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Effect of Seed Size on Quality and Field Performance in Frenchbean (*Phaseolus vulgaris* L.)

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ABSTRACT Both laboratory and field trials were conducted for two seasons to find out the effect of seed size on seed quality and field performance in frenchbean cv. Arka Komal. The study revealed that sieve size of grading screen used in Air screen cleaner could be reduced from 4.75mm to 4.35mm without any significant reduction in seed quality as well as the performance of those seeds in field in terms of pod and seed yield. By reducing the screen size, the level of rejection during processing could be brought down from 34 to 12% in some seed lots.

Keywords: Frenchbean, seed size, seed quality, yield

Seed size, as a seed quality attribute has been a subject of controversy. Seed size had little or no effect either on germination capacity, vigour or on yield in barley [1], swede [2], lucerne [3], rape [4] and soybean [5]. On the other hand small seeds were reported to be low in vigour in sugarbeet [6], groundnut [7] and cotton [8]. Poor vigour of small seeds sometimes resulted in fewer seedling establishments in turnips [9] and swede [2].

The recommended screen size (grading screen) for cleaning and grading in air screen cleaner for frenchbean is 4.75 mm. This is being used for all frenchbean varieties irrespective of seed size in the absence of specific recommendations for individual varieties. In the State of Karnataka, India, seed production of frenchbean is mainly taken up under rainfed conditions hence, sometimes due to failure of rains during seed development stage seeds will be small in case of Arka Komal, a leading variety. Although these seeds look like normal seeds in all respects except for size, they get rejected while processing using recommended sieve size of 4.75 mm. Sometimes the rejection levels are as high as 35% resulting in low returns to the seed growers. Hence, this study was taken up to know whether the seed size has any effect on seed quality and in turn on field performance in this cultivar.

MATERALS AND METHODS

A popular frenchbean cultivar Arka Komal was selected as it is widely grown throughout India. Bulk seed procured by the Karnataka State Seed Corporation from contract seed growers, was used for the first season's study and the seeds obtained from the first season were used for the next season. Seed cleaning and grading was done using 3-screen air cleaner. Different sieve sizes viz, 4.75, 4.5, 4.35 and 4.00 mm (oblong) were used to grade the seeds. Bulk seed was passed through the lowest sieve size and the seed retained over this sieve was passed through the next lowest size and so on. Care was taken not to subject for mechanical injuries while feeding to the hopper each time. Seven size grades were made *viz.*, >4.75mm, >4.5mm, >4.35mm, seeds between <4.75->4.5mm, <4.5->4.35mm, <4.35->4.00mm and <4.00mm. Only the first five size grades along with bulk seed were used for quality evaluation and their field performance.

Four replicates of 100 seed each were selected randomly from each size category and 100 seed weight was recorded in grams. As per ISTA [10] germination test was conducted in rolled paper method in four replicates of 50 seeds each. Germination percentage was recorded on 10th day. Four replicates of 5 seedlings each were selected

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Table 1. Effect of seed size on seed quality in frenchbean cv. Arka Komal

Seed size	Composition of of bulk seed (%)		100 seed weight (g)		Germination (%)		Dry weight of 5 seedlings (g)		Field emergence (%)	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
>4.75mm	65.8	92.2	35.56	37.13	92.0	96.0	0.55	0.71	84.5	93.7
>4.50mm	86.7	96.8	32.90	36.84	94.0	95.5	0.49	0.65	85.2	95.0
>4.35mm	88.1	98.2	31.79	36.94	94.5	96.5	0.42	0.62	83.5	95.0
<4.75->4.50mm	20.8	4.6	27.23	27.28	95.5	94.5	0.42	0.47	83.5	91.5
<4.50->4.35mm	1.4	1.4	25.21	22.78	96.0	93.5	0.42	0.45	83.9	90.0
<4.35->4.00mm*	1.7	0.8	...	...	...	...	...	...	...	...
<4.00mm*	9.6	0	...	...	...	...	...	...	...	...
Bulk	...	...	31.45	36.23	93.0	94.5	0.43	0.72	84.5	94.7
C.D. at 5%	...	...	0.55	0.43	NS	NS	0.054	0.105	NS	NS

