

## Effect of harvesting stages on seed quality of soybean (*Glycine max* L.) during storage

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**ABSTRACT:** An experiment was conducted to study the effect of different harvesting stages of soybean, on storability and seed quality during storage, with variety JS 335 grown in 3 consecutive *khari* seasons. The crop was harvested at 85, 90, 95 and 100 days after sowing (DAS) and stored under ambient conditions. Bimonthly observations were recorded for germination, moisture content, vigour index and electrical conductivity from the seeds harvested at different stages. The maturity symptoms at physiological maturity (85 DAS) were yellowing of leaves, stem, pods with basal 2-3 dried as well as few upper green leaves. The IMSCS for germination was maintained for 12, 10, 8 and 6 months when the crop was harvested at 85, 90, 95 and 100 DAS, respectively. Similar trend was observed for vigour indices. The highest germination was observed in the seeds when the crop was harvested at physiological maturity and remained highest at subsequent storage period up to 12 months. Hence it is concluded that for maintaining the germination as well as other quality parameters, soybean should be harvested at physiological maturity which retain its viability during storage above IMSCS up to 12 months.

**Key words:** Soybean, Harvesting stages, Physiological maturity, Storage, Longevity

Soybean [*Glycine max* (L.) Merrill] has become a miracle crop of the twentieth century. It is a triple beneficiary crop, a unique food, a valuable feed and an industrial raw material. It is one of the most important protein and oil seed crop and occupies third place both in seed and oil production throughout the world. Its oil is the largest component of the world's edible oils and its protein is composed of ten properly balanced amino acids.

Loss of seed viability during storage and resultant poor stand are the major constraints in soybean seed production. The seed reaches its maximum dry weight at physiological maturity. Studies on seed development and physiological maturity become important because seeds should be harvested at proper time to ensure their quality in terms of germinability and vigour. The short shelf life of soybean seed is the result of its high lipid content and high levels of polyunsaturated linolenic and linoleic acids. Justice and Bans [1] reported that soybean suffers

from poor seed longevity and included soybean in the least storable group.

Retaining viability of soybean through a storage season is a major challenge in quality seed production. Physiological maturity of the seed is the stage at which the seed attains its maximum dry weight and it represents the stage marked with maximum viability and vigour. The changes that occur in the seed beyond physiological maturity is mainly dehydration without accumulation of reserves. Allowing the seed to dehydrate on the mother plant till the harvest maturity did not bring any additional improvement in the seed quality than that attained at physiological maturity.

Retaining of seeds on mother plant may lead to the development of hard or discolored seeds in leguminous crops. In soybean, if the seeds are retained on mother plant beyond physiological maturity, the crop may suffer losses due to pod shattering. Soybean seeds attained maximum

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germination potential at physiological maturity followed by forced desiccation and seed longevity potential reached its maximum at a stage beyond physiological maturity at 16-28% seed moisture. Therefore harvesting of crop near physiological maturity would be desirable. Some workers suggest that maximum seed quality is attained after certain period of physiological maturity.

Storability of seeds is mainly a genetic character and is influenced by pre-storage history of seed, seed maturation and environmental factors during pre and post harvest stages [2]. Early harvested seeds will be immature and poorly developed and as such are poor storers compared to seed harvested at physiological maturity [3, 4].

In view of this, an experiment was conducted to study the effect of different harvesting stages on seed quality of soybean during storage.

## MATERIALS AND METHODS

The soybean crop was grown for three years with recommended package of practices. The crop was harvested at 85, 90, 95 and 100 DAS and maturity symptoms were recorded. Crop was allowed to dry in the field itself before threshing. After proper drying the seed was stored in gunny bags and stored in godown at ambient conditions. The bimonthly observations for seed quality parameters from different harvesting stages *viz*; germination, moisture content, vigour index and electrical conductivity was recorded as per ISTA [5] for determination of seed quality during storage.

