Research paper

Effect of Seed Storage Periods,Conditions and Materials on Germination of Some Soybean Seed Cultivars

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ABSTRACT

A Laboratory experiment was conducted in Agronomy Department, Fac. Of Agric. Mansoura Univ., Egypt during 2011 and 2012 in order to examine the effect of storage period, storage conditions and storage materials on germination parameters of some soybean cultivars. Seedgermination characters offinal germination percentage (%), germination index (%), emergence rate (%) and energy of germination (%)were decreased with the period of ageing. Giza 111 exceeded the other cultivars in energy of germination, emergence rate. Giza 21 cultivar exceeded the other cultivars in germination index. Giza 35 cultivar exceeded the other cultivars infinal germination percentage.Storage under refrigerator conditions at 10^0C ± 1 exceeded storage under ambient conditions in final germination percentage, germination index, energy of germination,emergence rate. Results indicated that storage seed in plastic bags enhanced energy of germination percentage compared with cloth bags.Results clearly showed that final germination percentage, germination index, energy of germination andemergence rate significantly affected by the varies interactions.

Key Words: Soybean, cultivars, storage, viability, deterioration, seed vigor and periods.

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INTRODUCTION

Storage conditions and duration are important factors affecting germination parameters. Seed vigor is used as a measure of accumulated damage in seed as viability declines. In Egypt, soybean the most important crop and being the edible oil. Preservation of seed viability depended on storage condition and duration [1]. The decline of germination is much more acute under tropical conditions. These environmental conditions make very difficult to maintain its viability during storage [2]. Such seed deteriorated is one of the basic reasons for low productivity in

soybean. Changes that occur in seed during ageing are significant in terms of seed qualityamong other things, also implies seed longevity [3]. Different periods of seed storage, as well as ageing conditions adversely affected the seed vigor[4].[9]concluded that seed viability gradually decreased from 64.5 to 39.2% as the time of storage increased, from 2 to 12 months. Changes occurring in seed during ageing are very significant with regard to quality and longevity of seed. Characteristics of oily plants seed composition are related to specific processes occurring in seed during storage [5].

The soybean seed generally deteriorated with storage and deterioration was particularly strong for grains stored with initial moisture contents of 12.8 and 14.8 % at 40°C. The grains stored with initial moisture contents of 14.8 % at 30 and 40°C were classified as out of market standard after 135 and 90 days respectively [6]. Differences in oil percentagethat affected by storage longevity were significant among tested crops and genotypes. Storage longevity was negatively associated with oil content. At storage conditions at 12°C/60%, decreasing of seed oil content than in storage conditions at 25°C/75% [7]. In addition, [3]and[1]showed that preservation of seed viability depended on storage condition and duration. [8]suggested that variations occurred with the viability constants of a seed deterioration model between the soybean cultivars. Different periods of seed storage, as well as storage conditions adversely affected the seed vigor[8].Similar conclusions was reported by[8, 10, 11]**.**Highest germination of seed stored at 40°C than ambient temperature[9]**.**Similar results was indicated by[5, 12 13]**.**[11]incubated soybean seeds at two different temperatures of 34ºC and 40ºC for varying times. They indicated that soybean viability decreased by increasing storage temperature.

Regarding to storage materials, [14]stated that storability of soybean cultivars could be enhanced by four months after storing seed in polythene bag compared to cloth bag. [15] reported that soybean seeds stored in cloth bag maintained satisfactory germination only for 4 months of storage. Soybean germination and vigor varied among cultivars and M-351 had the highest mean germination parameters [16].Wheat seed stored in gunny, cloth and plastic bags were in good terms with temperature, moisture content and germination capacity in comparison with those in metal and earthen bins [17]. Sorghum seeds stored inside gene bank and freezer irrespective of the packaging materials and type of accession retain their

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viability to the tune of 90.67 to 100%. Whereas seeds stored at ambient temperature had low germination percentage except those stored in aluminum can [18].

