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EFFECT OF SEED AGE, VARIETIES AND INTRA ROW SPACING ON YIELD OF SOYBEAN (*GLYCINE MAX* (L.) MERRILL) IN DANGUR DISTRICT, METEKLE ZONE, WEST SOUTHERN ETHIOPIA

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ABSTRACT

The importance of seed age, varieties and spacing on soybean seed yield and quality has not been established in Ethiopia. This study was conducted in Dangur District at Pawe Agricultural Research Site with the objective of evaluating the effect of seed age and soybean varieties on growth, yield components and yield to assess the effect of seed age and varieties on physical, physiological and health quality of soybean during 2013 cropping season. The experiment was designed with factorial combinations of three intra row spacing (5cm, 10 cm and 15 cm), two seed age (year one and year two) with two varieties Belessa-95 and TGX was laid out in a randomized complete block design with three replications. Analysis of variances showed that significant ($p \leq 0.01$) differences were recorded for days to flowering, plant height, number of branches, number of pods per plant, cluster per plant, pod per cluster, yield and above ground dry biomass occurred due to the main effect of seed age. Similarly days to flowering and plant height were affected by three way interaction effect. The significantly higher number of pods per plant (104.82), above ground dry biomass (3676.0 k/ha) and grain yield 2303.3kg/ha was recorded on year one. Therefore, it could be concluded that the combination of both soybean varieties in Dangur District area year one attained maximum yield.

KEYWORDS: seed age; varieties; intra row spacing; yield and soybean.

INTRODUCTION

Soybean [*Glycine max* (L.) Merrill] belongs to the family Fabacesae sub family Papilionoideae and genus Glycine. The crop also does well in some areas as low as 500 m and as high as 1900 m above sea level that receives a well distributed average rain fall of 550 to 700 mm throughout the growing period.[1] The need for a long growing season and satisfactory soil moisture during flowering and pod filling are very important for higher yield of soybean. It grows best under good soil conditions. A fertile, medium textured soil usually is the best for the crop to perform.[2] Soybean varies in growth habit, height and has two types, determinate and indeterminate. The big inconspicuous, self-fertile flowers are born in the axel of the leaf and are white, pink or purple.[3]

Soybean seed is planted in rows with a seed drill 2-3 cm deep in soil having moisture content or 4 cm in lighter soils. The recommended spacing between rows varies from 40 to 60 cm and from 4 to 5 cm between plants. About 65-75 kg of seed is sufficient for 1 ha area. Soybean, it is useful in crop rotation as its nodules fix atmospheric nitrogen and thus builds up the soil fertility by fixing large amount of atmospheric nitrogen through the root nodules, and also through leaf fall on the ground at maturity.[4] Soybean can be grown in a wide range of environments, has moderate drought tolerance, and does not require nitrogen fertilization because of symbiosis with the nitrogen fixing bacteria, *Rhizobium*. Among grain legumes, soybean has the highest protein and oil content. The soybean seed on an average contains 40% protein and 20% oil, 35% carbohydrate and about 5% ash, which determine the economic worth of seed in the globe.[5]

Soybean was first introduced to Ethiopia in 1950`s for nutritional value, multipurpose use and wider adoptability in different cropping systems.[1] It is a crop that can play major role as protein source for resource poor farmers of Ethiopia who cannot afford animal products. Besides, it can also be used as an oil crop, animal feed, poultry meal, soil fertility improvement and more importantly as income for the country.[6] Soybean has become a crop of growing importance in the country as it has demonstrated an increase in area from 1027 ha in 2004 to 11, 261 ha in 2010 under private peasant holdings with a production of 15824.4 tons with average productivity of 1.4 t/ha.[7] Because of constraints like disease, insect- pest, weeds, soil and agronomic factors, the average yield of soybean is low. Excess plant density reduces yield due to competition for water, sunlight, nutrient and space, which cause self thinning, branches and spindly stalks. Similarly, wider spacing rendered low yields due to decreased plant populations/unit area.[8, 9] The recommended plant spacing for early and late varieties is 40x5cm and 60x5cm respectively.[10] It can grows very well from 1300 to 1800 m above sea level; where average mean annual temperature range between 20-25^{0}c and pH varies from 5.5 to 7.[11] Studies also showed that the yield range from these areas was between 1000 to 2900 kg/ha depending on the management.[11]

