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DEVELOPMENTAL MORPHOLOGY OF INDUCED SEMIDWARF AND STUNTED MUTANTS IN LENTIL

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ABSTRACT

Study on the developmental morphology of two true breeding dwarf mutants in lentil revealed that reduction in both internode length and number were responsible for their short stature. The stunted mutant, with marked reduction in the number of leaves and pods per plant, length of pod bearing zone, biological and seed yield, was only 1/4 of the parent variety Pant L-639. The stunted character is also associated with late flowering. However, pod size, seed size and weight, and harvest index increased in the mutant. The semidwarf mutant also had reduced number of primary branches, pods/plant, biological and seed yield besides plant height. The difference in height of the semidwarf mutant and parent variety becomes noticeable only after 40 days of crop growth. Seed protein content was high in stunted (26.2%) as well as semidwarf (24.7%) mutants than the parent variety (23.1%).

Key words: Mutations, plant height, lentil, protein content.

A number of mutants have been induced by several workers in lentil, but detailed studies on most of these mutants are lacking. This paper deals with the developmental morphology of two induced true breeding mutations for plant height (designated as semidwarf and stunted) in lentil.

MATERIALS AND METHODS

Two mutations with reduced plant height, namely semidwarf and stunted were isolated from gamma irradiated populations of the lentil variety Pant L-639 in the M_2 generation [1]. The M_6 seed of these two mutants along with that of parent variety were used in this study. The growth and development of the mutant and control plants were closely observed at various stages and the data on a number of quantitative characters recorded starting from 20 day old seedlings till maturity. For internode length, average value of the lower four internodes in a plant at maturity was used. Seed protein content was estimated by Lowry et al. [2].

RESULTS AND DISCUSSION

Developmental morphology of two induced mutations of lentil namely semidwarf and stunted was studied along with their parent variety (Fig. 1). The data on various quantitative characters are presented in Tables 1 and 2.

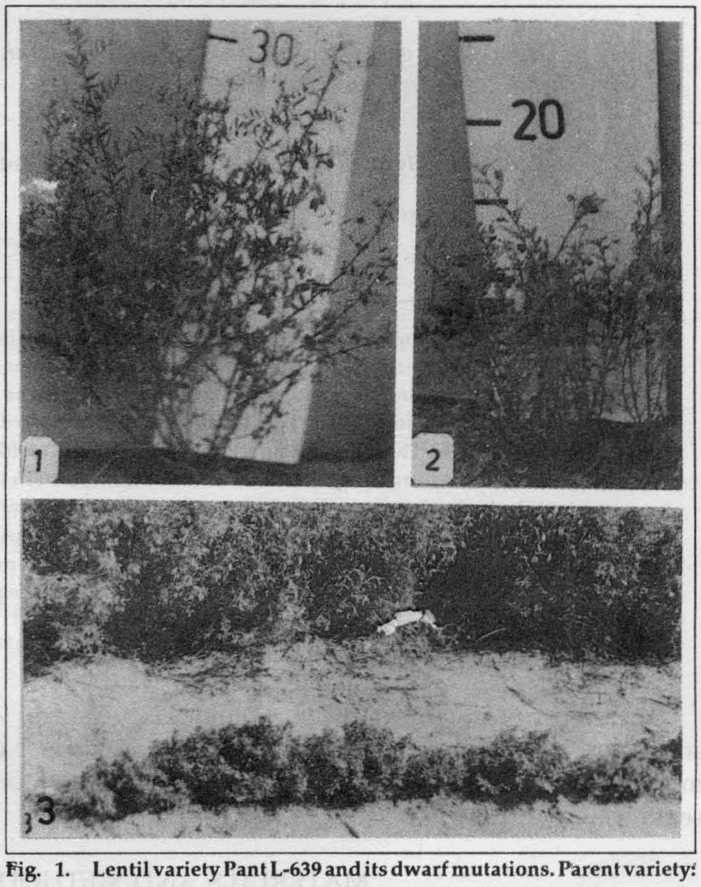

Fig. 1. Lentil variety Pant L-639 and its dwarf mutations. Parent variety: single plant (1) and a row (3, upper), Semidwarf mutant: single plant (2), Stunted mutant: a row (3, lower)