A significant differences between soybean genotypes (Sb1, Sb2, Sb3, Sb4, Sb5 and Sb6) in final germination percentage, germination index and emergence rate. These differences between genotypes might be due to the genetic factors and seed chemical composition influence the expression of seed deterioration and vigor decline[4].[8]reported that initial viability was same 100% among DPX and Sahar cultivars. Also, the vigor power i.e.final germination percentage had no significant difference between DPX and Sahar cultivars but in Shahar, values of all vigor trials.Similar conclusions were reported by [7, 19, 20].Sorghum seeds storedinside gene bank and freezer irrespective of the packaging materials and type of accession retain their viability. Whereas seeds stored at ambient temperature had low germination percentage except those stored in aluminum [18]. Similar results was obtained by [9, 24, 25]**.** The objective of this research was to determine the effects of storage period, storage conditions and materials on seed germination parameters of different soybean cultivars.

MATERIALS AND METHODS

A laboratory experiment was conducted at experimental seed testing laboratory of Agronomy Department, Faculty of Agriculture, Mansoura University, Egypt during 2011 and 2012. The objectives of this investigation were aimed to study response of some soybean cultivars i.e. Giza 21, Giza 22, Giza 35, Giza 111 and Crawford to storage periods i.e. 3,6,9 and 12 months, storage conditions i.e. ambient conditions and refrigerator conditions at 10^0C±1 as well as storage materials i.e. seed with cloth bags, seed with plastic bags, pods with cloth bags and pods with plastic bags on germination characters.

Treatments and Experimental Design:

Treatments were arranged in factorial experimental in completely randomize design, consisted of totally 160 treatments combinations involving tow storage conditions i.e. ambient conditions and refrigerator conditions at 10^0C±1, four different kinds of package materials i.e. seed with cloth bags, seed with plastic bags, pods with cloth bags and pods with plastic bags.Four storage periods i.e. 3,6,9 and 12 months and five of soybean cultivars i.e. Giza21, Giza22, Giza35, Giza111 and Crawford.Soybean (*Glycine Max* L. Merr.) cultivars which were harvested in

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October 2011, cleaned from dust and dirt then dried and processed for storage. Every three months, from a total 12 months of storage, germination characters were evaluated.

Studied characteristics:

The following germination characters were studiedas following:

1-Final germination percentage:

Final germination percentage test was conducted as per the procedure prescribed in ISTA rules [26]**.** Hundred seeds in four replications were kept forgermination in rolled rowels in a germinator maintained at 25 ± 7°C and 95 % relative humidity. The normal seedlings was counted, $5^{th}$and 8^{th}day. Then final germination percentage was calculated according to[27, 28] as the follows equation:

$$\text{Final germination percentage} = \frac{\text{Number of normal seedlings}}{\text{Number of seeds}} \times 100$$

2-Germination index (GI):

Germination index wascalculated as described by [29] as the following formulae:

$$(GI) = \frac{\text{\% Germination each treatment}}{\text{\% Germination in the control}}$$

3-Energy of germination: It was recorded at the fourth day of germination. Energy of germination was the percentage of germinating seeds at 4 days after sowing relative to the number of seeds tested according to[28]**.**

4-Emergence rate:

The emergence rate was computed according to [30] using the following formula:

Emergence rate =1/2(number of seedling emerged on 5th day after planting+ number of seedling emerged on 8th day after planting).

RESULTS AND DISCUSSION

1 - Storage periods effects:

The results in (Table 1) showed that final germination percentage, germination index percentage, energy of germination percentage and emergence rate percentage were decreased as storage periods were increased. The results revealed that before storage treatments significantly exceeded the other storage periods in

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final germination percentage, germination index percentage, energy of germination percentage and emergence rate percentage followed by those storage after 3 months. While, after 12 months from storage recorded lowest final germination percentage, germination index percentage, energy of germination percentage and emergence rate percentage.It could be concluded that increasing storage periods from 3, 6, 9 and 12 months decreased final germination percentage by 3.11, 9.91, 18.87 and 25.80%, respectively compared with final germination percentagebefore storage.Increasing storage periods from6, 9 and 12 months decreased germination index percentageby 6.51, 15.34 and 26.40 %, respectively compared with germination index percentage after 3 months. Increasing storage periods from 3, 6, 9 and 12 months decreased energy of germination percentageby 11.06, 15.63, 38.38 and 48.47 %, respectively compared with energy of germination percentage before storage.Increasing storage periods from 3, 6, 9 and 12 months decreased emergence rate percentageby 5.73, 11.51, 24.44 and 33.42%, respectively compared with emergence rate percentage before storage. In this respect, [9] stated that germination percentage was inversely related to storage duration, where germination gradually decreased from 64.5 to 39.2% as the time in storage increasedfrom 2 to 12 months. In addition, [31] reported that differences in germination index due to storage periods might be due to lipid changes of seed during storage and decline in phospholipids and polyunsaturated fatty acids leading to marked decline in seed vigor and germination index. Moreover,[32] indicated that seed deterioration results in decreased percentage and rate of germination and decreased percentage of normal seedlings. Seed ageing is generally marked by reduction in vigor[33].The longer seeds storage period increases intensity of seeds ageing [22]. These results are in good agreement with those reported by [8, 31, 34, 35, 36, 37].