The spatial distribution of plants in a crop community is an important determinant of yields. Many experiments have been conducted to determine the spacing between rows and between plants with in the row, which maximizes yield. There are two general concepts frequently used to explain the relationship between row spacing, plant density, and yield. First, maximum yield could be obtained only if the plant community produced enough leaf area to provide maximum light interception during reproductive growth.[12] Secondly, equidistance spacing between plants affected inter plant competition. Hence it will be imperative to adjust the spatial distribution of the recommended population in order to have maximum yield.[13] Longevity of stored seed of any crops considerably depends of the stored conditions, primarily in terms of air temperature and relative air humidity in storage. The seeds of many crops deteriorate at fast rate and lose the planting value. Ageing of the seed is a serious problem associated with oxidation of lipids increase in fat acidity and membrane integrity leading to deterioration.[14]

Temperature and seed moisture content are the main factors influencing seed deterioration and viability loss in storage. Lower temperature and humidity result in delayed seed deteriorative process and aging there by leading to extended viability period. Seed ageing is generally marked by reduction in vigor, viability, rate and capacity of germination, increased solute leakage and susceptibility to stresses and reduced tolerance to storage under adverse conditions. Thus, in oil crops, such as soybean and sunflower, auto oxidation of lipids and increasing the content of free fatty acids during storage period are the main reasons for rapid deterioration of seed as announced by.[20, 21] and [22] In Ethiopia seeds are stored for various periods and reasons; seeds are not sold after they are produced, seeds are not planted immediately after harvested due to unfavorable growing conditions, and seed market is variable and unpredictable. In view of the above, seed get aged. However, the effect of variable seed ages by varieties and spacing have not yet well assessed on yield and quality of seed for subsequent utilization. Hence, this study was initiated to evaluate the effect of seed age, variety and intra row spacing on growth, yield components and yield of soybean.

MATERIALS AND METHODS

Description of the Site: Pawe Agricultural Research Center is located in north western part of Ethiopia. It is located in BeniShangul-Gumuz Region, Metekle Administrative Zone, and 573km far Addis Ababa at altitude of 1197 meters above sea level. The climate of Pawe is tropical hot humid with annual rain fall range from 1000-1500 mm concentrated in one season from May to October. Annual minimum and maximum temperature were 16^0c and 32.4 ^{0}c respectively.[23] The soil type of the area is Nitosol. The total amount of rainfall received during the experimental period (June to October) was 1112.3 mm.[23]

Treatments, Experimental Design and Cultural Management: The treatments consisted of three factors the seed age (year one and two), intra row spacing (5, 10 and 15 cm) and varieties of soybean (TGX and Belesa-95). The size of each plot was 4x3m (12 m^2). The space between blocks was 1m and the space between rows in each plot was 60cm. 100kg of DAP was applied. The experiment was laid out as randomization complete block design (RCBD) in a factorial arrangement with three replications (3x2x2). TGX and Belesa-95 varieties released in 2003 and adaptable to several areas including Awassa, Gutin, Baco, Dedessa and Pawe etc. were used. It is one of the high yielding varieties and has been recommended and distributed to the farmers and state farms for large scale production in the country. These varieties need 150 days to maturity. Sowing was done on 21^{th} of June by placing the seeds at an appropriate distance as per the treatments with the help of tape meter and then covering it manually with the soil.

Data Collection and Measurements

Field data

Days to flower initiation: It was recorded as the number of days from sowing to the time when one open flower appeared (R1 growth stage) at any node on the main stem from those ten randomly pre tagged plants.

Number of primary branches per plant: It was recorded from ten randomly pre tagged plants from the net plot area and averaged to get number of branches per plant from those ten randomly pre tagged plants at R2 (reproductive stage two) soybean growth stage.

Plant height (cm): It was recorded at R7 (when one normal pod on the main stem had reached its mature pod color) and expressed as per plant those ten randomly pre tagged plants.

Days to maturity: It was recorded as the number of days from sowing to the time when R7 stage begins (the seed as well as pod turn at yellow) those ten randomly pre tagged plants.

Pods per plant: It was counted from ten randomly pre tagged plants from net plot area of each plot at the time of harvesting stage and expressed as pods per plant those ten randomly pre tagged plants.

