Effect of harvesting time on the seed yield and quality of common bean for seed production (*Phasiolus vulgaris* L.)

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Introduction

Bean (*Phaseolus vulgaris* L.) is an important leguminous crop growing in Badulla, Kandy, Rathnapura and part of Nuwara Eliya district. According to the Department of Census and Statistics, Sri Lanka, annual bean production extent is 8,279 ha and annual production is 66,163 mt in year 2015.

Use of poor quality seeds, low soil fertility, adverse weather conditions and incidence of pests and diseases have been identified as some of the major constraints to bean production in the tropics (Wortmann and Allen, 1994; Gridley and Danial, 1995). While substantial research work has been done on breeding for improved varieties, response to soil fertility and pest and disease control and production of good quality seeds have not been sufficiently studied.

Seed development is the period between fertilization and accumulation of maximum of fresh weight, and the seed maturation begins at the end of seed development, which continues until harvest (Mehta *et al*., 1993). Seeds reach its maximum dry weight at physiological maturity and they should be harvested at that stage to ensure its quality in terms of germination and viability (Shaheb *et al*., 2015). Quality of bean seeds depends on many pre and post-harvest factors, like the area of production, cultivation techniques, seed maturity, methods of harvesting and threshing, processing and storage conditions.

To increase yield, use of quality seeds are essential for both vegetable and seed production. Seed maturity, viability and storability are important criteria correlated with each other (Shaheb *et al*., 2015). Early harvested seeds which are immature and poorly developed, resulting in poor quality that affects storability compared to seeds harvested at correct physiological maturity stage.

Delayed harvesting also results in the loss of yield due to shattering, damage of seeds and the risk of exposing to rain that affect quality of seeds. On the other hand, if seeds retained on plant after its physiological maturity, physiological changes in seed

**** Short Communication***

may result formation of hard seeds or off colored seeds in pulse crops (Shaheb *et al*., 2015).

According to Greven *et al*. (2004) time of harvesting is important due to reduce seed immaturity and rewetting which reduces seed quality. Kumar *et al*. (2002) reported that seed yield and quality largely depend on the stage of maturity of the crop. Therefore, harvesting seeds at optimum maturity stage is an essential requirement to maintain quality of seeds.

In Sri Lanka, time of harvesting is predicted by the change in color of the pods from green to yellow and finally to straw yellow. Bean harvesting starts when pods color have changed to straw yellow and may proceed until the pods are completely dry to the extent of shattering. The late harvest could lead to exposing the seed to deleterious conditions and enhance deterioration.

Local seed production sector suffered with low productivity under poor agronomic practices. The same agronomic practices have still being practised for both vegetable bean production and bean seed production. Therefore, Sri Lanka has to import large quantities of bean seeds to fulfill seed requirement of the country. According to DOA statistics, Sri Lanka has imported 128.5 mt of bean seeds in 2016.

Therefore the present study was conducted with the objective to identify appropriate harvesting time to maximize seed yield and to ensure quality of seed beans.

Materials and methods

The trial was conducted at the research field of Agriculture Research Station, Rahangala during *Maha* season from November 2017 to January 2018. The experimental site was located in IU_{3d} Agro Ecological Region and having Red Yellow Podsolic soil.

The experimental treatments comprised of five different dates of harvesting *viz*., H_1: 65 Days after emergence (DAE), H_2: 70 DAE, H_3: 75 DAE, H_4: 80 DAE and H_5: 85 DAE. The harvesting stages were characterized by deep green with light yellow color of pod (65 DAE), 50% green and 50% yellowing of pods (70 DAE), light brown with few yellow color pods (75 DAE), 90% brown color of pods (80 DAE) and 100% brown color and dried pods (85 DAE), respectively.

The Pole bean variety Bandarawela Green released by the Department of Agriculture was used for the experiment. The experiment was laid out according to Randomized Complete Block Design (RCBD) with four replications.

Planting bed size was 1-2 m with 50 cm ditches between beds and 200 g of dolomite was applied into each bed two weeks before planting. 2 kg of well decomposed cattle manure added to each bed five days before planting and incorporated well.

Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MOP) were applied one day before planting at the rate of 110, 270 and 75 kg/ha respectively as the basal dressing recommended by the Department of Agriculture.

Seeds were then soaked in water overnight and treated with Thiamethoxam 70% WS over one hour before planting to control bean fly. Water soaked seeds were dibbed into planting holes with 70 x 20 cm spacing on well wetted beds. Irrigation was done at 2 days interval up to seedling emergence and thereafter 4 days interval until flower initiation. Approximately 100% field emergence was recorded at 10 days after sowing. At the flowering stage irrigation was done with 2 days interval up to 50 days (mid pod filling stage). Urea, and MOP applied at the rate of 110 and 75 kg/ha, respectively at 3 weeks after planting (WAP). Manual weeding was done at 2 WAP and 6 WAP.

Pods were harvested at different harvesting dates and number of pods per plant was counted with 10 randomly selected plants. Collected pods were sun dried until the moisture content reached up to 10-12%. Seed yield data collected from individual plots were calculated per hectare.

100 seed weight was obtained from two samples in each plot using well filled seeds with uniform seed size, shape and color and free from damages. Quality seeds were selected after drying when moisture content was 12%. Abnormal seeds that were damaged, deformed, diseased or discolored were discarded.

20 seeds from each plot were planted in pots and shoot length & root length of seedlings were measured at 7 days after emergence to calculate vigor index (Abdul-Baki and Anderson, 1973).