2 - Storage cultivars effects:

Results in (Table 1)revealed that Giza 111 cultivar significantly exceeded the others in energy of germination percentage and emergence rate percentage. While, Giza 35 surpassed the others in final germination percentage. Giza 21 cultivar recorded the lowest energy of germination percentage and emergence rate percentage. Giza 22 cultivar recorded the lowest germination index percentage.While,Crawford cultivar recorded the lowest final germination percentage. Giza 111surpassed Giza 21, Giza22, Giza 35 and Crawford cultivars in energy of germination percentage by 13.06, 10.59, 9.54 and 1.51 %, respectively. Giza 111 surpassed Giza 21, Giza 22,

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Giza 35 and Crawford cultivars in emergence rate percentageby 5.27, 3.31, 3.31 and 0.80 %, respectively. Crawford cultivar surpassed Giza 21, Giza22, Giza 35 and Giza 111 cultivars in energy of germination percentage by 0.92, 2.16, 2.25 and 1.96 %, respectively. In this respect, [4]stated that there was significant differences between soybean genotypes. These differences between genotypes might be due to the genetic factors and seed chemical composition influence the expression of seed deterioration and vigor decline. In addition, [38]stated that assessment of some soybean cultivars seed viability during storage by monitoring germination and germination after ageing percentages.Moreover, [39] stated that the storability of different soybean cultivars is also regulated by initial seed quality, physical and chemical composition of seed as different cultivars possess different physical structure and chemical composition which determine the viability of seed in storage. These results are in good accordance with those obtained by [4, 8, 22, 31, 36, 37].

3 - Storage conditions effects:

The results showed that a significant effect of storage conditions on the average of final germination percentage, germination index percentage, energy of germination percentage and emergence rate percentage as shown in (Table 1).Storage under refrigerator conditions at 10°C surpassed ambient conditions in final germination percentage, germination index percentage, energy of germination percentage and emergence rate percentage by 4.71, 5.85, 11.67and7.77 %, respectively.In this respect, [9]recorded that highest germination percentage was in seed stored at 4^0C than room temperature. These results are in good harmony with those obtained by[8, 31, 32, 36, 37, 41].

4 - Storage package materials effects:

The resultsshowed that a significant effect of package materials on the means of energy of germination percentageas shown in (Table 1).The results showed that energy of germination percentagesignificantly affected by package materials. Highest energy of germination percentage were obtained from storage soybean seed in cloth bags followed by storage seed in plastic bags. However, the lowest energy of germination percentage were obtained from storage soybean pods in cloth or plastic bags.In case of final germination percentage of soybean seed decreases all cases but the rate of deterioration is highest in cloth bag [21]**.** Seeds were stored in Metallized film bags and Aluminum foil bags observed highly standard germination and seed vigor, and keep water activity and seed moisture content in low level could delay

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seed quality deterioration followed by Polypropylene bags and woven bag[22].Seeds were stored in aluminums foil bags observed highly seedling vigor and keep moisture content in low level could delay seed deterioration followed by polyethylene and wheat bags[23].These results are in harmony with those reported by[8, 23, 34, 37]**.**

4- Interaction effects:

1) Interaction between soybean cultivars and storage periods:

