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MOISTURE LEVEL AND STORAGE CONTAINER EFFECTS ON SEED QUALITY OF SOYBEAN GENOTYPES UNDER AMBIENT CONDITION

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Abstract

The experiment was conducted at the Seed Laboratory, Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Jamalpur in 2013 to study the effect of seed moisture content and storage containers on seed quality of soybean genotypes. Three genotypes of soybean (AGS 191, ASET 93 and Shohag), four initial seed moisture content (6, 8, 10 and 12%) and two types of storage containers (polythene bag and glass jar) were included in the experimental treatment. Seeds of soybean genotypes was stored at ambient condition were temperature ranged from 15.97 to 29.37 ^{0}C, relative humidity ranged from 75.21 to 86.23% and rainfall ranged from 0.00 to 425mm during the whole storage period. Seed moisture content (%), germination (%) and vigour index were recorded at 50, 100, 150 and 200 days after storage (DAS). Result showed that final seed moisture content increased with the increase of initial seed moisture content. Genotype AGS 191 showed the highest germination (%) and vigour index. Seeds stored in polythene bag or glass jar showed similar performance for germination (%) and vigour index. Highest seed moisture content significantly reduced the germination and vigour index errespective of containers. The results indicate that soybean seed can be stored safely for at least 200 days maintaining >80% germination and high vigour when stored in polythene bag or glass jar with 6-8% initial moisture content at ambient room temperature and relative humidity.

Keywords: Soybean, seed moisture, storage container, vigour

Introduction

Soybean (*Glycine max* [L.] Merrill) is the world's most important grain legume crop in terms of total production and international trade. Soybean seed contains 36-47% protein and 15-25% oil, 20-26% carbohydrate (Rahman, 2001). It is a high and available source of calcium, phosphorus, iron, thiamine including vitamins A, B, C and D. The common people of Bangladesh can not afford animal protein like egg, milk, meat and fish in their daily diet because of their high cost. The demand of soybean is increasing for making different food

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products for human consumption as well as feed for poultry and fish in Bangladesh. The soil and climatic condition of Bangladesh is congenial for soybean production. The lack of supply of quality seed to the farmers render major problem in the expansion of area under soybean cultivation. It has been reported that soybean seed is short lived and loses its viability in very short period of storage even with good nonporous storage container. Arunnandhy and Senanayaka (1991) reported that the soybean seeds can be kept with high germination and vigour for more than one year when stored in sealed containers. Storage containers or packaging materials are considered as one of the most important factors influencing longevity of seeds in storage. Storage container had significant effect on moisture content of wheat seed at different observation date of storing (Rahman *et al*., 2010). When seed could be packaged in moisture proof containers, the relative humidity of the air around the seed remains low, then the seed equilibrium moisture remains low and the seed maintains its viability and vigour for a longer time (Poonam *et al.*, 2001; Agha *et al.*, 2004). Storage container influences seed quality and initial adjustment of seed moisture played a vital role in the preservation and longevity of seeds. The physical properties and storage potential of seed were influenced to a very large extent by moisture content and the relative humidity of the atmosphere surrounding the seed (Kong *et al.*, 2008). Reports are also available that polythene bags can be used as moisture proof container (Alam and Rahman, 2005). Soybean seeds stored in moisture proof containers retain high viability than those in moisture permeable containers (Tatipata, 2009). Depending on initial condition, seed deteriorates less rapidly in impermeable then permeable containers. Use of proper storage container to maintain the quality of farmer-saved seed in storage and preserving its viability should be an important consideration to reduce seed loss and increase crop yield. In view of the above facts, the present study was undertaken to develop appropriate storage techniques to maintain desired viability and vigour of soybean seeds.