Number of seeds per pod: It was counted at the time of harvest from randomly ten pre tagged plants from net plot area and sum up the seeds; these total seeds were divided by the total number of pods to get the average number of seeds per pod those ten randomly pre tagged plants.

Number of clusters per plant: It was counted from ten randomly pre tagged plants from net plot area of each plot at the time of harvesting stage and expressed as cluster per plant those ten randomly pre tagged plants.

Number of pods per cluster: It was counted at the time of harvest from randomly ten pre tagged plants from net plot area and summed the pod; those total pod were divided by the total number of plant to get the average number of pod per cluster those ten randomly pre tagged plants.

100 Seed weight (g): It was determined by weighing one hundred seeds from each net plot area and sun dried until they reach 13% moisture content and weighing them on sensitive balance in Pawe Agricultural Research Center Laboratory those ten randomly pre tagged plants.

Above ground dry biomass: It was recorded from ten randomly plants from pre targeted plants at R7 (reproductive stage seven), when one normal pod and the lower one leaf turns to yellow, plants were harvested just above the ground level and put them in an oven for 24 hours at 65^0c and weight measured by sensitive electrical balance the result were multiplied by the stand count of plants and economic yield was added and converted to hectare bases.

Seed yield: It was obtained after sun dried and threshed according to its treatment in plot wise. The seed yield per plot area was recorded from the net plot area of 11.99 m^2 and converted it in to hectare (kg/ha) and adjusted at 13% moisture content.

Harvest index: It was determined as the ratio of the dry matter of harvested part of the crop (grain yield) to the total above dry matter production.

Data Analysis: The analysis of variance was performed following the procedure of [31] using the SAS computer soft ware. The treatments significant differences were subjected to LSD (least significant difference) test for mean separation at ($p<0.01$) and (<0.05) significant levels.

RESULTS AND DISCUSSION

Days to flowering

Analysis of variance showed that there were significant ($P\leq 0.01$) differences observed on days to flowering by the main effect of variety, seed age, intra row spacing and three factors interaction effect. While the interaction effect of variety x intra row spacing significantly ($P\leq 0.05$) affected days to flowering of soybean. On other hand, the interaction effect of variety x seed age and intra row spacing x seed age did not significantly affect the days to flowering. The longest days to flower initiation was recorded by the interaction of TGX x year two x 15cm while the lowest days was recorded by the interaction of Bellesa-95 x year one x 5cm was on 48 days (Table 1). This result was in agreement with that of [32] who reported that with the decrease of intra row spacing there was a decrease of days to flowering of soybean, whereas, with an increase in intra rows there was an increase in days to flowering. The finding of this study was in contrary with [33] reported that the wide plant spacing of 50 cm reduced the number of days to flower in broad bean. However, [34] worked on lentil reported that denser plant population hastened the days to flowering. Therefore, it seemed that the influence of plant population on days to flower initiation varies from crop to crop depending on the prevailing environmental conditions under which the crops are grown might also have pronounced effect on it. This result showed that with the decrease of intra row spacing there was a decrease in days to flowering on soybean and vice versa is true.

Table 1: Interaction effect of age, variety and spacing on date of flowering of soybean grown in Pawe District in 2013.

Treatments			Parameter
Variety	**Age**	**Spacing (cm)**	**Days to flowering**
Bellesa-95	Year one	5	49.00^{g}
Bellesa-95	Year one	10	51.33^{f}
Bellesa-95	Year one	15	56.00^{ab}
Bellesa-95	Year two	5	53.33^{d}

Bellesa-95	Year two	10	51.67[ef]
Bellesa-95	Year two	15	53.33[d]
TGX	Year one	5	53.00[de]
TGX	Year one	10	53.67[cd]
TGX	Year one	15	53.00[de]
TGX	Year two	5	51.67[ef]
TGX	Year two	10	55.00[bc]
TGX	Year two	15	56.67[a]
LSD (5%)			1.61
CV%			1.79

Mean followed by the same letter along columns are not significantly different from each other at 5% P-level.

Days to maturity: Analysis of variance showed that there was no significant differences observed on days to maturity of soybean by all two factors combinations, three factor combination and by the main effect of variety and seed age. But maturity of soybean was significantly (P≤0.05) affected only by the main effect of intra row spacing. Maturity of soybean was delayed at 15cm intra rows spacing while earlier maturity of soybean was recorded at 5cm intra rows spacing (Table 2). This result agrees with [35] as plant population increased maturity of plants was earlier which might be due to greater intra specific competition for growth factors among plant populations for narrow spacing as compared to wider spacing.