The results clearly indicated that pre storage of Giza 35 cultivar recorded the highest final germination percentage followed by storage Giza 111 storage for 3 months(Fig.1). The lowest final germination percentagewas recorded from storage Giza 35 and Giza 111 cultivars after 12 months without significant differences between them. Highest germination index percentagewas produced from storage for 3 months of Giza 111 cultivar. The lowestgermination index percentagewas recorded from storage Giza 35 and Giza 111 cultivars after 12 months without significant differences between them(Fig. 2).Highest energy of germination percentagewas recorded from pre storage of Giza 111 cultivar followed with Giza 111 cultivar when storage for 3 months. The lowest energy of germination percentagewas recorded from storage Giza 21 cultivar after 12 months(Fig. 3).The results clearly indicated that highest emergence rate percentagewas obtained from Giza 111 cultivar before storage. While, the lowest emergence rate percentage was recorded from storage Giza 21 and Giza 22 cultivar for 12 months without significant between them(Fig. 4).These results in agreement with those obtained by [1, 8, 22, 23, 34].

2) Interaction between storage periods and storage conditions effects:

The results clearly indicated thatpre storage treatment was recorded the highest final germination percentage followed by storage for 3 months under refrigerator conditions at 10°C(Fig. 5). The lowest final germination percentagewas recorded from storage for 12 months of storage under ambient conditions.The results clearly showedthat after 3 months of storage treatment under refrigerator conditions at 10°Crecorded highest germination index percentage followed by storage after 6 months under refrigerator conditions at 10°C(Fig. 6). The lowest germination index percentagewas recorded from storage for 12 months under ambient conditions. The results clearly showedthatpre storage treatment recorded highest energy of germination percentage followed by storage for 3 months under refrigerator conditions at 10°C(Fig. 7). The lowest energy of germination percentagewas

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recorded for 12 months of storage under ambient conditions. The results clearly indicated thatpre storage treatment recorded the highest emergence rate percentage followed by storage for 3 months under refrigerator conditions at 10°C(Fig. 8). The lowest emergence rate percentage was recorded from for 12 months under ambient conditions.These results are in conformity with those reported by [8, 31, 32, 36, 37, 41].

3) Interaction between soybean cultivars and storage conditions effects:

The results clearly indicated that highest energy of germination percentagewas obtained from storage Giza 35 and Giza 111 cultivarsunder refrigerator conditions (10^0C±1). The lowest energy of germination percentagewas obtained from storage Giza 21 and Giza 22 cultivar under ambient conditions without significant differences between them(Fig. 9). Highest emergence rate percentagewas obtained from Crawford followed by Giza 111 cultivars when storage under refrigerator conditions (10^0C±1). The lowest emergence rate percentagewas obtained from storage Giza 21 and Giza 22 cultivars under ambient conditions without significant differences between them(Fig. 10).These results are in conformity with those reported by[1, 8, 22, 23, 34, 40].

4-Interaction between storage periods, soybean cultivars and storage conditions:

The results clearly indicated that highest energy of germination percentage was obtained from before storage of Giza 22 cultivar. The lowest energy of germination percentage was obtained from storage Giza 21 under ambient and or refrigerator conditionsfor 12 months without significant differences between them(Fig. 11).Highest emergence rate percentage was obtained from before storage of Giza 22 cultivar. The lowest emergence rate percentage was obtained from storage Giza 22 cultivar under ambient and refrigerator conditionsfor 12 months without significant differences between them(Fig. 12).These results are in good agreement with those reported by[8, 31, 32, 36, 37, 41].

5-Interaction between storage periods and package materials:

The results clearly indicated thatenergy of germination percentage and emergence rate percentagesignificantly affected due to the interaction between storage periods and package materials. It could be noticed that highestenergy of germination percentagewas obtained from pre storage treatment followed by storage soybean cultivars seeds in cloth bags for 3 months(Fig. 13). The lowest energy of germination percentagewas obtained from storage soybean pods in cloth bags for 12 months. The

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results showed that highest emergence rate percentage was obtained from pre storage treatment followed by storage of studied soybean cultivars seeds in cloth bags for 3 months(Fig. 14). The lowest emergence rate percentage was obtained from storage soybean pods in cloth bags for 12 months.These results are conformity with those reported by[8, 40].