## RESULTS AND DISCUSSION

### *Maturity symptoms*

The maturity symptoms of the crop harvested at different stages are presented in Table 1. At 85 days after sowing, the symptoms of physiological maturity were observed. At this stage there was yellowing of leaves and plant along with peduncle and basal 2-3 leaves were dried and upper 2-3 leaves were green. At 90 days after sowing i.e. 5 days after physiological maturity, yellowing of all leaves, stems and pod along with maximum defoliation was observed. At 95 days

after sowing i.e. 10 days after physiological maturity, drying of whole plant including leaves and pod was observed. Few leaves and pods of same plants were yellowish and shattering of few pods was observed. At 100 days after sowing i.e. 10 days after physiological maturity, all plants were with 2-3 yellow leaves at the tip and shattered seeds from same pods were observed.

Maximum potential for germination and seed vigor occurs during physiological maturity. However, seeds have high water content at this stage, which hinders mechanized harvesting and threshing. At physiological maturity of soybean the change of pod colour or leaf colour to yellow can be used as an index for harvesting of soybean.

Seed could be stored for varying lengths of time after harvest. Viability at the end of any storage period is the result of the initial viability at harvest, as determined by factors of production, methods of handling and rate at which deterioration takes place. This rate of physiological change varies with the kind of seed and the environmental condition of storage, primarily temperature and humidity.

### *Storage studies*

The pooled data of three years on effect of different harvesting stages on seed quality parameters of soybean during storage are presented in Table 2. From the table, it was seen that the highest initial germination (93%) was attained when the crop was harvested at 85 days after sowing and it was sustained up to 12 months. During storage, seed quality is affected by several factors like environmental conditions during seed production, pests, diseases, seed oil content, seed moisture content, mechanical damages of seed during processing, packaging materials, pesticides, air temperature and relative air humidity in storage [6, 7]. Seed genetics, the environment where seeds are produced and storage environment are the three major factors that influence seed viability and vigor [8].

Maximum seed quality, as defined by seed germination and vigor, coincides with the developmental stage of physiological maturity [9].

Table 1. Symptoms of maturity at the time of harvesting

Stage/days of maturity	Symptoms of maturity
I Physiological maturity (85 DAS)	I. Yellowing of peduncle of third leaf from top. II. Yellowing of lower leaves and pods, stem and basal 2-3 leaves were dried. III. Two-three upper leaves were still green.
II 5 days after Physiological maturity (90 DAS)	I. Yellowing of all leaves, stem and pods II. Drying of lower leaves, peduncle and few pods. III. Only 2-3 yellow leaves remained on plants. Some plants were completely defoliated
III 10 days after Physiological maturity (95 DAS)	I. Drying of whole plants, including leaves and pods. Only few pods and leaves of some plants were yellowish. II. Some plants were completely dried, defoliated and shattering of seed of few pods
IV 15 days after physiological maturity (100 DAS)	I. All plants were completely dried and defoliated. II. Only few plants had 2-3 yellow leaves at the tip. III. Shattering of seed from some pods.

At physiological maturity, seed shall have maximum viability and vigour. Attainment of physiological maturity is a genotypic character which is influenced by environmental factors [10, 11]. As such harvesting of seed crop at optimum stage of seed maturation is essential to obtain better seed quality. Beyond this stage, the seed starts deteriorating. Seed deterioration, therefore, is an inexorable process that cannot be reversed. Only its rate can be slowed by storage in a controlled environment.

The germination of the seed harvested at 90 days after sowing was at par with the crop harvested at 85 days after sowing up to 2 months of storage. After 2 months of storage there was significant difference in the germination. The MSCS for germination was maintained up to 12 months of storage when the crop was harvested at 85 DAS. However, the MSCS for germination was maintained only up to 10 months when the crop was harvested at 90 days after sowing. The lowest initial germination (86%) was recorded when the crop was harvested at 100 days after sowing. The IMSCS for germination was

maintained only for 8 and 6 months when the crop was harvested at 95 and 100 DAS, respectively. It is difficult to assess the effective storage period because the storability of the seed is a function of initial seed quality and the storage conditions and may vary among different seed types [12-14].

