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Variation in seed size of faba bean (*Vicia faba*) as influenced by cultivars, irrigation regimes and nitrogen

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ABSTRACT

An experiment was conducted during the winter season of 1991–92 and 1992–93 to study the variation in seed size of faba bean (*Vicia faba* L.) as influenced by water regimes and nitrogen fertilization. Seed-size distributions were determined using round-hole screens ranging from 6.0 to 9.0 mm in diameter. All seed lots showed a wide range in seed size. The seed size on a single screen varied significantly among cultivars (77.7–85.1 mg/seed), irrigation regimes (73.9–95.5 mg/seed) and fertility (91.9–100.0 mg/seed). The treatments that showed an influence on mean seed size also affected the proportion of the various sizes in the seed lot. Variations in seed size within a seed lot were not associated with differences in seed quality.

Seed size, as measured by the 100-seed weight (seed index), is an important yield component in faba bean (*Vicia faba* L.) and other grain crops. Seed size in faba bean is under genetic control, and there are genotypes available with sizes ranging from 70.3 to 99.3 mg/seed. However, it is well known that there is variation in the size of the individual seed making up a lot. Similar variations in seed size within a seed lot of soybean have been reported by Inouye and Jin (1981). Seed size is affected by environmental conditions during seed development.

It is clear that mean seed size of a lot is a function of the proportions of various sized seeds making up the lot. However, little is known of the variability of seed size within a seed lot or the effects of cultivar differences, irrigation regime and nitrogen fertilization on faba bean mean size. The objective of this study was to investigate the effects of these factors on the size of individual seed within a seed lot.

MATERIALS AND METHODS

Seed lots of 'Hassawi 1' ('Hass 1'), 'Hassawi 2' ('Hass 2') and 'Hassawi 3' ('Hass 3') were collected from 2 field trials conducted during the winter season of 1991–92 and 1992–93 at Al-Hassa, Saudi Arabia.

Trial I

It was laid out to study the effects of water regimes on yield and yield components of faba bean cultivars. The experimental design, was split-plot design replicated 4 times with cultivars as the main plots and irrigation regimes as the subplots. Nine treatments were used consisting of a factorial combination of 3 volumes of water [400 (A), 600 (B) and 800 (C) m^3/ha]; and 3 watering intervals [7(D), 10(E) and 15 (F) days]. The water regimes were imposed 35 days after sowing. Nitrogen @ 120 kg/ha in the form of urea was applied in 3 splits during the vegetative phase of growth.

Trial II

It was carried out to study the effects of nitrogen level on yield and yield components of faba bean cultivars. The trial was laid out in split-plot design, replicated 4 times, with cultivars as the main plots and nitrogen as the subplots. The nitrogen treatments used were 120, 240 and 360 kg N/ha. Full dose of nitrogen was top-dressed 30 days after sowing. All plots received water @ 800 m^3/irrigation/ha/week.

In both trials, 3 m x 5 m plots were used. Each trial received a broadcast application of 120 kg P_2O_5/ha and 60 kg K_2O/ha, applied in 3 equal doses at 1 month intervals starting 2 weeks from emergence. Flood irrigation was used throughout and water was delivered through metal pipes and gated plastic tubing supplied with water meters.

Table 1. Effect of different treatments on the size of seeds (mg/seed) of faba bean staying on screens with varying hole size