6-Interaction between soybean cultivars and package materials:

The results clearly showed that highestenergy of germination percentagewere produced from storage Giza 111 cultivar seeds in cloth bags(Fig. 15).The lowest energy of germination percentage were obtained from storage Giza 21 cultivar pods in cloth bags or seeds in plastic bagswithout significant differences between them. Highestemergence rate percentagewere produced from storage Giza 111 cultivar pods storage in plastic bagsor seeds in cloth bags(Fig. 16).The lowest emergence rate percentagewere obtained from storage Giza 21 cultivar pods in cloth bags or seeds in plastic bagswithout significant differences between them. These results are conformity of those reported by[8, 31, 32, 36, 37].

7-Interaction between storage periods,soybean cultivars and package materials:

The results clearly indicated that highest final germination percentagewas obtained from before storage of Giza 22 cultivar. The lowest energy of germination percentagewas obtained from storage Giza 35cultivar pods in plastic bags for 12 months(Fig. 17). Highest germination index percentagewas obtained from Giza 35 cultivar before storage. The lowest germination index percentagewas obtained from storage Giza 35cultivar pods in plastic bags for 12 months(Fig. 18).These results are in good agreement with those reported by[8, 3132, 36, 37, 41]**.**

8-Interaction between storage conditions and package materials:

The results clearly showed that highest final germination percentagewas obtained from storage soybean cultivars pods in plastic bags under refrigerator conditions (10^0C±1). The lowest final germination percentagewas obtained from storage soybean cultivars pods in cloth bags under ambient conditions(Fig. 19).Highest germination index percentagewas obtained from storage soybean cultivars pods in plastic bags under refrigerator conditions (10^0C±1).The lowest germination index percentagewas obtained from storage soybean cultivars pods in plastic bags under ambient conditions(Fig. 20).Highest energy of germination percentage was obtained from storage soybean cultivars seeds in cloth bags under refrigerator conditions (10^0C±1). The lowest energy of germination percentage was obtained from storage

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soybean cultivars seeds in plastic bags under ambient conditions (Fig. 21).These results in good harmony with those reported by[8, 31, 32, 36, 37].

9-Interaction between storage periods, storage conditions and package materials:

The results clearly indicated that highest energy of germination percentagewas obtained from pre storage treatment followed by storage soybean seed cultivars in cloth bags under refrigerator conditions (10^0C±1) for 3 months. The lowest energy of germination percentagewas obtained from storage soybean seeds cultivars in plastic bags under ambient conditions(Fig. 22).These results in good harmony with those reported by[8, 31, 32, 36, 37].

10-Interaction between soybean cultivars, storage conditions and package materials:

The results clearly indicated that highest energy of germination parentagewas obtained from storage Giza 111cultivarunder refrigerator conditions(10^0C±1)as seeds in cloth bags (Fig. 23).Lowest energy of germination parentagewas obtained from storage Giza 35cultivar under ambient condition seeds in plastic bags.The results clearly indicated that highest emergence rate percentagewas obtained from storage Giza 111cultivar under refrigerator conditions(10^0C±1)using seeds in plastic bags (Fig. 24).Lowest emergence rate percentagewas obtained from storage Giza 21 cultivar under ambient condition using seeds in plastic bags. These results in good harmony with those reported by[8, 31, 32, 36, 37].

CONCLUSION

This investigation was revealed that for maximizing soybean seed germinationparameters, it should be storage Giza 111 cultivar under refrigerator conditions (10^0C±1) in pods or seeds in cloth bags for 3 months.

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REFERNCES

1. BalesevicTubic SM,Tatic V,Dordevic Z,Nikolic,V. (2010). Seed viability of oil

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crops depending on storage conditions. Helia. 2010; 33 (52): 22-35.

153-160.svetlanabt@ifvcns.ns.ac.rs

2. ShelarVR,ShaikhRS,NikamAS. Soybean Seed Quality during Storage: A Review. Agric. Rev. 2008; 29 (2): 125 – 131.

http://www.arccjournals.com/pdf/Reviews/ar-29-2/ar-29-2-006.pdf

3. MiloševićM, Malešević M. Semenarstvo. Naučniinstitutzaratarstvoipovrtarstvo, Novi Sad. 2004: 110-114.

http://cigr.ageng2012.org/documentos/posters/P-PF.pdf

4. Tatic M,Balesevic- TubicS, DordevicV, MiklicV, VujakovicM,DukicV. Vigor of sunflower and soybean ageing seed. Helia. 2012; 35 (56): 119-126.

http://www.doiserbia.nb.rs/img/doi/1018-1806/2012.