Table 2: Main effect of variety, seed age and intra row spacing on days to maturity and branch number of soybean.

Treatments	Parameters	
Spacing (cm)	**Days to maturity**	**Branch number**
5	104.79[b]	6.05
10	114.00[a]	6.26
15	118.00[a]	6.38
LSD (5%)	8.82	NS
Age		
Year1	114.00	7.27[a]
Year2	110.53	5.18[b]
LSD (5%)	NS	0.36
Variety		
Belessa-95	110.5	6.34
TGX	114·0	6.12
LSD (5%)	NS	NS
CV%	9.28	8.56

Mean followed by the same letter along columns are not significantly different from each other at 5% P-level.

Number of branches per plant

Analysis of variance showed that there were no significant differences observed on number of branches per plant of soybean by all two factors combinations, three factor combination and by the main effect of spacing and variety. But numbers of branch per plant of soybean was significantly ($P \leq 0.05$) affected only by the main effect of seed age. The more number of branches per plant was obtained by year one compared to year two (Table 2). This might be due to the fact that as seed age increases seed viability and germination capacity decreases which intern decreases individual performance of the plant, physiological activity of the plant and number of branches per plant.

Plant height

Analysis of variance showed that there was a significant ($P \leq 0.01$) difference by the main effect of seed age on plant height. More over the three way interaction effect significantly ($P \leq 0.05$) affect plant height of soybean. The main effect of variety, spacing, and the two way interaction effects did not show significant difference on plant height but there were no significant differences observed on plant height by main effect and two way interaction effects. The tallest plant height was recorded under the interaction of TGX x year one x 5 cm intra row spacing (55.05cm) and the shortest plant height was recorded at the interaction of Bellesa-95 x year two x15cm spacing (36.14) (Table 3). These result in contrary with finding of.[36] Worked on spacing experiment observed that increasing the density of plants led to significant increases in plant height. And the results agree with the findings of [12] which might be due to enough leaf area and provide maximum light interception during vegetative and early reproductive growth stages) and [37] who reported that observations recorded under field conditions revealed that the various invigoration treatments showed significant differences of seed age on growth characteristics like plant height, productive tillers/plant, days to 50% flowering, yield component like panicle length, weight of seeds/ panicle (g), seed recovery percentage, yield parameters and quality characters like 1000 seed weight.

Table 3: Interaction effect of seed age, variety and intra row spacing on plant height of soybean grown in Pawe District in 2013.

Treatments			Parameter
Variety	**Age**	**Spacing (cm)**	**Plant height (cm)**
Bellesa-95	Year one	5	55.05^{a}
Bellesa-95	Year one	10	40.46^{ab}
Bellesa-95	Year one	15	41.96^{ab}
Bellesa-95	Year two	5	37.18^{b}

Bellesa-95	Year two	10	39.08^{ab}
Bellesa-95	Year two	15	36.13^{b}
TGX	Year one	5	44.21^{ab}
TGX	Year one	10	50.72^{ab}
TGX	Year one	15	39.23^{ab}
TGX	Year two	5	37.13^{b}
TGX	Year two	10	37.40^{b}
TGX	Year two	15	42.56^{ab}
LSD (5%)			8.67
CV%			9.2

Mean followed by the same letter along columns are not significantly different from each other at 5% P- level.

Number of pods per plant: Number of pods per plant was significantly ($P \leq 0.01$) affected by the main effect of seed age while the main effect of variety, spacing, interactions of the two way and three way interactions did not significantly affect number of productive pods per plant. Higher number of pods per plant was (104.82) recorded from year one compared to year two (Table 5). This might be due to more number of branches per plant were recorded on year one over year two (Table 2) which resulted in more number of pods per plant from year one plants over year two plants. This result agrees with[38] who reported that reducing plant density by thinning treatment in the standard and low plant density increased the total pod, filled pod and individual seed weight.[39] Suggest that high plant densities prompt greater competition among sinks for assimilates, causing more severe abscission of flowers and young pods in the absence of environmental crop stress. This competition for assimilates during a short but critical phase (start of pod development) may be a major determinant of seed yield. Similarly,[40] the greatest number of pods/plant was produced from plants at the lowest population perhaps due to greater available space and reduced interplant competition. On other hand result where in contrary with the findings of[41] who reported that number of pod per plant where increased with increasing ageing period. Similarly, number of pods per cluster was significantly ($P \leq 0.01$) affected by the main effect of seed age.