Treatment	Screen hole diameter (mm)					
	6.0	6.8	7.4	8.2	9.0	Mean
			Seed size			
Cultivar						
'Hass 1'	72.8	79.9	83.5	89.0	99.3	85.1
'Hass 2'	72.7	77.7	82.9	87.3	90.7	82.3
'Hass 3'	70.3	74.3	77.5	81.8	84.7	77.7
CD (P = 0.05)	2.2	3.1	2.7	5.4	5.8	2.9
Irrigation regime						
A x D	82.7	85.9	87.7	89.1	93.7	87.8
A x E	70.3	71.9	74.3	78.9	84.3	75.9
A x F	68.6	70.7	72.8	76.6	80.9	73.9
B x D	87.3	90.5	93.6	94.8	96.6	92.6
B x E	82.8	84.8	86.2	88.4	91.2	86.7
B x F	77.7	80.7	85.1	89.1	89.8	84.5
C x D	90.7	93.6	96.1	97.7	99.3	95.5
C x E	86.4	88.7	89.6	90.2	92.8	89.5
C x F	82.6	83.4	84.2	87.6	90.1	85.6
CD (P = 0.05)	1.9	3.6	1.7	2.5	3.2	2.9
Nitrogen (kg N/ha)						
120	83.9	88.4	90.5	95.1	101.6	91.9
240	86.8	89.9	92.4	99.5	110.2	95.8
360	90.9	93.1	97.6	103.2	115.2	100.0
CD (P = 0.05)	2.1	3.0	4.8	3.7	4.2	3.5

Details of irrigation regimes are given in text

Seeds were removed from harvested pods by hand, and the weight of each seed was recorded after drying to a constant weight. Seed size distribution was determined using screens with round holes ranging from 6 to 9 mm in diameter. The screens were stacked on the top of each other and a random sample of 500 seeds was placed on the top screen. The screens were shaken and the number and weights of seeds remaining on each screen were recorded. Seed density was estimated by measuring the volume of 25 seeds from each replicate using the technique described by Wessel-Beaver *et al.* (1984). Total nitrogen content of the seeds was determined by Kjeldahl's method using ground seeds.

RESULTS AND DISCUSSION

The seeds of faba bean showed a wide range in seed size. The size of seeds remaining on a specific screen varied among cultivars, irrigation and nitrogen treatments. Seeds that remained on the screen with holes 6.0 mm diameter averaged 80.0 mg/seed across cultivars, irrigation regime and nitrogen compared with 97.2 mg/seed for seed staying on a screen with 9.0 mm diameter holes (Table 1). In general, the number of seeds staying on the smallest and largest (6.0 and 9.0 mm) screen sizes was very low, which resulted in large variation in the weight estimates. However, there were significant differences in seed size between and within cultivars for seed remaining on each screen. These differences indicated that seeds remaining on a specific screen were not always of the same size.

The effect of cultivars, irrigation regime and nitrogen on seed-weight distribution is shown in Figs. 1 and 2. The data are presented as per cent of weight of the total seed lot that stayed on each screen. Seed-size distribution of a cultivar seemed to be a stable characteristic irrespective of substantial differences in environmental conditions during plant growth and most of the seeds were held on screens with intermediate hole diameters (ranging from 6.8 to 8.2 mm). This represents a range in seed size from approximately 83.7 (6.8 mm) to 91.2 (8.2 mm) mg/seed (Table 1), indicating that a wide range in seed size exists within a lot. It is apparent that individual seed size from populations grown in the field varied substantially in cultivars 'Hass 2' and 'Hass 3' than in 'Hass 1' and that variability was not merely the result of a small number of outlying individuals. Thus, the micro-environmental condition for plant growth differed greatly among individuals within a row. The variation in seed size associated with the differences in cultivar responses to environment was consistent. Seed size of 'Hass 3' is consistently smaller than both 'Hass 1' and 'Hass 2' and that of 'Hass 2' is smaller than 'Hass 1', suggesting that the 3 cultivars differ genetically in seed size.

Responses to irrigation regimes

Seed sizes of 'Hass 1', 'Hass 2' and 'Hass 3' showed similar responses to variation in water supply (Table 1). Seed size of faba bean decreased significantly across the gradient from most to least water. Seed size decreased when plant growth was restricted by less water, but it was somewhat constant within a cultivar. The small variability of seed size within a cultivar under these irrigation regimes implied close coupling of the processes of vegetative and reproductive growth.

Reduction in mean size may be due to changes in the proportion of various sized seeds in a seed lot. Comparison between treatments showed that water stress resulted in reduced seed size. Compensation in seed size occurred in some cases where seed numbers had been reduced by water deficit during the vegetative growth and the size of the remaining seed is exceptionally large. This indicates that when the number of seeds is limited in relation to leaf area, reduction in seed number may be compensated for by an increase in the size per seed. Logically, seed sizes were reduced due to reduced net photosynthesis, reduced translocation of dry matter from leaves to the seed and accelerated leaf senescence.