The initial vigour index was the highest (3076) when the crop was harvested at 85 days after sowing however it was at par with vigour index of crop harvested at 90 DAS (2957). The significantly lower (2633) vigour index was observed when the crop was harvested at 100 days after sowing. A similar trend was noticed throughout storage.

The initial electrical conductivity was significantly lower (0.715) when the crop was harvested at 85 days after sowing, than the seeds of crop harvested at 95 and 100 days after sowing. However, it was at par with electrical conductivity of the seeds of crop harvested at 90 days after sowing. Similar trend was maintained throughout storage.

Table 2. Year wise and pooled analysis of three years data of effect of different harvesting stages on storability and seed quality of soybean during storage

Treat	Germination %				Vigour Index-II (G % X SDW)				Vigour Index-I (G % X RS)			
	1 <sup>st</sup> year	2 <sup>nd</sup> year	3 <sup>rd</sup> year	Mean	1 <sup>st</sup> year	2 <sup>nd</sup> year	3 <sup>rd</sup> year	Mean	1 <sup>st</sup> year	2 <sup>nd</sup> year	3 <sup>rd</sup> year	Mean
A1B1	92	92	94	93	94	108	100	101	2955	3128	3146	3076
A1B2	90	90	92	91	90	104	106	100	2798	2880	2875	2851
A1B3	87	88	90	89	87	101	102	97	2617	2824	2812	2751
A1B4	85	82	85	84	84	86	86	85	2450	2370	2403	2408
A1B5	88	75	76	80	78	73	74	75	2287	2250	2277	2271
A1B6	76	73	73	74	73	69	68	70	2039	2030	2126	2065
A1B7	71	71	70	70	68	67	67	67	1840	1974	1964	1926
A2B1	92	91	91	92	93	106	106	102	2849	3011	3012	2957
A2B2	90	89	90	90	90	104	104	99	2693	2766	2755	2738
A2B3	85	88	88	87	84	101	102	96	2558	2720	2720	2666
A2B4	82	88	82	82	81	84	82	82	2296	2282	2321	2300
A2B5	78	74	75	76	76	70	71	72	2152	2138	2163	2151
A2B6	72	72	72	72	70	68	67	68	1902	2037	2098	2012
A2B7	69	70	69	69	68	66	67	67	1766	1890	1882	1846
A3B1	85	89	89	88	86	102	104	97	2543	2751	2760	2687
A3B2	84	88	88	87	82	101	101	95	2429	2720	2682	2610
A3B3	81	85	85	84	79	97	99	92	2261	2643	2617	2507
A3B4	78	73	75	75	75	73	76	75	2145	1978	2022	2048
A3B5	71	71	70	71	68	67	67	67	1868	1917	1916	1900
A3B6	67	69	67	68	64	65	61	63	1681	1856	1804	1780
A3B7	62	67	62	64	58	62	57	59	1540	1748	1599	1629
A4B1	85	88	87	86	85	100	100	95	2493	2720	2685	2633
A4B2	83	88	85	85	79	101	99	93	2342	2713	2635	2563
A4B3	79	85	84	83	75	96	96	89	2219	2535	2547	2434
A4B4	75	72	74	74	71	70	72	71	1988	1915	1988	1964
A4B5	70	70	65	68	67	66	60	64	1791	1890	1741	1807
A4B6	62	68	63	64	58	63	57	59	1550	1823	1683	1685
A4B7	60	67	60	62	54	62	55	57	1374	1729	1569	1557
SE (±)		1.37				3.19				46.50		
CD at 5%		3.90				9.02				131.55		

A1 to A4= Harvesting Stage: A1- Physiological maturity; A2- 5 days after physiological maturity; A3: 10 days after physiological maturity; A4- 15 days after physiological maturity; B1 to B-7 = Storage Period: B1: Initial; B2: 2 month; B3: 4 month; B4: 6 month; B5: 8 month; B6: 10 month; B7: 12 month

Table 2. contd...