S1-First Season; Second Season

* Not included for seed quality and performance assessment

Table 2. Effect of seed size on field performance in frenchbean cv. Arka Komal

Seed size	Pod yield/ha(t)		Seed yield/ha (kg)		100 seed weight (g)	
	S1	S2	S1	S2	S1	S2
>4.75mm	15.90	11.31	2040	1555	36.99	28.29
>4.50mm	15.26	11.06	2081	1580	35.63	26.65
>4.35mm	15.58	10.59	2079	1415	36.08	28.64
<4.75->4.50mm	15.19	9.09	1776	1332	36.84	25.94
<4.50->4.35mm	15.08	9.09	1922	1058	35.88	26.50
Bulk	16.70	11.75	2028	1306	38.24	27.12
C.D. 5%	NS	NS	NS	228	NS	NS

S1-First Season; S2-Second Season

randomly from the germination test. Cotyledons and leaves were removed from the seedlings and dried at 80°C for 48h. The dry weight of seedlings was recorded in milligrams.

The different categories of seeds were tested for field performance during 2000-01 and 2001-02. The experiment was laid out in Randomized Block Design with four replications with a plot size of 6 m^2. Exactly 132 seeds per plot were used for sowing in a spacing of 33.3 cm × 13.6 cm. The recommended production practices were followed to raise the crop. The number of seedlings emerged out of soil was recorded on 15th day after sowing for field emergence. Out of 6 rows 4 middle rows were harvested at tender pod stage for vegetable purpose and the remaining 2 rows were left for seed production. Frour pickings of tender pods were made from middle 4 rows starting from 45th day after sowing at an interval of 6 days and weight was recorded in grams. Only the total weight of 4 pickings is given in data. The yield data was also expressed on per hectare basis. The seed yield from 2 rows was recorded in grams and 100 seed weight was recorded as described above.

Statistical analysis of the data was done using ANOVA technique. The percentage data was subjected for arc sine transformation before analysis. The means were compared using LSD at 5% (11).

RESULTS

First Season (2000-2001):

The bulk seed graded into different size groups were expressed into percentages (Table 1). Seed having >4.75mm size constituted 65.8% of the total bulk, whereas seeds with >4.5mm and >4.35mm size constituted 86.7% and 88.1%, respectively. Only the first 5 seed size groups mentioned in the Table 1 were used along with bulk seed for studying their quality and performance in the field. These size groups differed significantly for 100 seed weight, and seedling dry weight (Table 1). The bold seeds with >4.75mm size recorded the highest seed weight (35.56g). There were no significant differences among various size groups for germination. Even ungraded bulk-recorded 93.0% germination. The dry weight of the seedling was highest (0.55g) in bold seed (>4.75mm) followed by next bigger seed group (>4.5mm) and they were significantly higher than others.

Field emergence percentage did not differ significantly among various size groups (Table 1); even the smallest seed group recorded field emergence (84.0%) on par with any of the bigger size seeds. There was no significant difference in pod and seed yield among different seed size groups (Table 2). In fact bulk seed recorded the highest pod yield (16.7 t) and seed yied (2028 kg) per ha but on par with different seed size groups. The test weight of seed harvested from different size groups also showed no significant differences.

Second Season (2001-2002):

The seeds obtained from the earlier experiment were used in this experiment. The bulk seed was grouped into different size groups as in case of first experiment. The seeds were relatively bold compared to the seeds used in the first season. More than 92% of the bulk was constituted by seed size of >4.75mm and there was no seed below 4.00mm size (Table 1). As in the first experiment, only the first 5 seed size groups were used for evaluating the seed quality and field performance.

