spike, in cm), number of internodes/tiller, length of each internode (cm), spike length (cm), number of spike-nodes, and grain yield/plant (g). The basal internode of the culm was taken as the first and the one below the spike as the last.

Plant height in the mutants ranged from 72.4 cm (dwarf mutant) to 121.80 cm (lax spike mutant), while the control measured 125.8 cm. The maximum reduction (~ 45%) in height was observed in the dwarf mutant while in the spike mutant, the reduction was minimum (< 4%). Average number of productive tillers per plant, in general, showed an increase in dwarf, early maturing and semidwarf mutants compared to control while in chlorina mutant there was decrease (Table 1).

The data on number of internodes per culm (Table 2) reveals that in all the mutants except semidwarf early maturing mutant, there was slight decrease in average number of internodes per tiller compared to control. The mean lengths of all the internodes of a tiller in control and 6 mutants indicate that the basal internode is the smallest in length and the successive internodes have progressively increased length. The last internode that supports the spike is the longest, and accounts for about 32% of the total culm length in control and 30-37% in the mutants. There was considerable increase in the length of basal internode in all mutants except dwarf over that of control. In the dwarf mutant, however, there is significant reduction in the lengths of all internodes, maximum being in the middle ones. In dwarf, semidwarf and chilorina mutants, the major cause of height reduction was shortening of their respective spike bearing internode while in the other mutants it was the middle internodes which accounted for more height reduction. Over all, significant reduction occurred in the length of the spike bearing internode and the middle internodes in the mutants.

The reduction in plant height can be due to decrease in the number of internodes and/or length of internodes. There may be general decrease in internode length of all internodes of a culm or this alteration is limited to specific internodes of the plants [2]. The results of the present study suggest that shortening of the ear bearing internode and middle internodes was the major path of height reduction in most of the mutants. The role of reduced internode number in height reduction of mutants can not be ignored, even though it is small. In rice, dwarfism or semi-dwarfism is often combined with a reduction of the internode number.

Spike length in most of the mutants has recorded a decrease, to a maximum extent of 25% in dwarf and between 5-14% in other mutants. However, in lax spike mutant, there was an increase. Spike nodes, on the other hand, decreased in all except dwarf and semi-dwarf mutants. The association of culm nodes with spike nodes is positive but not significant (correlation coefficient, r = 0.69). The correlation between average length of spike and culm internodes (r = 0.41) is also not significant.

The height reduction is associated with earliness

Table 1. Yield and some agronomic traits in six reduced height mutants of cv. K-169

Mutant	Secondary characters	Culm length (cm)	Spike length (cm)	Total plant height	No. spike nodes	Productive tillers/plant	Grain yield/plant
Dwarf	Slow growth. Maturity: 119 days	56.2**±0.9 (53.9)	16.2**±0.7 (74.5)	72.4**±1.8 (57.6)	21.3±1.7 (98.2)	8.0±0.9 (115.9)	7.7**±0.5 (58.3)
Semidwarf	Semidwarf. Maturity: 120 days	81.9**±0.9 (78.7)	20.4*±0.8 (94.2)	102.4**±1.0 (81.4)	21.6±0.8 (99.9)	7.1±0.1 (102.9)	11.4±1.0 (86.4)
Chlorina	Yellowgreen,slow growth. Maturity: 119 days	84.5**±0.9 (81.2)	19.3*±0.3 (89.1)	103.8**±5.3 (82.5)	16.1±1.2 (74.4)	6.2±0.4 (90.3)	5.1**±0.8 (38.8)
Semidwaff, early maturing	Early maturity, fast growth; Maturity: 113 days	95.9*±0.6 (92.1)	18.9*±1.1 (87.4)	114.8*±1.8 (91.3)	18.6±0.9 (86.0)	6.8±0.3 (99.0)	12.2±0.7 (92.6)
Early maturing	Semidwarf,fast growth; Maturity: 111 days	97.5*±0.4 (93.6)	18.6**±0.2 (85.9)	116.1*±0.7 (92.2)	18.7±1.1 (86.1)	8.3±0.9 (119.6)	13.3±1.1 (100.9)
Lax spike mutant	Loose panicle,late maturity (129 days)	99.2±0.8 (95.2)	22.6±0.7 (104.3)	121.8±1.0 (96.8)	19.4±1.5 (89.3)	6.9±0.8 (100.0)	10.8**±0.1 (82.1)
Control (cv. K-169)	Maturity: 120 days	104.2±0.4 (100)	21.7±0.5 (100)	125.8±0.4 (100)	21.7±0.8 (100)	6.9±0.5 (100)	13.2±0.7 (100)

*,**: Significance at 5 % and 1% levels, respectively; Figures in parentheses indicate the values in per cent of control.