Materials and Methods

The experiment was conducted at Seed Laboratory of Regional Agricultural Research Station, BARI, Jamalpur during May to December 2013. Daily temperature (maximum, minimum and mean), total monthly rainfall and monthly relative humidity were collected from records of the Regional Agricultural Research Station, Jamalpur. The average monthly maximum and minimum temperature, relative humidity and total rainfall that prevailed during the experimental period have been presented in Table 1. The maximum and minimum temperatures were found in the month of April and January, Heavy rainfall was observed during the month of April to October whereas it was scanty during the month of November to March. There was no rainfall in the month of December. Monthly average relative humidity ranged from 75.21 to 86.23%.

Table 1. Monthly record of air temperature, rainfall and relative humidity the experimentation period at Bangladesh Agricultural Research Station,, Jamalpur from January to December 2013

Month	Air temperature			Relative humidity (%)	Rain fall (mm)
	Maximum	Minimum	Average		
January	21.77	10.17	15.97	83.65	Trace
February	26.67	15.49	21.08	75.21	27.10
March	27.95	18.11	23.03	75.39	114.00
April	31.63	22.25	26.94	80.07	96.20
May	32.03	23.33	27.68	81.13	265.00
June	30.57	25.68	28.13	86.23	425.30
July	31.81	26.89	29.35	85.00	212.90
August	31.36	26.42	28.89	85.00	192.40
September	32.22	25.95	29.09	84.23	330.90
October	31.29	22.89	27.09	84.77	105.80
November	28.79	18.54	23.67	82.53	83.10
December	25.32	14.40	19.86	84.06	00.00

Source: Regional Agricultural Research Station, Jamalpur.

Three soybean genotypes (AGS 191, ASET 93 and Shohag), two storage container (polythene bag and glass jar) and four level of initial seed moisture content (6, 8, 10 and 12%) were used as treatment variables. The experiment was laid out in a Completely Randomized Design with three replications. The crop was grown at Regional Agricultural Research Station Farm, Jamalpur with proper agronomic management. The crop was harvested at full maturity and after proper processing, cleaning and drying the seed was stored in polythene bags until used for experimentation. The seed was dried in the sun on a *tripale* set on the cemented floor to about 6% initial seed moisture content (SMC). Just before final storage the seed was re-hydrated at 70% relative humidity (RH) for required period of time to obtain targeted moisture contents were achieved. Each container was completely filled with seed as per experimental specification and then made air tight. The seed was tested for different quality parameters at 50, 100, 150 and 200 days after storage (DAS). The containers were kept in the laboratory under ambient room condition (23-32^{o}C temperature and 78.64% relative humidity). The quality parameters tested were seed moisture content, germination percentage and vigour index.

Seed moisture content was measured using high constant temperature oven dry method following ISTA rules (2003). About 5-8g of seeds were taken in the

alluminium dish and dried in the oven at 130 ºC for 2 hours (until constant weight reached). Germination test was done in sand culture method. Two third of a plastic dish (20 cm diameter and 15 cm deep) was filled with sterilized sand having 60% water holding capacity. Randomly collected 100 seeds from each container were placed into the sand for the germination test. The germination dishes were placed in the germination cabinet and seedling evaluation was done at 8 days after placing the test. The number of normal seedlings per dish was regarded as the germination percentage. Germination index of seed was estimated from the seed set in the germination test by calculating the vigour index formula. The seedling emerged each day having radical length of 2 cm or more was considered as germinated. At the end of the storage period, randomly selected 100 seeds from each seed lot in three replications were sown in the well prepared field. The number of seedlings emerged each day were counted up to 15 days after sowing.

Data analysis was done following the analysis of variance (ANOVA) technique and mean differences were adjusted by Duncan's New Multiple Range Test at 5% level of significance with a computer package programme MSTAT-C.