The highest test weight of 37.13g was recorded in seeds with >4.75 mm and it was significantly superior over other size groups. There was no significant difference among size groups with respect to germination percentage, but seedling dry weight of bold seeds and bulk recorded higher values (Table 1).

In the field, again there was no significant difference among the different size groups for field emergence, pod yield and test weight of the harvested seed from crop raised from different size groups seed (Table 2). The seed yield was highest (1580 kg/ha) in seeds with >4.5mm size and it was significantly superior over seeds with <4.75->4.5mm and <4.5->4.35mm but on par with seeds of >4.75mm, >4.35mm and bulk.

DISCUSSION

Seed size had no or little effect on seed quality, field emergence and field performance in both the seasons studied in frenchbean c.v, Arka Komal. Even the smallest seed <4.5->4.35 mm recorded germination, field emergence, pod yield on par with other greater sized seeds in both seasons except for seed yield during 2001-02 season. Lang and Holmes [2] in swede; Beveridge and Wilsie [3] in lucerne and Singh, *et.al.* [5] in soybean have obtained similar results. It seems that in frenchbean small size seeds which look like normal seeds in all respects but for size possess enough food materials in the cotyledons to support the germinating embryo till it attains a stage that can support on its own. Burlis *et. al.* [12] observed that photosynthetic rate in cotyledons and unifoliate leaf in soybean is lower in case of large seed while it is more in small seeds. This may be due to large supply of stored carbohydrate in large cotyledons that may have reduced the tendency of the seedling to make more. That means small soybeans do not suffer from any handicap in producing carbohydrate by photosynthesis to support growth. Provided adequate stands are achieved, yields that results from planting soybeans of different sizes generally show little association with final yield. However, extremely small seeds may result in poor yield but such seeds would likely to be cleared out during processing [13].

Wood *et. al.* [14] are of the opinion that the effect of size grading on crop establishment have differed with the species, cultivars, seed lot and source of seed but one of the main factors controlling its effectiveness has been the extent of peripheral of fruit material where the seeds of a species are covered only by a relatively thin testa or pericarp eg. peas and barley. Size of the seed as a whole reflects the size of the embryo and the reserves contained and the small shrunken seeds are usually discarded along with chaff during initial cleaning. As a result germination percentages of seed bulks are often very higher ie., 80-100% and usually there has been little or no benefit from grading. This is true in case of frenchbean also. In the present study the bulk seeds performed on par with the bold seeds

(>4.75mm) in both the seasons in all respects. The processed seed with >4.35mm size also performed on par with bigger size seeds both in lab and field though bigger size seeds produced heavier seedlings as reflected in seedling dry weight. Although large seeds produce heavier seedlings with large cotyledons and first leaves, this advantage may diminish in the field situation where interplant completion develops and plants from large and small seed may eventually attain similar yields [14].

Seed grading on size basis in frenchbean is very important in case of precision sowing wherein uniformity of seed size is needed. Otherwise seed grading may be resorted to remove only the smallest, shriveled seeds and other unwanted materials present in the seed lot of frenchbea in. In the seed lot used in the first season, the seeds with size > 4.75 mm constituted only 66% of the bulk. By including seeds with size >4.35mm, the rejection level can be reduced to just 12% of the bulk as these seeds also performed on par with the seeds of bigger seeds (4.75mm).

Test weight of seed collected from the first season harvest was recorded to see if any variation in weight distribution present in proportion to the size of the seed used to plant. There was no variation in test weight of seed produced from different seed size groups. Seed size of a given variety planted does not determine the size of seed produced. It is the genetic potential of the seed that determines the size of the seed.

This study revealed that in case of frenchbean cv. Arka Komal the seed size of >4.35mm can be used instead of seeds with >4.75mm size as presently practiced. By doing so the rejection levels during seed processing can be brought down from 34% to 12% in some seed lots.

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