Table 2. Internode number and length in reduced height mutants in barley.

Mutant	No. of internodes	Mean internode length						
		1	2	3	4	5	6	7
Dwarf	6.6±0.3	0.9±0.1 (1.5)* **67.9[a]**	2.8±0.3 (5.1) **49.6**	4.7±0.4 (8.4) **44.0**	5.9±0.3 (13.6) **44.9**	7.7±0.3 (13.6) **41.1**	13.3±0.7 (23.7) **63.9**	20.9±1.7 (37.1) **61.7**
Semidwarf	6.3±0.3	1.9±0.2 (2.3) **148.4**	5.3±0.5 (6.4) **91.8**	7.5±0.5 (9.1) **69.9**	9.5±0.8 (11.6) **72.6**	14.1±0.9 (17.2) **75.4**	16.5±0.8 (20.1) **79.0**	27.2±0.7 (33.2) **80.4**
Chlorina	6.3±0.3	1.6±0.2 (1.9) **128.0**	5.2±0.7 (6.2) **91.2**	10.1±0.7 (11.9) **94.2**	11.3±0.9 (13.4) **86.1**	12.8±0.6 (15.1) **68.6**	17.6±0.6 (20.8) **84.1**	25.9±1.2 (30.6) **76.6**
Semidwarf, early maturing	7.0±0.0	1.4±0.1 (1.4) **107.0**	3.7±0.30 (3.9) **65.0**	9.7±0.8 (10.1) **90.3**	13.6±0.4 (14.2) **103.6**	14.4±0.8 (14.9) **76.9**	20.5±0.3 (21.3) **98.1**	32.7±0.7 (34.1) **96.6**
Early maturing	6.3±0.3	1.7±0.2 (1.7) **132.0**	6.2±0.5 (6.3) **107.8**	11.1±0.6 (11.3) **103.1**	12.5±0.7 (12.8) **95.1**	15.6±0.8 (15.9) **83.1**	17.4±0.8 (17.9) **83.5**	33.1±1.2 (33.9) **97.7**
Lax spike	6.3±0.3	1.4±0.2 (1.4) **109.0**	5.8±0.5 (5.8) **101.3**	10.3±0.5 (10.4) **96.54**	12.5±0.5 (12.6) **95.1**	16.6±0.3 (19.7) **89.0**	20.7±0.9 (20.9) **99.4**	31.8±0.8 (32.0) **94.0**
Control (cv. K-169)	7.0±0.0	1.3±0.2 (1.2) **100.0**	5.7±0.6 (5.5) **100.0**	10.7±0.6 (10.3) **100.0**	13.1±0.5 (12.6) **100.0**	18.6±0.6 (17.9) **100.0**	20.9±0.5 (19.9) **100.0**	33.8±1.1 (32.5) **100.0**

*Figures in parentheses indicate per cent values; [a]Per cent value of corresponding internode length in control.

spike alteration, or impairment of chlorophyll synthesis, suggesting pleiotropic effects of dwarfing genes. Some short stemmed mutants have been developed into commercial varieties in barley. Induced erectoides mutants in barley have led to the development of improved, high yielding cultivar 'Pallas' in Sweden, which is widely grown in weastern Europe and shows a pronounced lodging resistance and high productivity than its control 'Bonus' [3]. Similarly, the 'Norin' and 'Sue Seun' dwarfing genes in wheat have been extensively used in the production of short statured, high yielding and non-lodging varieties [4]. The early maturing mutant in the present study is of considerable agronomic importance because of its reduced height (conferring lodging resistance), early maturity (by 9 days), and grain yield at par or slightly better (with increased tillering) compared to control (Table 2). The semidwarf mutant, inspite of its low yield, is of considerable interest to the breeder. In this mutant, though there is considerable reduction in culm length, but there is no corresponding decrease in spike length and spike nodes.

References

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