Results and Discussion

Seed moisture content (SMC)

The effect of storage container, initial seed moisture content and genotypes on seed moisture content and germination performance was evaluated in terms of germination, germination index and field performance. The interaction effect of storage container, initial seed moisture content and genotypes on moisture content of soybean seed was statistically significant at each of the observation dates during the storage period in 2013. The moisture content of ASET 93 stored in glass jar with 6% initial MC were 6.90, 7.23, 8.09 and 8.70%, respectively at 50, 100, 150 and 200 DAS and it was statistically at par to those of AGS 191 or ASET 93 or Shohag in polythene bag or glass jar with 6% initial MC with, respectively (Table 1). The moisture content of Shohag stored in polythene bag at 12% initial MC were 12.40, 12.70, 13.40 and 13.93%, respectively at 50, 100, 150 and 200 DAS and it was statistically at par to those of AGS 191 and ASET 93 stored in glass jar or polythene bag with 12% initial MC (Table 2). When seed could be packaged in moisture proof containers, the relative humidity of the air around the seed remains low, then the seed equilibrium moisture remains low (Poonam *et al.*, 2001; Agha *et al*., 2004, Kong *et al.*, 2008). Similar genetic variations in moisture content of soybean seed have also been reported by Tatic *et al*., 2012. These results are in good agreement with those reported by Tatipata (2009).

Table 2. Interaction effect of storage container, genotype and initial seed moisture content onmoisture content of soybean seed at different days after storage

Container×genotype × initial SMC	Seed moisture content (%) at different days after storage			
	50	100	150	200
$C_1V_1M_1$	7.14e	7.60e	8.40def	8.95ef
$C_1V_1M_2$	8.36d	8.90c	9.50cb	10.03d
$C_1V_1M_3$	10.47c	11.04b	11.60b	12.13b
$C_1V_1M_4$	12.35a	12.60a	13.25a	13.64a
$C_1V_2M_1$	7.07e	7.55e	8.32ef	8.96ef
$C_1V_2M_2$	8.50d	8.90c	9.21c-f	10.10d
$C_1V_2M_3$	10.28c	10.80b	11.40b	11.93bc
$C_1V_2M_4$	12.40a	12.70a	13.04a	13.32a
$C_1V_3M_1$	7.08e	7.80de	8.50c-f	9.02ef
$C_1V_3M_2$	8.38d	8.96c	9.53c	10.16d
$C_1V_3M_3$	10.39c	10.80b	11.43b	11.85bc
$C_1V_3M_4$	12.40a	12.70a	13.40a	13.93a
$C_2V_1M_1$	7.01e	7.48e	8.21f	8.86ef
$C_2V_1M_2$	8.44d	8.90c	9.33cd	9.87d
$C_2V_1M_3$	11.02b	11.30b	11.65b	11.87bc
$C_2V_1M_4$	12.30a	12.70a	13.20a	13.49a
$C_2V_2M_1$	6.90e	7.29e	8.09f	8.70f
$C_2V_2M_2$	8.43d	8.70c	9.15c-f	9.49de
$C_2V_2M_3$	10.21c	10.60b	11.02b	11.36c
$C_2V_2M_4$	12.31a	12.60a	13.02a	13.30a
$C_2V_3M_1$	7.00e	7.40e	8.10f	8.73f
$C_2V_3M_2$	8.22d	8.60cd	9.10c-f	9.50de
$C_2V_3M_3$	10.20c	10.60b	11.00b	11.40c
$C_2V_3M_4$	12.20a	12.70a	13.19a	13.53a
CV (%)	4.28	6.29	5.34	7.21

CV= Coefficient of variation, C_1= Polythene bag, C_2=, Glass jar, V_1= AGS-191, V_2= ASET-93, V_3= Shohag, SMC= Seed moisture content, M_1= 6% SMC, M_2= 8% SMC, M_3= 10% SMC, M_4= 12% SMC, In a column, figures having similar letter(s) do not differ significantly by DMRT.