Under water stress, all 3 cultivars exhibited a relatively high proportion (8–25% of the total number) of seeds in the smallest size class (Fig. 1). Most seeds in this size class were less than 20 mg dry weight/seed ('Hass 1', 8%; 'Hass 2', 17%; and 'Hass 3', 25%) and probably represented seeds that aborted in the pod very early in development.

There was a low proportion (< 10%) of the seeds that fell into the intermediate size classes (30—40) mg/seed for 'Hass 2' and 'Hass 3' and 50–60 mg/seed for Hass 1. Hass 1, a large-seeded type, has a fairly even distribution of seeds from 90 to 115 mg/seed.

Response to N

Nitrogen fertilizer significantly changed mean seed size and also showed a significant effect on the proportion of seeds left on the various screens (Fig. 2). Increased levels of nitrogen increased mean seed size of all cultivars, which resulted in an increase in the proportion of the seeds staying on a screen with holes 8.2 mm diameter. The effect of nitrogen on the size of the seeds that stayed on individual screens was more pronounced. Seeds that stayed on a screen with 9.0 mm diameter holes from the 360 kg N/ha were larger (115.2 mg/seed) than seeds from the 240 kg N/ha (110.2 mg/seed) or 120 kg N/ha treatment (101.6 mg/seed).

Table 2. Quality parameters for seeds of faba bean within a seed lot that stayed in different screens

Genotype	Screen hole diameter (mm)					CD (P = 0.05)
	6.0	6.8	7.4	8.2	9.0	
			Seed density (g/m^2)			
'Hass 1'	1,280	1,286	1,300	1,310	1,315	NS
'Hass 2'	1,215	1,226	1,230	1,224	1,235	NS
'Hass 3'	1,178	1,182	1,190	1,186	1,200	NS
			Nitrogen content (g/kg)			
'Hass 1'	68.5	71.1	73.3	74.0	82.7	NS
'Hass 2'	63.3	63.0	64.0	66.0	68.3	NS
'Hass 3'	53.3	55.0	58.7	62.3	61.0	NS
			Ash content (g/kg)			
'Hass 1'	20.4	20.4	22.4	23.0	23.2	NS
'Hass 2'	18.8	19.1	20.6	22.2	22.7	NS
'Hass 3'	15.8	15.7	17.8	19.2	20.0	NS