Treat	Moisture Content (%)				Electrical Conductivity			
	1 <sup>st</sup> year	2 <sup>nd</sup> year	3 <sup>rd</sup> year	Mean	1 <sup>st</sup> year	2 <sup>nd</sup> year	3 <sup>rd</sup> year	Mean
A1B1	9.43	10.1	8.92	9.47	0.758	0.698	0.697	0.715
A1B2	9.13	9.98	9.05	9.39	0.791	0.715	0.726	0.742
A1B3	8.88	9.58	9.00	9.15	0.825	0.781	0.785	0.795
A1B4	9.75	8.85	9.22	9.27	0.826	0.808	0.806	0.812
A1B5	10.4	9.95	8.95	9.77	0.839	0.818	0.828	0.828
A1B6	10.9	10.1	9.05	10.0	0.860	0.706	0.855	0.816
A1B7	9.95	9.88	8.97	9.60	0.885	0.839	0.879	0.870
A2B1	9.05	9.95	9.00	9.33	0.754	0.700	0.712	0.721
A2B2	9.06	9.98	9.15	9.40	0.790	0.730	0.737	0.750
A2B3	8.93	9.45	8.95	9.11	0.830	0.783	0.82	0.813
A2B4	9.83	8.80	9.17	9.27	0.834	0.815	0.825	0.825
A2B5	10.4	9.98	8.87	9.74	0.862	0.823	0.836	0.840
A2B6	10.9	10.2	9.07	10.0	0.882	0.847	0.865	0.865
A2B7	10.1	9.93	9.60	9.86	0.910	0.843	0.888	0.882
A3B1	9.15	10.0	10.1	9.73	0.790	0.726	0.781	0.769
A3B2	9.1	9.88	10.2	9.71	0.798	0.768	0.805	0.793
A3B3	8.98	9.53	9.76	9.42	0.837	0.805	0.850	0.834
A3B4	9.90	8.75	9.30	9.32	0.841	0.828	0.912	0.869
A3B5	10.3	9.95	9.95	10.1	0.860	0.839	0.948	0.894
A3B6	10.9	10.0	9.80	10.3	0.895	0.856	0.981	0.923
A3B7	10.1	9.93	9.92	9.97	0.931	0.861	0.995	0.941
A4B1	9.15	9.98	10.4	9.85	0.823	0.736	0.811	0.794
A4B2	9.18	9.88	10.1	9.73	0.849	0.77	0.831	0.820
A4B3	9.05	9.53	10.4	9.66	0.879	0.81	0.864	0.854
A4B4	10.0	8.75	10.5	9.78	0.884	0.844	0.912	0.886
A4B5	10.5	9.95	10.2	10.2	0.900	0.86	0.967	0.919
A4B6	12.0	9.98	10.2	10.7	0.930	0.884	0.990	0.944
A4B7	10.2	9.93	10.8	10.3	0.939	0.886	1.003	0.953
SE ( $\pm$ )	0.345	0.01						
CD at 5%	0.976	0.03						

**A1 to A4=** Harvesting Stage: **A1**- Physiological maturity; **A2**- 5 days after physiological maturity; **A3**: 10 days after physiological maturity; **A4**-15 days after physiological maturity; **B1 to B-7 =** Storage Period: **B1**: Initial; **B2**: 2 month; **B3**: 4 month; **B4**: 6 month; **B5**: 8 month; **B6**: 10 month **B7**: 12 month

**CONCLUSION**

Longevity of seed in storage is influenced by the seed quality as well as storage conditions. Storage of seeds with high initial quality can maximize longevity. Irrespective of initial seed quality, unfavourable storage conditions, particularly air temperature and air relative humidity, contribute to accelerating seed deterioration during storage. Harvesting time of any crop for seed quality depends on its maturity, time and physiological maturity. Harvesting of seeds at optimum stage of maturity helps to obtain better quality seed. Harvesting stage influences the quality of seed in relation to germination, vigour, viability and also storability. From the study it was concluded that soybean seeds harvested at physiological stage would retain superior quality up to 12 months in ambient storage condition.

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