Germination percentage

The interaction of effect of storage container, genotypes and initial seed moisture content on germination percentage was statistically significant at each of the observation dates during the storage period in 2013. The germination percentage of AGS 191 stored in glass jar with 6% MC were 96.66, 94.00, 93.33 and 92.00%, respectively at 50, 100, 150 and 200 DAS and it was statistically at par to those of AGS 191 or ASET 93 or Shohag stored in glass jar or polythene bag with at 6% and 8% initial SMC. Those values for Shohag in polythene bag with 12% initial SMC were 74.00, 62.00, 24.00 and 6.33%, respectively (Table 3). These results are conformity of those reported by Balesevic-Tubic *et al.*, 2005. Storage containers or packaging materials are considered as one of the most important factors influencing longevity of seeds in storage. Storage container had significant effect on moisture content of wheat seed at different observation date of storing (Rahman *et al*., 2010 and Ali *et al.*, 2018).

Field emergence performance

Field emergence performance was evaluated in terms of field emergence and mean germination time in field. Soybean genotype, storage container and initial seed moisture content had significant effect on field emergence of soybean seed at 200 DAS (Table 3). The field emergence percentage of AGS 191 seed stored in polythene bag were 88.66, 88.00, 36.00 and 8.00% at 6, 8, 10 and 12% initial SMC while those stored in glass jar were 90.00, 88.00, 54.00 and 16.00%, respectively (Table 3). The field emergence of ASET 93 seed stored in polythene bag were 86.30, 83.33, 42.66 and 6.00% at 6, 8, 10 and 12% initial SMC while those stored in glass jar were 86.00, 84.00, 40.00 and 18.00%, respectively (Table 3). The field emergence of Shohag seed stored in polythene bag were 80.00, 80.00, 16.33 and 3.33% at 6, 8, 10 and 12% initial SMC while those stored in glass jar were 80.00, 80.00, 36.00and 12.00%, respectively (Table 3). Though the field emergence (%) among the genotype was statistically identical but AGS 191 showed the best performance followed by ASET 93 and Shohag. Upto 8% SMC, more than 80% field emergence was observed. After that the same was drastically declined irrespective of container. Poonam *et al.* (2001) also reported that seeds of soybean cv. PK-327 at moisture content of 7-8% stored in single and double polyethylene bags could be stored for up to 8 months under ambient conditions.

Table 3. Interaction effect of storage container, genotype and initial seed moisture content on germination and field emergence of soybean seed

Container×genotype× initial SMC	Germination (%) at different days after storage				Field emergence at 200 days after storage
	50	100	150	200	
$C_1V_1M_1$	96.33a	94.00a	92.00a	91.66a	88.66a
$C_1V_1M_2$	96.00a	93.33ab	90.92ab	90.00a	88.00a
$C_1V_1M_3$	89.33c-f	83.33de	62.00e	40.00ef	36.00c
$C_1V_1M_4$	80.00gh	60.00g	30.00hi	8.66i	8.00def
$C_1V_2M_1$	94.00ab	92.33abc	88.66abc	87.33abc	86.3a
$C_1V_2M_2$	94.00abc	92.00a-d	88.00abc	85.33abc	83.33a
$C_1V_2M_3$	84.33efg	72.00fg	64.00e	46.66e	42.66bc
$C_1V_2M_4$	78.00gh	60.00g	33.00ghi	10.00i	6.00ef
$C_1V_3M_1$	92.00a-d	86.00b-e	84.00bc	82.00bc	80.00a
$C_1V_3M_2$	92.00a-d	84.00cde	82.00cd	80.00c	80.00a
$C_1V_3M_3$	89.33c-f	72.00g	43.33fg	21.33h	16.33d
$C_1V_3M_4$	74.00h	62.00g	24.00i	6.33i	3.33f
$C_2V_1M_1$	96.66a	94.00a	93.33a	92.00a	90.00a
$C_2V_1M_2$	96.00ab	93.66ab	92.33a	91.33a	90.00a
$C_2V_1M_3$	90.00c-f	84.00cde	74.00d	62.00d	54.00b
$C_2V_1M_4$	82.00fgh	62.00g	42.00fg	27.00gh	16.00d
$C_2V_2M_1$	94.00abc	92.00abc	90.00ab	88.00ab	86.00a
$C_2V_2M_2$	94.00abc	92.00ab	90.00ab	87.00abc	84.00a
$C_2V_2M_3$	90.00b-e	82.00ef	62.00e	48.00e	40.00c
$C_2V_2M_4$	80.00gh	70.00g	40.00fg	26.00gh	18.00d
$C_2V_3M_1$	92.00a-e	86.00b-e	84.00bc	82.00bc	80.00a
$C_2V_3M_2$	92.00a-d	86.00b-e	84.00bc	82.00bc	80.00a
$C_2V_3M_3$	89.33c-f	67.00g	48.66f	34.00fg	36.00c
$C_2V_3M_4$	85.33d-g	60.00g	34.66gh	21.33h	12.00de
CV (%)	4.95	6.69	7.23	8.20	7.32