NS, Not significant at the 0.05 probability level

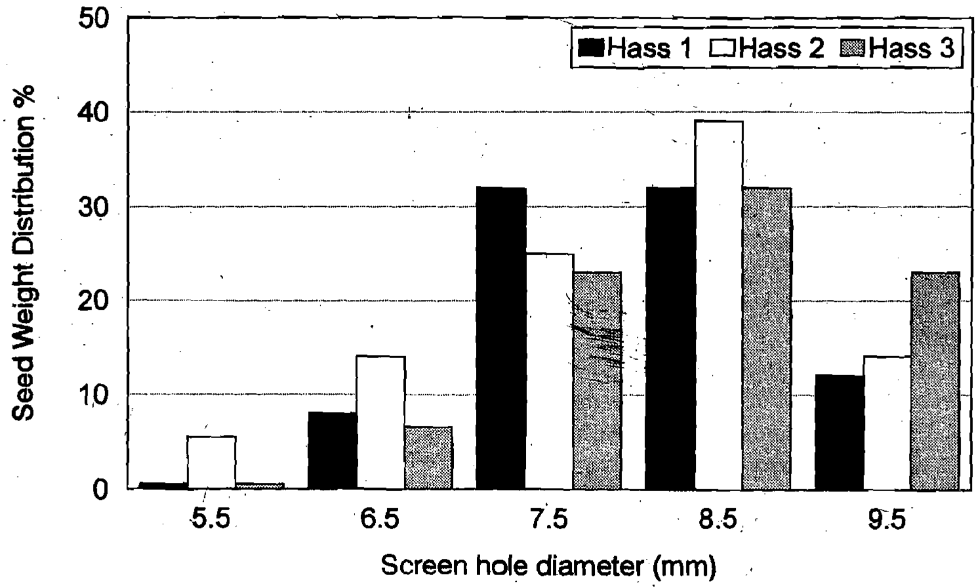

Fig. 1. Effect of cultivars and nitrogen level on seed weight distribution

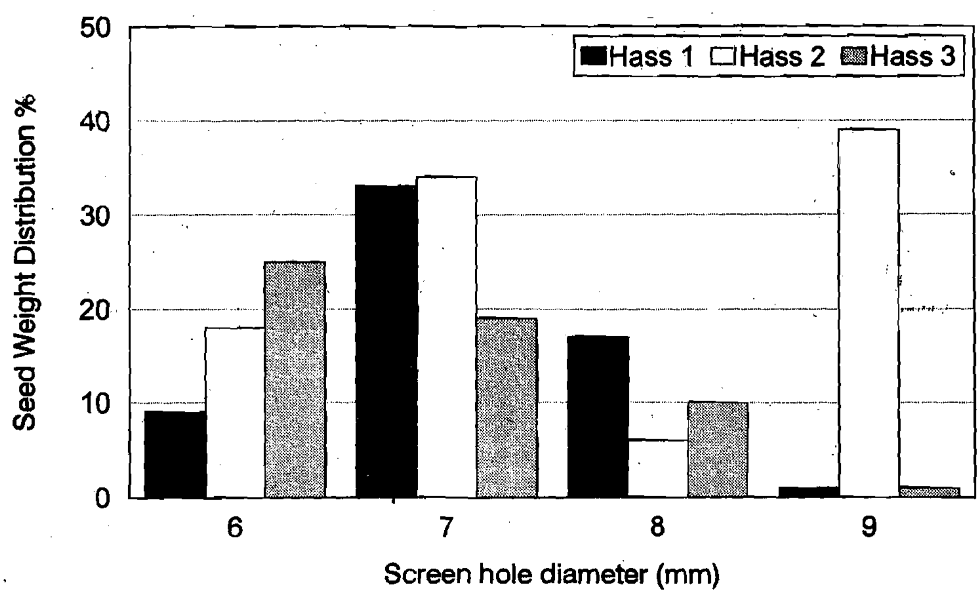

Fig. 2. Effect of cultivars and irrigation regime on seed weight distribution

Seed size responded to nitrogen application, with size increases ranging from 7.9 to 13.8 between the lowest and highest levels. The seed size (Table 1) recorded the highest value in response to nitrogen at the highest level. This is in contrast to the findings of Ahmed (1973), who reported that faba bean was not affected in its size by the application of nitrogen. However, higher nitrogen supplies are expected to add dry matter to the developing seeds by increasing the phytosynthetic area.

Seed parameters for the 3 faba bean species are presented in Table 2. Seed density, seed nitrogen and ash contents showed no significant differences with variation in size. This indicates that seeds which stayed on various screens were identical in all parameters tested except for variation in their size. The data suggest that all seeds went through a similar trend during their growth and development from anthesis to maturity.

The results of this study suggest that the mean seed size may be influenced by the cultivar as well as by environmental conditions during seed development. Both irrigation and nitrogen play a significant role in determining mean seed size and thus have an important impact on yield of faba bean.

REFERENCES

Ahmed, M. M. E. 1973. 'Growth and yield response of horse bean to plant population and nitrogenous fertilizer.' M. Sc. Thesis, Faculty of Agriculture, Ain Shams University.

Inouye, J. and Jin, I. D. 1981. Studies on the seedling emergence in crops : seed size and elongation force of soybean seedlings. *Japanese Journal of Crop Science* **50** : 344–350.

Wesse l-Beaver, L., Beck, R. H. and Lambert, R. J. 1984. Rapid method for measuring kernel density. *Agronomy Journal* **76** : 307–309.