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Influence of seed size on pod development in lentil (*Lens culinaris*)*

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Lentil (*Lens culinaris* Medik*)* is an important dietary source of energy and proteins. The breeding for large-seeded lentil has assumed importance in recent years owing to its culinary and market preference. It is an important legume crop in west Asia, the Indian subcontinent, Ethiopia, northern Africa and to a lesser extent in southern Europe. Globally, India ranks first in area as well as production (Erskine *et al.* 1998). It is the second most important cool season legume crop after chickpea (*Cicer arietinum* L.) in India and occupied 1.38 million ha area with a production 0.96 million tonnes in India during 2008–09 (ASG 2009). Traditionally small-seeded lentils (100-seed weight below 2.5 g) are cultivated in northern India, whereas large-seeded (100-seed weight 2.5 to 3.5 g) are confined to central India (Madhya Pradesh and Bundelkhand tracts of Uttar Pradesh). Recently, large-seeded varieties of lentil have been developed for northern India also. Large variations have been observed for pod-filling duration in genotypes with varying seed size and maturity (Bhattacharya 2004). The grain-filling period is likely to depend on maturity duration and seed size. Higher mitotic activity in the cotyledons of large-seeded genotypes is expected in comparison with small-seeded genotypes. Chopra *et al*. (2007) reported in *Vigna* that biomass accumulation in large seeds take more time in comparison to small-seeded genotypes. Understanding the influence of seed size on grain-filling period would facilitate cultivar improvement in lentil. Therefore, the experiment was carried out to analyze the relationship between duration and rate of pod filling, and seed size.

An experiment was designed involving 15 lentil genotypes of varying seed size in completely randomized block design with three replications following standard agronomic practices to raise the crop at Indian Institute of Pulses Research, Kanpur in winter (*rabi*) season (2006-07). Observations were recorded for days to 50% flower, days to pod-initiation, grain-filling period after pod initiation, 100-seed weight and yield/plant. Days to 50% flower were recorded on plot basis. A total of 25 double-flowered inflorescence of each genotype were tagged on the same day in each replication keeping same date of anthesis for all genotypes and pod initiation and pod maturity were recorded to find out the grain filling period. Yield/ plant (g) was recorded on the basis of five randomly selected uniform plants and 100-seed weight (g) for three samples in each replication.

In another experiment, two genotypes of lentil, 'DPL 62' (large-seeded: 3.5g/100-seed weight) and 'IPL 211' (small-seeded advanced breeding line: 2g/100-seed weight) were also grown in same winter season in two adjacent blocks with two replications. Both genotypes were of same flowering duration. After anthesis 600 double-flowered inflorescences (300 in each replication) of both genotypes were randomly selected and tagged on the same day for recording observations on 50 inflorescences at two days interval. Thus flowers blooming on the same day but born on different plants or branches were tagged to find out the dry matter accumulation in pods at frequent interval in both, large as well as small-seeded genotypes. Pod initiation was observed on the basis of 50 flower buds. Nineteen days after anthesis of bud when seed development (accumulation of dry matter in pod) started, pods were detached from the pedicel at two days interval and kept in the dessicator for drying and to find out the rate of pod-filling and dry matter accumulation in both genotypes. After subsequent pod harvest and drying, total number of pods and seeds were counted for individual harvest. Per cent pod sets and average number of seeds/pod was calculated based on total count. As the number of seeds and pods may vary on different harvest dates due to differences in number of pod sets, dry weight of seeds and pod wall were converted into 100-seed weight (g) and 100- pod wall weight (g). The analysis of variance and computation of multiple correlations for the first experiment was performed with SPSS 10.0 software package. The graph was plotted for seed weight and pod wall growth against day after anthesis.

*Short note

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Table 1 ANOVA for different traits along with mean value, range and correlation

Character	df	Days to 50% flowering	100-seed weight (g)	Grain-filling period	Yield/plant (g)
Replication (R)	2	0.68 (0.68)	0.02 (0.08)	8.60 (0.16)	59.08 (7.24)
Treatment (T)	14	43.92 (0.00)	1.33(0.00)	20.61(0.00)	1.29 (0.46)
Error	28	1.83	0.07	4.43	1.23
Mean±SE		73.6 ± 0.58	2.76 ± 0.15	40.56 ± 0.49	4.43 ± 0.32
Range		68–80	2–4.3	32–47	1.7–7.5
Correlation coefficient(r)					
100-seed wt		–0.66**	1		
Grain-filling period		–0.19 (Ns)	0.71**	1	
Yield/plant		–0.59**	0.98**	0.81**	1