Vigour Index (VI) = (Mean root length (MRL)+Mean shoot length (MSL) x % germination (PG)

The data were statistically analyzed by using SAS system for Windows 9.0 and means were separated by using Duncan's Multiple Range Test (DMRT) at 0.05 probability level.

Results and discussion

Highest germination (98.7%), root length (6.3 cm) and shoot length (10.1 cm) of seedlings and vigour index (1574.7) recorded from seeds harvested at 80 DAE (Table 1) while lowest germination (65.3%), root length (4.7 cm), shoot length (6.6 cm) and vigour index (738.7) were recorded from seeds harvested at 70 DAE (Table 1).

Seeds harvested at 80 DAE, 85 DAE and 90 DAE did not show a significant difference for % germination and vigour index of seedlings. Khatun *et al*. (2010) reported that early harvested seeds were immature and poorly developed compared to seeds harvested at physiological maturity. The present findings are in agreement with those findings while giving poor seed qualities in early harvested seeds (seeds harvested at 70 DAE).

Table 1. Effect of time of harvesting on seed germination, root & shoot length and vigour index of seedlings

	Germination %	Root length (cm) 7 DAE	Shoot length (cm) 7 DAE	Vigour index
T1 (70 DAE)	65.33c±SE2.0	4.70^{b}	6.6^{c}	738.7^{b}
T2 (75 DAE)	71.33b± SE2.0	4.73^{b}	6.76^{c}	819.93^{b}
T3 (80 DAE)	98.66a± SE1.4	6.33^{a}	10.13^{a}	1574.67^{a}
T4 (85 DAE)	96.66a± SE0.8	5.96^{a}	9.13^{b}	1459.40^{a}
T5 (90 DAE)	95.66a± SE0.3	6.00^{a}	8.9^{b}	1470.47^{a}
CV%	3.11	3.48	4.99	3.20
R^2	0.981	0.976	0.956	0.993

Note: means followed by the same letter are not significantly different, at p = 0.05

The highest total of seed yield was recorded for seeds harvested at 80 DAE (1.21 t/ha) and the lowest total seed yield was recorded from the seeds harvested at 70 DAE (Table 2).

100 seed weight was highest at seeds harvested at 80 DAE (25.8 g) with lowest value for seeds harvested at 70 DAE (24.3 g). 100 seed weight of seeds harvested at 80, 85 and 90 DAE did not show significant difference, but it showed gradual reduction in seed weight after 80 DAE.

According to Shaheb *et al*. (2015) seed reaches its maximum dry weight at physiological maturity and seeds should be harvested at this stage to ensure the quality in terms of germinability and vigour. According to the results of the present study, seeds harvested at 80 DAE showed maximum 100 seed weight (25.8 g), maximum %

germination and vigour index. Therefore, 80 DAE can be considered as physiological maturity stage for common bean cultivate under Up Country Intermediate zone conditions.

Table 2. Total seed yield, quality seed yield

Treatment	Total seed yield (t/ha)	Quality seed yield (t/ha)	100 seed weight (g)
T1 (70 DAE)	0.66[b]	0.45[b]	24.27[b]
T2 (75 DAE)	0.80[b]	0.63[b]	24.43[b]
T3 (80 DAE)	1.21[a]	1.09[a]	25.80[a]
T4 (85 DAE)	1.16[a]	1.03[a]	25.47[a]
T5 (90 DAE)	1.14[a]	1.03[a]	25.23[a]
CV%	13.79	17.13	1.24

Note: Means followed by the same letter are not significantly different, at p = 0.05

The marketable quality seeds yield (1.09 mt/ha) was highest at 80 DAE while lowest (4.5 mt/ha) for 70 DAE. As shown in Figure 1, the difference between total seed yield and quality seed yield is highest at early harvests. After 80 DAE, difference between total seed yield and quality seed yield was more or less similar up to 90 DAE.

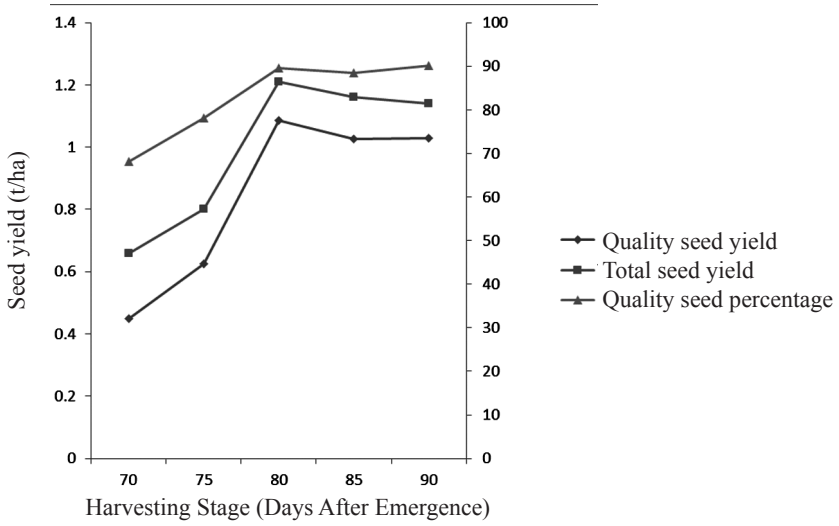

Figure 1. Variation of quality seed yield, total seed yield and quality seed percentage with harvesting time

Conclusion

80-90 days after emergence period can be considered as the best period for bean seed harvesting without significantly affecting seed yield, quality seed yield & 100 seed weight. Therefore, it is advisable to harvest dry pods for seed extraction at 80 DAE soon after reaching to physiological maturity.

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