INFLUENCE OF DELAYED HARVEST ON SOYBEAN SEED QUALITY

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INTRODUCTION

Production of soybean (*Glycine max* (L.) Merrill) seeds under a favourable environment with low precipitation, absence of early morning fog and / or dew, and low relative humidity during preharvest and harvest periods have many advantages. There is low incidence of plant and seed diseases and seed quality is good when produced under appropriate conditions. Perhaps it may be rather difficult to find such ideal weather conditions in humid tropical countries including Sri Lanka. Adverse weather conditions during the post-maturation preharvest period would cause moderate to severe seed quality problems (Delouche, 1974) and exposure to periods of dampness would cause deterioration in soybean seeds (Moorse *et al.*, 1950).

Harvest delays beyond optimum maturity extend field exposure and intensify field deterioration in soybeans. Soybean seed quality declined with subsequent reduction in germination and field emergence when the harvest was delayed by two weeks (Paschal and Ellis, 1978) and also when the seeds were harvested within 30 days after "harvest maturity" in hot humid weather conditions (Tekrony *et al.*, 1980). Costa (1979) obtained highest seed quality when 95 percent of the pods were mature as compared to the lowest seed quality when the harvest was delayed by 42 days after 95 percent maturity. The incidence of fungi also increased remarkably when harvest was delayed (Paschal and Ellis, 1978).

This paper reports the reduction in field emergence and seedling vigour in six soybean cultivars when the harvest was delayed by two and four weeks after 95 percent of the pods were mature under the environmental conditions that prevailed in Maha Illuppallama, Sri Lanka.

MATERIALS AND METHODS

In this experiment seeds of six soybean cultivars, harvested at optimum maturity when 95 percent of the pods were mature and at two and four weeks after maturity, were evaluated for field emergence and seedling vigour. All the seeds were produced from planting made on October 26, 1982 at the Agricultural Research Station, Maha Illuppallama.

Each cultivar was planted in six rows, each five metres in length and spaced 40 cm apart. Two rows of each cuitivar were harvested at optimum maturity, another two rows after two weeks, while the balance two rows were harvested at four weeks after maturity. These cultivars reached the optimum maturity almost at the same time ($\pm$ 2 days). The harvested seeds were dried to a moisture content of 8-10 percent and kept in cold storage at 15°C and 50 percent relative humidity until planted in the field on March 11, 1983. The experiment was designed as randomized complete block with split plot arrangement of treatments, where the time of harvest was the main treatment and cultivar as subtreatment.

Seventy-five randomly selected seeds of each cultivar from every harvest were planted in the field, 25 seeds in each replicate. The seed beds were watered uniformly everyday until the number of emerged seedlings was recorded on the seventh day after planting. Five emerged seedlings from each treatment combination in each replicate were uprooted carefully without damaging the root system, and the length of each seedling was measured from the base of the cotyledons right up to the root tip. The nonemergent seeds were excavated and examined for infection by fungi.

The transformation of the data was performed wherever necessary and subjected to the standard analysis of variance. The means were compared by using Least Significant Difference (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

The mean percentage of field emergence for seed harvested at optimum maturity was 86.3 percent which was respectively 5.2 percent and 52.0 percent higher than that of seed harvested at two and four weeks after maturity (Table 1). The major portion of the variation (76.0 percent) in the data analysis of field emergence in this experiment was attributable to the harvest time and only seven percent of the variability was accounted for the cultivar. A significant reduction of 52.0 percent in field emergence for seed harvested at four weeks after maturity as compared to that at optimum maturity was noticed in this investigation meanwhile the difference of 5.2 percent in emergence between seed harvested at optimum maturity and two weeks later was not found significant (P=0.05). High ambient temperatures above 35°C (maximum) from February 17 to March 2, 1983 along with moderate relative humidity (Table 2) would have caused rapid seed deterioration in the field during the period between two and four weeks after maturity and perhaps it may be one of the reasons for such a sharp decline in emergence in seed harvested at four weeks after maturity. The nonemergent seeds were excavated and examined. They were found associated with fungi. The greater proportion of fungal infected seeds were noticed in seed lots harvested at four weeks after maturity as compared to the others and it may be another reason for drastic reduction in emergence by 52.0 percent at this harvest, in addition to the unfavourable environmental conditions mentioned earlier. This observation was in agreement with Paschal and Ellis (1978) who reported that the incidence of fungi increased by 36 percent in seed harvested at four weeks after maturity as compared to the seed harvested at optimum maturity.

The soybean cultivars used in this test did not show remarkable differences in field emergence when harvested at optimum maturity. The percentage of emergence of the cultivars varied from 78.8 to 90.5 at this harvest (Table 3). However, the range in their percentage of emergence was greater in the other two harvests and in the range of 64.1 to 94.6 percent for seed harvested at two weeks after maturity and 12.6 to 52.1 percent for seed harvested at four weeks after maturity. The cultivars also differed significantly in their ability to emerge when the harvest was delayed by two and four weeks. At two weeks after maturity, Foster was found significantly inferior in emergence ability to the other cultivars except Bossier, but it was inferior to only two cultivars S. J-2 and Bossier at four weeks after maturity. These data reveal that there is genotypic variation in seed deterioration under field conditions when delaying the harvest. All the cultivars, excluding Williams, showed a decline in percentage of emergence as the harvest was delayed; however, it was not at the same rate in all cultivars. The seed of the cultivar Foster with the lowest percentage of emergence at optimum maturity declined faster in emergence ability than the other cultivars, all of which had a field emergence level of over 84.0 percent at optimum maturity. The cultivar S. J-2 consistently maintained high percentage of emergence at all harvests while seed of Williams harvested at two weeks after maturity showed higher percentage of emergence than at optimum maturity. The different behaviour of the cultivars at different harvests may be due to the interaction between cultivar and time of harvest, which was significant at the 5% level.