Plant growth during early vegetative phase was very slow in the control as well as mutants, however, the plants of the parent variety developed fast later but not of the mutants (Table 2). Hawtin and Saxena [3], while reporting similar observation, suggested the possibility of genetic improvement using this character. Both the mutants studied can be placed in the broad category of dwarf mutations, the most frequent type of mutation induced by mutagenic treatments [4]. However, they are not identical morphologically, anatomically or genetically. The reduction in plant height can be due to reduction in the number or length of internodes, which could be a consequence of reduction in cell length or cell number [5]. The semidwarf and stunted mutants under study showed reductions not only in the number (58.1 in the semidwarf and 51.2 in the stunted compared to 76.2 in the parent), but also in the length of internodes (1.27 and 0.54 cm in the semidwarf and stunted mutations, respectively, compared to 2.15 cm in the control) resulting in significant decrease in plant height (Tables 1 and 2). However, the relative contribution of internode length to plant height reduction (about 65% in the semidwarf and 78% in the dwarf mutants) is much more than the contribution of internode

Table 1. Data on quantitative characters of semidwarf and stunted mutants of lentil variety Pant L-639

Character	Semidwarf		Stunted		Pant L-639	
	range	mean	range	mean	range	mean
Plant height (cm)	17.8–18.8	18.14	8.0–8.2	8.05	30.9–33.0	31.2
No. of internodes/plant	54–62	58.1	45–54	51.2	69–82	76.2
Internode length (cm)	1.1–1.4	1.27	0.4–0.6	0.54	2.0–2.8	2.15
Primary branches/plant	5–7	5.87	5–7	6.0	6–9	7.62
Angle of branching	Narrow		Wide		Narrow	
Leaves/branch	8–10	9.3	7–9	8.4	12–14	13.4
No. of leaves/plant	48–61	56.7	43–52	49.6	68–85	74.3
Leaflets/leaf	9–10	9.4	8–10	8.6	10–13	11.3
Leaflet size: length (cm)	—	0.64	—	0.61	—	0.94
width (cm)	—	0.21	—	0.22	—	0.21
Plant canopy	Open type		Slightly clustered		Open type	
Length of flower bearing zone (cm)	6–8	6.75	3.5–4	3.7	12–15	13.7
Days to flower bud formation	86–92	90	102–110	105	76–84	80
Days to 50% flowering	100–112	106	118–122	120	102–110	105
Days to maturity	143–147	145	148–152	150	145–150	148
No. of flowers/peduncle	2–2	2.0	2–2	2.0	2–3	2.28
Peduncle length	1.3–1.7	1.5	1.2–1.4	1.35	1.5–2.2	2.01
No. of pods/plant	42–63	45.9	42–61	47.7	60–91	73.9
No. of seeds/pod	1–2	1.6	1–2	1.5	1–2	1.6
Pod size: length (cm)	—	1.0	—	1.21	—	0.96
width (cm)	—	0.51	—	0.71	—	0.43
Seed yield/plant (g)	0.8–1.2	1.02	1.0–1.5	1.34	1.6–2.1	1.93
Biological yield/plant (g)	4.2–4.9	4.52	3.6–4.1	3.85	5.1–8.1	6.54
100-seed wt. (g)	1.38–1.45	1.42	1.8–1.85	1.81	1.6–1.7	1.61
Harvest index (%)	21.8–23.4	22.56	33.2–35.6	34.8	27.1–31.4	29.5
Seed size	Slightly smaller than control		Bold		Medium	
Protein content (%)	—	24.75	—	26.25	—	23.12

number (about 35% in the semidwarf and 22% in the stunted mutations). The extent of reduction in internode length of the stunted mutant was high (about 75%) compared to the semidwarf mutant (about 41%). The stunted mutant plant measured only one fourth length of the parent variety (Tables 1 and 2).

The growth of the stunted mutant was very slow from early seedling stage till maturity with marked reductions in the length of the pod bearing zone, number of leaves and pods/plant, biological yield and seed yield. Further, the stunted character was associated with late flowering. However, there was marked increase in the size of pods and seeds, 100-seed weight, and harvest index. The harvest index increased due to a greater reduction in vegetative growth (about 45%) than in grain yield (about 30%) of the mutant (Table 1). Though this particular mutant may not be useful for direct commercial cultivation because of reduced yield, it may, however, be used in hybridization to transfer some of its useful traits to other high yielding cultivars of lentil. Though, it is not easy to eliminate the negative traits of the pleiotropic spectrum from the positive ones, the pleiotropic pattern of a mutant gene can be altered to some extent by transfering it into a specific genotypic background [6]. Gaul and coworkers using distinct traits of the barley *erectoides mutant ert 16* such as awn, culm, spike and internode

Table 2. Plant height, internode length, rachis length, number of leaves/branch and leaflets/leaf in the dwarf mutations of lentil and parent variety at different growth stages