CV= Coefficient of variation, C_1= Polythene bag, C_2=, Glass jar, V_1= AGS-191, V_2= ASET-93.

V_3= Shohag, SMC= Seed moisture content, M_1= 6% SMC, M_2= 8% SMC, M_3= 10% SMC, M_4= 12% SMC.

In a column, figures having similar letter(s) do not differ significantly.

Table 4. Interaction of storage container, genotype and seed moisture content on germination index of soybean seed at different days after storage

Container×genotype × initial SMC	Germination index at different days after storage			
	50	100	150	200
$C_1V_1M_1$	38.00ab	34.00a	28.00ab	24.33abc
$C_1V_1M_2$	38.00ab	35.00a	27.00ab	23.66abc
$C_1V_1M_3$	34.00a-e	26.00def	18.00de	12.00de
$C_1V_1M_4$	34.00a-e	19.33h	9.0gh	1.00h
$C_1V_2M_1$	38.00ab	32.00abc	27.00ab	24.33abc
$C_1V_2M_2$	37.00abc	30.00a-d	26.00ab	24.33abc
$C_1V_2M_3$	32.00c-f	25.00d-g	18.00de	11.00def
$C_1V_2M_4$	30.00ef	20.00gh	7.00gh	1.37h
$C_1V_3M_1$	31.00def	27.00cde	24.00abc	20.66bc
$C_1V_3M_2$	30.00ef	27.00cde	23.00bcd	20.33c
$C_1V_3M_3$	24.00gh	18.00hi	11.00fg	8.00efg
$C_1V_3M_4$	20.00h	12.00j	5.00h	1.00h
$C_2V_1M_1$	39.00a	35.00a	30.00a	26.33a
$C_2V_1M_2$	39.00a	34.00a	28.00ab	25.55ab
$C_2V_1M_3$	36.00a-d	30.00a-d	24.00abc	14.33d
$C_2V_1M_4$	34.00a-e	22.00e-h	15.00ef	4.40gh
$C_2V_2M_1$	38.00ab	33.00ab	29.00ab	25.66ab
$C_2V_2M_2$	38.00ab	32.00abc	28.00ab	26.00a
$C_2V_2M_3$	33.00b-e	26.00def	20.00cde	15.00d
$C_2V_2M_4$	31.00def	21.00fgh	10.00fgh	5.10gh
$C_2V_3M_1$	32.00c-f	28.00bcd	25.00abc	22.33abc
$C_2V_3M_2$	32.00c-f	27.00cde	24.00abc	21.66abc
$C_2V_3M_3$	28.00fg	22.00e-h	15.00ef	7.00fg
$C_2V_3M_4$	22.00h	14.00ij	8.00gh	3.66gh
CV (%)	8.41	6.48	5.75	7.32

CV= Coefficient of variation, C_1= Polythene bag, C_2=, Glass jar, V_1= AGS-191.

V_2= ASET-93, V_3= Shohag, SMC= Seed moisture content, M_1= 6% SMC, M_2= 8% SMC, M_3= 10% SMC, M_4= 12% SMCIn a column, figures having similar letter(s) do not differ significantly.