Values inside the parentheses indicate 'p' value

The 15 genotypes in the first experiment included two Indian cultivars, 'DPL 15' and 'Pant L 406', three exotic lines from ICARDA ('E 348', 'ILL 7616' and 'ILL 8114'), eight advanced breeding lines ('IPL 524-1', 'P 3290', 'P 3419', 'P 4085', 'P 4271', 'P 4437', 'P 4442' and 'P 4453') and two indigenous germplasm collections ('VKS 16-11', 'VKS 16-21'). The ANOVA revealed highly significant difference among the genotypes for days to flower, grain-filling period and seed size (Table 1). Nine genotypes were of medium maturity and six were late maturing (days to flowering > 75 days). Seed size ranged between 2–4.3 g/ 100 seeds. Among these seven genotypes weighed more than 3 g and 'P 4271' had the largest seed size with 45 days grain-filling period. The mean grain-filling period was 41 and the range was 32 to 47 days. Seed size was positively correlated with the grain filling period (r=0.71**). The similar kind of relationship was observed by Shrestha *et al.* (2006). Days to 50% flowering was negatively correlated with seed size and yield/plant and with grain filling period there was no significant association of any kind. Seed yield of plant is negatively correlated with 50% flowering because early flowering restricts vegetative growth. The yield/plant was positively correlated with seed size and (r=0.98**) and grain-filling period (0.81**). Wang (1996) reported in his study in soybean that seed-filling period was closely associated with seed yield and the extension of seed-filling period raised seed yield mainly through positive effects on seed size.

The influence of seed size on grain-filling was simultaneously examined by another experiment with two genotypes of contrasting seed size with comprehensive pod-filling and dry matter accumulation study. It was observed that in lentil, after anthesis it takes 4-5 days for pod initiation and unlike chickpea both pods as well as seeds mature simultaneously, although pod development is faster initially in comparison to seed development (Fig 1), as pod wall weight is more than seed weight during early pod filling stages. The per cent pod set was higher in 'DPL 62' (60%) than the 'IPL 211' (48%), whereas mean number of seeds/ pod were more in 'IPL 211' (2.14) than 'DPL 62' (1.34),

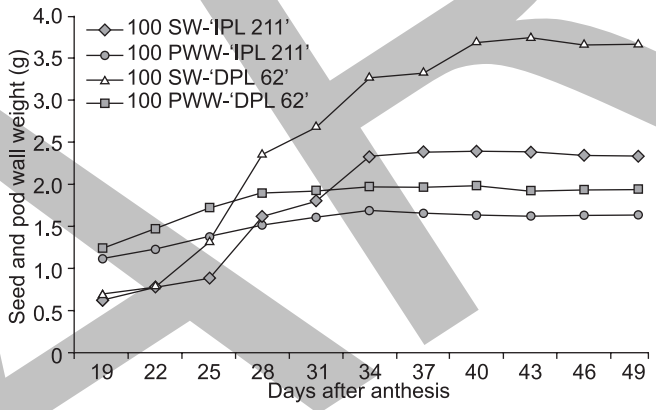

Fig 1 Seed and pod wall weight vs pod-filling duration (days after anthesis) in small-seeded genotype 'IPL 211' and large-seeded genotype 'DPL 62'

mainly due to genotypic behaviour. The dry matter accumulation in pod wall increased in a linear fashion for first 30 days and after that dry weight accumulation remained almost constant showing straight line (Fig 1). Pod wall dry weight gain was maximum at 34 days after anthesis in both the genotypes, indicating that seed size has no effect on pod wall development rate. Large-seeded genotype 'DPL 62' had accumulated maximum seed weight at around 43 days after anthesis in comparison to small-seeded genotype 'IPL 211', which took around 37 days to reach maximum grain-filling indicating that grain-filling period depends upon seed size. Remobilization of dry matter from pod wall to seeds was not evident as pod wall dry matter remained constant after the initiation of seed development. Hamid *et al.* (1995) also reported similar observations while examining pattern of dry matter accumulation in five mungbean genotypes. While Davis *et al.* (1999) observed reductions in the dry weight of the pod shell suggesting that remobilization of dry matter from the pod may contribute 9–15% of the seed weight in rainfed chickpea. The genotype 'DPL 62' exhibited higher rate and longer seed development duration, larger seed size than another genotype 'IPL 211'. Grain-filling period in large-

seeded lentil genotypes are longer compared to small-seeded genotypes, which may effect total maturity duration in similar way, but many of large-seeded varieties are of early maturity, which might be possible due to high correlation between seed size and early vigour, and compensation of short vegetative period by long reproductive period. Furthermore, the comprehensive study of dry mater accumulation can be done in controlled condition by including large number of genotypes.

SUMMARY

The influence of seed size on pod-filling period or seed growth was examined through two field experiments during winter (*rabi*) season (2006-07). In first experiment, 15 genotypes of varying seed sizes were evaluated for days to flowering, seed size, grain-filling period and yield. The grain-filling period was positively correlated with seed size (r=0.71**) and yield (r=0.81**) and the extension of grain-filling period raised seed yield mainly through positive effects on seed size. Another experiment was conducted where two genotypes having contrasting seed sizes ('DPL 62' and 'IPL 211'), were grown in two adjacent plots for detailed study of dry matter accumulation at subsequent pods harvest. The large-seeded cultivar, 'DPL 62' exhibited higher seed development, longer duration of seed-filling than small-seeded one 'IPL 211', which suggested the positive influence of seed size on seed development rate.

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