However, the main effect of variety, spacing, the two way interactions and three way interactions effects did not significantly affect number of pods per cluster. Plants from year one significantly gave more number of pods per cluster (8.44) over those from year two (Table 5) as more number of cluster per plant were recorded on year one. On the contrary, the main effect of seed age, varieties, intra row spacing and two ways and three way interaction effect were not significantly different on number of seeds per pod.

Table 4: Main effect of variety, seed age and intra row spacing on pods per cluster, pods per plant and seeds per pod of soybean.

Treatments	Parameters		
Spacing (cm)	**Pods per cluster**	**Pods per plant**	**Seeds per pod**
5	6.93	67.68	2.36
10	6.29	73.41	2.32
15	6.73	72.37	2.37
LSD (5%)	NS	NS	NS
Age			
Year1	8.44 [a]	104.82 [a]	2.39
Year2	4.86 [b]	37.49 [b]	2.30
LSD (5%)	1.07	9.54	NS
Variety			
Belessa-95	6.72	68.31	2.38
TGX	6.57	74.00	2.32
LSD (5%)	NS	NS	NS
CV%	21.08	18.58	7.85

Mean followed by the same letter along columns are not significantly different from each other at 5% P-level.

Number of clusters per plant: Analysis of variance showed that there was a significant ($p \leq 0.01$) difference observed on number of cluster per plant by the main effect of seed age. But the main effect of spacing was significant ($p \leq 0.05$) on number of cluster per plant. Similarly, interaction effect of spacing and seed age was significant ($p \leq 0.01$) difference in number of cluster per plant. While the main effect of variety, the two way interactions effects of seed age and varieties and three way interactions effects did not significantly affect number of cluster per plant. Higher mean number of cluster per plant was obtained (8.23) on year one and lower mean was recorded on year two (3.4) (Table 6). These might be due to the most of the time aged seed have lower in germination rate due to utilization of reserved food on storage and when the spacing increases the cluster number was increase.

Table 5: Interaction effect of seed age *spacing on soybean in 2013.

Treatments	Clusters per plant		
	Spacing (cm)		
Seed age	5	10	15
Year-one	4.91 [b]	8.23 [a]	8.01 [a]
Year-two	4.4 [b]	3.4 [b]	3.91 [b]
LSD (5%)	2.04		
CV %	21.9		

Mean followed by the same letter along columns are not significantly different from each other at 5% P-l

Seed weight

The main effect seed age was significantly ($p \leq 0.05$) affect hundred seed weight. But the main effect of varieties, intra row spacing, two way interaction and three ways interaction were not significantly affecting hundred seed weight. These indicted that seed age has influence on seed weight (Table 7). This result agrees with [42] who report that there were statically not significant different observed by spacing on 100 seed weight. On other hand result where in contrary with the findings of [41] who reported that seed age where no significant effect on 100 seed weight.

Table 6: Main effect of seed age, varieties and spacing on hundred seed weight on soybean.

Treatments	100 seed weight
Age	
Year one	14.69^{a}
Year two	14.39^{b}
LSD (5%)	0.32
Spacing (cm)	
5	14.48
10	14.62
15	14.53
LSD (5%)	NS
Variety	
Belessa-95	14.62
TGX	14.47
LSD (5%)	NS
CV%	2.57

Mean followed by the same letter along columns are not significantly different from each other at 5% P-level.

Dry Biomass

Analysis of variance showed that dry biomass accumulation was significantly ($p<0.05$) affected by main effect of seed age but not affected by main effect of varieties, intra row spacing, two way interaction and three way interaction. The highest mean biomass accumulation was recorded year one (3676.0 kg) and the lowest mean were recorded year two (1713.4 kg) (Table 8). These results agree with [43] reduction in dry biomass was during seed development anabolic processes predominate and bring about gradual decrease in dry matter including development of an embryo and food reserve. When the seed has no reserve food plant, it may not germinate and it will die.

Table 7: Main effect of variety, seed age and intra row spacing on seed biomass, harvest index and yield of soybean.