Germination index

The interaction of storage container, genotypes and initial seed moisture content on germination index was statistically significant at each of the observation dates during the storage period in 2013. The highest germination index for AGS 191 in glass jar with 6% initial MC were 39.00, 35.00, 30.00 and 26.33, respectively at 50, 100, 150 and 200 DAS and it was statistically at par to those of AGS 191 in glass jar with 8% initial MC, ASET 93 in polythene bag with at 6% and 8% SMC, Shohag in glass jar with 6 or 8% initial MC. Those values for Shohag in polythene bag with 12% initial MC were 20.00, 12.00, 5.00 and 1.00 and it was statistically identical to Shohag in glass jar with 12% initial MC, respectively (Table 4). These results are conformity of those reported by Balesevic-Tubic *et al.*, 2005. Agha *et al*., 2004 reported that when seed could be packaged in moisture proof containers, the relative humidity of the air around the seed remains low, then the seed equilibrium moisture remains low and the seed maintains its viability and vigour for a longer time.

Conclusion

The study conclude that seeds of AGS 191, ASET 93 and Shohag could be stored in polythene bag or glass jar at 6 to 8% initial seed moisture content safely for maintaining high seed quality. However, seed with high moisture content should never be stored in air tight container.

References

Agha, S. K., Z. H. Malik, M. Hatam and G. H. Jamro. 2004. Emergence of healthy seedlings of soybeans as influenced by seed storage containers. *Pakistan J. Biol. Sci.* **7**(1): 42-44.

Ali, M. R., M. M. Rahman, M. A. wadud, A. H. F.Fahim and M. S. Nahar. 2018. Effect of seed moisture content and storage container on seed viability and vigor soybean. *Bangladesh Agron. J.* **21**(1):131-141.

Alam, M. M. and M. M. Rahman. 2005. Effect of seed moisture content and thickness of polythene bag on germination and vigour on soybean seed. Bangladesh Seed Sci. Technol. **9**(1&2): 33-38.

Arunnandhy, V. and Senanayaka, Y.D.A. 1991. Changes in viability, vigour and chemical composition of soybean seeds stored under the humid tropical conditions. *Legume Research.* **14**(3):135-140.

Balesevic-Tubic, M. Tatic, V. DorDevic, Z. Nikolic, J. Subic and V. Dukic. 2011. Changes in soybean seeds as affected by accelerated and natural ageing. *Romanian Biotechnological Letters.* **16**(6):6740-6747.

Balesevic-Tubic, M. Tatic, V. DorDevic, Z. Nikolic, J. Subic and V. Dukic. 2011. Changes in soybean seeds as affected by accelerated and natural ageing. Romanian *Biotechnological Letters*. **16**(6):6740-6747.

Kong, F., S. K. C. Chang, Z. Liu and L. A. Wilson. 2008. Change of soybean quality during storage as related to soyamilk and tofu making. *J. Food Sci.* **73**(3): 134-144.

Poonam S., N. Tewari, P. K. Katiyar, T. Das and C.P. Vaish. 2001. Storability of soybean (*Glycine max* Merr.) seeds in different containers under ambient conditions. *Progres. Agric.* **1**(1): 90-93.

Rahman, M. M., B. Hagidok, M. M. Masood and M. N. Islam. 2010. Effect of storage container and relative humidity on the quality of wheat seed. *Bangladesh J. Seed Sci. Technol.* **14**(1&2): 89-94.

Rahman, L. 2001. Soybean: Production Food Uses Technology (in Bangla). BAU-USDA Soybean Project, Dept. Genetics and Plant Breeding. Bangladesh Agril. Univ., Mymensingh, pp. 1-24.

Tatic M, S. Balesevic-Tubic, V. Dordevic, V. Miklic, M. Vujakovic and V. Dukic. 2012. Vigor of sunflower and soybean ageing seed. *Helia.* **25**(56):119-126.

Tatipata, A. 2009. Effect of seed moisture content packaging and storage period on microchondria inner membrane of soybean seed. *J. Agric. Technol.* **5**(1): 51-54.