The mean length of seedling emerged from seed harvested at optimum maturity was 8.5 cm, which was respectively 0.2 and 1.2 cm more than that of seedling emerged from seed harvested at two and four weeks after maturity (Table 4). The average length of seedling of the harvest at four weeks after maturity was significantly reduced by about 1.0 cm ($P=0.05$) as compared to the other two harvests. However, the length of seedling of the harvests at optimum maturity and two weeks after maturity was found to be statistically equal at the 5% level.

The seedling length of the cultivars ranged from 7.6 to 9.3 cm when harvested at optimum maturity, 7.4 to 9.2 cm at two weeks after maturity, and 6.5 to 7.9 cm at four weeks after maturity (Table 5). No significant difference ($P=0.05$) in seedling length between the harvests at optimum maturity and two weeks after maturity was noticed in any of the cultivars tested. However, the length of seedling of the harvest at four weeks after maturity, as compared to the harvest at optimum maturity, was significantly reduced in three cultivars UFV—1 BP—2, Tunia, and Williams out of six cultivars tested at the 5% level. The seedling length was similar (7.4—7.6 cm) at all three harvests in the cultivar Bossier. These data indicate that in general the seedling vigour decreases when the harvest is delayed up to four weeks after maturity. However, variation does exist among cultivars included in this investigation.

SUMMARY AND CONCLUSIONS

Emergence, which is an indication of seed quality, was significantly reduced in seed harvested at four weeks after maturity. However, it did not differ markedly between seed harvested at optimum maturity and two weeks later. The seedling vigour, measured in terms of seedling length, was again significantly reduced in seed harvested at four weeks after maturity. However, in one cultivar, Bossier, the seedling length was similar at all three harvests.

It appears that prolonged delay in harvest after maturity in soybeans (delay of four weeks in this study) has a significantly adverse influence on the ability of seedlings to emerge in the field and subsequent seedling vigour as well. On the other hand, a short delay in harvest after maturity does not significantly affect these two characteristics. Perhaps, it may depend on the environmental conditions that prevailed. Variation seems to exist in seed deterioration under field conditions among cultivars when the harvest is delayed. Selection against rapid seed deterioration would be advantageous if prolonged delay in harvest cannot be avoided.

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Table 1. Mean percentages of emergence for seed harvested at maturity and two and four weeks later, with corresponding arcsine transformed values.

Harvest time	*Percentage of emergence*	*Transformed values (Arcsine)*
At maturity	86.3	68.4
Two weeks after maturity	81.1	64.2
Four weeks after maturity	34.3	35.9
Mean	67.2	56.2
L. S. D (P = O . 05)		8.8

Table 2. Mean weekly climatic data from physiological maturity of the cultivars to the last date of harvest.

Date	*Rainfall (mm)*	*Relative humidity (%)*	*Maximum temperature (°C)*	*Minimum temperature (°C)*
Jan. 19—Jan. 25	0.24	72.0	30.1	22.0
Jan. 26—Feb. 02	0.00	62.9	32.0	19.7
Feb. 03—Feb. 09	0.00	58.7	33.5	21.6
Feb. 10—Feb. 16	0.00	59.5	32.6	20.2
Feb. 17—Feb. 21	0.00	53.0	35.1	21.0
Feb. 22—Mar. 02	0.00	53.3	35.4	21.9

Table 3. Percentages of emergence for seed of six soybean cultivars harvested at maturity and two and four weeks later, with corresponding transformed values.

Cultivar	*Harvest time (weeks after maturity)* 0		2		4		*Mean*	
	P°	A⁺	P	A	P	A	P	A
S. J - 2	88.9	70.5	85.4	67.5	52.1	46.2	77.1	61.4
Bossier	88.5	70.2	78.7	62.5	49.3	44.6	73.6	59.1
UFV-1 BP-2	90.5	72.3	83.5	66.0	38.6	38.4	73.3	58.9
Tunia	84.5	66.9	79.9	63.4	35.7	36.7	68.1	55.6
Williams	84.8	67.6	94.6	72.6	12.6	20.8	64.9	53.7
Foster	78.8	62.6	64,1	53.2	22.6	28.4	55.4	48.1
Mean	86.5	68.4	81.1	64.2	34.2	35.8	69.7	56.6
L. S. D (P=0.05)		N.S*		10.0		15.2		5.1

° P = Percentage of emergence
+ A = Arcsine transformation
* N. S = Not significant

Table 4. Mean length of seedlings emerged from seeds harvested at maturity and two and four weeks later.

Harvest time	*Seedling length in cm*
At maturity	8.5
Two weeks after maturity	8.3
Four weeks after maturity	7.3
Mean	8.0
L. S. D (P = 0.05)	0.5

Table 5. Length of seedlings of six soybean cultivars harvested at maturity and at two and four weeks after maturity.

	Harvest time (weeks after maturity			
Cultivar	*0*	*2*	*4*	*Mean*
UFV-1 BP-2	9.3[‡]	9.2	7.1	8.5
S. J-2	9.0	8.9	7.9	8.6
Tunia	8.9	7.7	7.6	8.1
Williams	8.0	8.2	6.5	7.6
Foster	7.9	8.2	7.0	7.7
Bossier	7.6	7.4	7.5	7.5
Mean	8.5	8.3	7.3	8.0

‡ Seedling length in cm. Mean of three replications of five seedlings each.

L. S. D (P = 0.05) for comparing seedling length between different harvest times within a cultivar was 1.2 cm.