Treatments Spacing (cm)	Biomass	Harvest index	Yield
5	2552.4	53.86	1489.4
10	2706.4	51.48	1470.2
15	2825.3	50.72	1548.7
LSD (5%)	NS	NS	NS
Age			
Year1	3676.0[a]	62.91[a]	2303.3[a]
Year2	1713.4[b]	41.13[b]	702.2[b]
LSD (5%)	409.89	13.28	21.19
Variety			
Belessa-95	2706.7	51.79	1530.2
TGX	2682.7	52.25	1475.4
LSD (5%)	409.89	5.10	223.49
CV%	NS	NS	NS

Mean followed by the same letter along columns are not significantly different from each other at 5% P-level.

Harvest index

The main effect of seed age was significant ($p \leq 0.01$) on the harvest index. But the main effect of varieties, intra row spacing, two way interaction and three way interaction were not significantly affecting harvest index. Analysis of variance revealed that year one had higher harvest index (62.91%) and the lower harvest index were recorded in year two (41.13%) (Table 8).

Yield

The main effect of seed age had significant ($p \leq 0.01$) difference on yield. However, there was no significant difference by main effect of varieties, intra row spacing, two way interaction and three way interactions on yield. The highest mean (2303.3kg/ha) recorded on year one and the lowest mean were (702.2kg/ha) recorded on year two (Table 8). Yield showed a reverse trend with seed age and which was an increase in yield with a decrease of aging. Year one was higher yielded than year two due to low germination capacity, vigor and viability was lost during storage. These agree with previous finding [44] and [41] who reported that seed yield was significantly affected by seed age. Similarly, [32] worked on spacing experiment on soybean observed that increasing and decreasing the intra row of plants led to not significant difference obtained on yield, seed weight and above ground biomass.

CONCLUSION AND RECOMMENDATION

A study was conducted to investigate the effect of seed age and intra row spacing on yield and seed quality of two soybean varieties. It was conducted during 2013 production season at the experiment site of Pawe Agriculture Research Center site in Dangure District, North of Benishangule Gumuz. The experiment was done using randomized complete block design (RCBD) with factorial arrangement of two varieties (TGX and Belerssa-95), three intra row spacing (5cm, 10cm and 15cm) and two ages (year one and year two) with three replications. Eleven phonological, yield components and yield were examined against the plant seed age, varieties and spacing combination. Days to flowering; days to maturity; plant height; number of branches, number of pods per plant, number of seeds per pod, above ground dry bio-mass, pod per cluster; cluster per plant; harvest index and yield.

Days to flower initiation was significantly ($p\leq0.01\%$) affected by the main effect of variety, seed age, intra row spacing and three factors interaction effect while the interaction effect of variety and spacing significantly ($p\leq0.05\%$) affected days of flowering of soybean. The interaction effect of variety, spacing and seed age did not significantly affect the date of flowering. But days maturity of soybean was significantly ($p\leq0.05\%$) affected only by the main effect of intra row spacing. Number of branches per plant, cluster per plant, pod per plant, pod per cluster, harvest index, yield and above ground dry bio mass were significantly ($p\leq0.01\%$) affected by seed age. On the contrary, the above parameters except cluster per plant all were not significantly affected by main effect of varieties and intra row spacing, two way interaction seed age and spacing, varieties and spacing and the three way interaction seed age, intra row spacing and varieties. In addition to these, cluster per plant were significantly ($p\leq0.05\%$) affected by interaction effect of intra row spacing and seed age. The maximum grain yield was recorded on year one (2303.3 kg/ha) where the lower yielded were (702.2kg/ha) in year two.

The result of this experiment indicated highly significant difference in seed age of grain yield, but not significant difference in varieties, intra row spacing and two way interaction and three way interaction on yield. The highest grain yield per hectare was recorded in year one 2303.3kg/ha while that of year two was 702.2kg/ha. In conclusion, production and proper storage of high vigor seeds are necessary for satisfactory crop production, particularly under stressful conditions. Sowing of aged seeds reduces crop yield by decreasing seedling emergence and establishment, hence, use of fresh seed for planting is imperative. In any case seed sown should not exceed more than one year for soybean, therefore, such seed should be stored at optimum level of moisture content for not more than one year. However, this tentative generalization should be validated by testing more spacing, different storage life and more varieties for more than one season to give a valid recommendation.

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