5. Ghasemnezhad A,HonermeierB. Influence of storage conditions on quality and viability of high and low oleic sunflower seeds. International Journal of Plant Production. 2007; 3(4): 41-50.

http://www.google.com.eg/#hl=ar&site=&source=hp&q=Ghasemnezhad%2C+A.

6. De Alencar ER, FaroniLRDA,de LacerdaFilho AF, Ferreira LG, MeneghittiMR. Influence of different storage conditions on soybean grain quality. 9th International Working Conference on Stored Product Protection. 2006;30-37.

http://www.cabdirect.org/abstracts/20093357410.html;jsessionid=6D268C5EF7B7BCD5969B78879BD5EAA7?gitCommit=4.13.20-5-ga6ad01a.

7. Simic B, SudaricA, LiovicI, KalinovicI, RozmanV,CosicV. Influence of storage condition on seed quality of maize, soybean and sunflower. 9th International Working Conference on Stored Product Protection. 2006; pp. 59-63.http://www.doiserbia.nb.rs.

8. Khaliliaqdam N, SoltaniA, LatifiN, GaderiFF. Quantitative response of the longevity of soybean seed under controlled conditions. American-Eurasian journal of agriculture and environments sciences. 2012; 12 (2): 224-230.

http://www.iurtc.org.ir/english/article.aspx

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9. Arif M. Effect of seed priming on emergence, yield and storability of soybean. Ph.DDissetation, NWFP Agricultural University Peshawar, Pakistan 2006. http://eprints.hec.gov.pk/1867/1/1795.htm

10. Sharma S, GambhirS,ManshiSK. changes in lipid and carbohydrate composition of germinating soybean seed under different storage conditions. Asian Journal of Plant Sciences. 2007; 6(3):502-507.

http://scialert.net/abstract/?doi=ajps.2007.502.507

11. Vijay D,DadlaniM. Molecular marker analysis of differentially aged seeds of soybean and sunflower. Plant Molecular Biology. 2009; 22: 282-291.

http://www.google.com.eg/#hl=ar&site=&source=hp&q=Vijay%2C+D.+and+M.

12. SimicB, Popovic R, SudaricA, RozmanV, KalinovicI,CosicJ. Influence of Storage Condition on Seed Oil Content of Maize, Soybean and Sunflower. Agric. Conspectus Sci. 2007; 72 (3): 211-213.

http://www.doiserbia.nb.rs.

13. Sharma S, VirdiP, GambhirS,MunshiSK. Effect of temperature on vigor and biochemical composition of soybean seed during storage. Journal Research Punjabi Agriculture university. 2006; 43:29-33.

http://scialert.net/abstract/?doi=ajps.2007.502.507

14. Padma V,Muralimohan Reddy B. Seed invigoration for extending storability of soybean seed. Journal of Research Acharya N.G. Ranga Agricultural University. 2001; 29 (4): 1-5.

http://www.scirp.org/journal/DetailedInforOfEditorialBoard.aspx?personID=1828

15. Singh KK,Dadlani M. Effect of packageing on vigour and viability of soybean (Glycine max (L.) Merrill) seed during ambient storage. Seed Research. 2003; 31 (1): 27-32.

http://oar.icrisat.org/184/1/24_2010_IB_no_82_Host_Plant.pdf

16. AjalaMO,ShokoyaTA,Daniel IO. The Effect Of Moisture Content On The Storage of Treated Seed of Soybean (*Glycine Max (L)Merril*) Varieties.

UNDER PEER REVIEW

An International Journal of Agriculture Sciences, Sciences and Environment and Technology. 2005; 5(1): 167-178.

http://www.unaab.edu.ng/component/content/article/231-information/5123-daniel-ios-publications.html

17. ChatthaShakeel H, liaquat A,Jamalikhalil A,MangioHR. Effect of Different Packing Materials and Storage Conditions on the Viability of Wheat Seed (Td-1 Variety). Sci., Tech. and Dev. 2012; 31 (1): 10-18.
http://www.pcst.org.pk/journal/JN/2012/STD%20vol%2031(1)%202012/Eff pdf.