Plant age (in days)	Semidwarf	Stunted	Pant L-639
Plant height (cm)			
20	1.66 ± 0.16	1.36 ± 0.04	1.75 ± 0.12
30	2.36 ± 0.01	1.84 ± 0.08	2.80 ± 0.08
40	2.96 ± 0.16	2.30 ± 0.11	4.31 ± 0.08
50	3.96 ± 0.16	2.66 ± 0.20	5.70 ± 0.18
60	4.73 ± 0.20	3.06 ± 0.08	7.24 ± 0.20
70	6.16 ± 0.08	3.50 ± 0.02	10.26 ± 0.43
80	7.72 ± 0.06	3.96 ± 0.04	14.52 ± 0.28
90	8.93 ± 0.20	4.30 ± 0.16	17.20 ± 0.18
100	11.04 ± 0.20	5.10 ± 0.23	19.10 ± 0.43
110	12.54 ± 0.38	5.81 ± 0.08	23.10 ± 0.49
120	12.98 ± 0.81	6.36 ± 0.12	25.36 ± 0.32
130	14.14 ± 0.44	7.40 ± 0.16	28.60 ± 0.83
140	16.04 ± 0.20	7.80 ± 0.08	30.66 ± 0.33
Maturity	18.10 ± 0.20	8.05 ± 0.04	31.20 ± 0.18
Internode length (cm)			
50	0.6 ± 0.02	0.35 ± 0.02	1.0 ± 0.09
75	0.7 ± 0.03	0.40 ± 0.02	1.3 ± 0.12
100	0.8 ± 0.03	0.45 ± 0.01	1.8 ± 0.14
125	0.9 ± 0.04	0.50 ± 0.02	2.0 ± 0.20
Maturity	1.27 ± 0.08	0.54 ± 0.02	2.15 ± 0.19
Rachis length (cm)			
45	0.6 ± 0.03	0.5 ± 0.02	1.5 ± 0.14
50	1.0 ± 0.06	1.0 ± 0.04	1.8 ± 0.13
70	1.6 ± 0.08	1.66 ± 0.06	2.2 ± 0.14
90	1.82 ± 0.10	1.9 ± 0.10	2.5 ± 0.16
Number of leaves/branch			
15	2.4 ± 0.48	2.4 ± 0.64	2.6 ± 0.48
45	5.5 ± 0.67	5.2 ± 0.74	6.2 ± 0.74
90	9.3 ± 0.78	8.4 ± 0.66	13.4 ± 0.80
Leaflets/leaf			
45	5.6 ± 0.48	5.6 ± 0.60	6.8 ± 0.74
60	7.6 ± 0.76	7.2 ± 0.72	8.6 ± 0.80
90	9.4 ± 0.48	8.6 ± 0.80	11.3 ± 0.86

± S.D.

characters of the complex can vary independently from each other by changing the genetic background of ert 16 [4].

The semidwarf mutant, on the other hand, showed reductions in the number of pods/plant, primary branches,biological as well as seed yield, harvest index besides plant height compared to control. A clearcut difference in plant height of the control plants and semidwarf mutant becomes noticeable only after 40 days of crop growth (Table 2). The semidwarf mutants isolated in lentil by Sharma and Sharma [7], however, showed increase in seed number/pod, pod setting percentage, and early maturity (by 16 days).

Seed protein content was found to be considerably higher in both the semidwarf (24.7%) and stunted (26.2%) mutants than in the control (23.1%) (Table 1). The increase in protein content over the control was greater in the stunted mutant (about 13.5%) than in the semidwarf mutant (6.9%). Induced mutants with increased as well as reduced seed protein content have been reported in different pulse crops [4]. In cereals and pulses, a negative correlation is generally observed between seed production and protein content as well as between seed size and protein content. However, a positive correlation between seed size and protein content is recorded in the stunted mutant. It is not clear whether the high protein content observed in the stunted and semidwarf mutants is due to the effect of the respective mutant genes or merely a consequence of their low seed production, because increases in protein content in some *Pisum* mutants was found to be merely a consequence of low seed production [4]. The correlations between number of seeds per plant and protein content become understandable by assuming that a distinct capacity of protein accumulation is combined with a low number of developing seeds, this resulting in a relatively high protein amount in each single seed. The basic reason for this kind of increased protein content would thus be reduced seed number [4]. If the high protein content has a genetic basis, attempts can be made to transfer this character to high yielding cultivars of lentil. In wheat, a mutant (TW 1) with a higher percentage grain protein but a lower grain yield than the parent cultivar Kalyan Sona was crossed to the parent and other promising cultivars to combine higher protein content with higher grain yield by Bhatia and associates [8]. They made some selections with significantly higher grain protein than that of Kalyan Sona and showing not much difference in grain yield.

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