18. OwoladeOF, Olasoji JO,Afolabi CG. Effect of storage temperature and packaging materials on seed germination and seed-borne fungi of sorghum (Sorghum bicolor (L.) Moench.) In South West Nigeria.African Journal of Plant Science. 2011; 5(15): 873-877.
http://www.academicjournals.org/AJPS/abstracts/abstracts/abstracts2011/6%20Dec/Owolade%20et%20al.htm

19. Venkatareddy DM, Bommegowda A,ParameshDS. Storability of soybean seeds as influenced by genotypes and containers. Seed Tech News. 1992; 22 (2): 41-46.

http://www.google.com.eg/#hl=ar&safe=active&spell=1&q=Venkat+Reddy,+D.+M

20. Kalavathi DK, Ramamoorthy,SundareswaranS. Relative viability and vigor of different genotypes of soybean (Glycine max (L.) Merrill) during storage. Madras Agricultural Journal. 1994; 81 (11): 612-615.

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1513189

21. Monira US, AminMHA, Marin M,Mamun MAA. Effect of containers on seed quality of storage soybean seed. Bangladesh Research Publications Journal. 2012; 7 (4): 421-427.
http://www.bdresearchpublications.com/admin/journal/upload/09364/09364.pdf

22. Chuansin S, VearasilpS, SrichuwongS,PawelzikE. Selection of Packaging Materials for Soybean Seed Storage. Proc. of Conference on International Agricultural Research for Development October11-13- 2006. University

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of Bonn, Bonn.Germany.

http://dpg.phytomedizin.org/fileadmin/tagungen/07_Tropentag/Doku/Tropentag%202006.pdf.

23. Tatipata A. Effect of seed moisture content, packaging and storage period on mitochondria inner membrane of soybean seed. Journal of Agricultural Technology. 2009; 5(1): 51-64.

http://www.ijat-aatsea.com/pdf/June_v5_n1_09/6-23-IJAt2009_03F.pdf

24. Charjan S,Tararj L, Effect of storage on germination and microflora of soybean (Glycine max L. Merrill) seed. Indian Journal Agriculture Science. 1992; 62:500-502.

http://www.google.com.eg/#hl=ar&site=&source=hp&q=Charjan%2C+S

25. Shanmugavel S, VarierA,DadlaniM. Physiological attributes associated with seed ageing in soybean (Glycine max (L.) merrill) cultivars. Seed Research. 1995; 23 (2): 61-66.http://etd.uasd.edu/ft/th9489.pdf

26. ISTA. International rules for seed testing. Seed Science and Technology. 1996; 24: 1-335.http://etd.uasd.edu/ft/th9489.pdf

27. Ellis RH,Roberts EH. The quantification of ageing and survival in orthodox seeds. Seed Science and Technology. 1981; 9: 373-409.
http://agris.fao.org/agris-ch/search/display.do?f=1982/XE/XE82053.xml;XE8182678

28. Ruan, S, XueQ, TylkowskaK. The Influence of Priming on Germination of Rice (Oryza sativa L.) Seeds and Seedling Emergence and Performance in Flooded Soils. Seed Sci. Technol. 2002; 30: 61-67.

http://cat.inist.fr/?aModele=afficheN&cpsidt=13659042

29. Karim MA, Utsunomiya N,ShigenagaS. Effect of Sodium chloride on germination and growth of hexaploidtriticle at early seedling stage. Jpn. J. Crop Sci. 1992; 61:279-284.

http://209.238.2.121/fulltext/?doi=pjbs.2001.351.355&org=11

30. Maguire J O. Speed of germination aid in selection and evaluation for seedling emergence and vigor. Crop Science. 1962; 2: 176-177.

UNDER PEER REVIEW

http://209.238.2.121/fulltext/?doi=pjbs.2001.351.355&org=11

31. Balesevic- Tubic S, MalencicD, TaticM,MiladinovicJ. Influence of ageing processes on biochemical changes in sunflower seed. Hellia. 2005; 28(42): 107- 114.svetlanabt@ifvcns.ns.ac.rs

32. Mohammadi H, SoltaniA, SadeghipourH R, ZeinaliE. Effects of seed ageing on subsequent seed reserve utilization and seedling growth in soybean. International Journal of Plant Production. 2011; 5 (1): 65-70.

http://journals.gau.ac.ir:8080/jm/Programs/JurnalMgr/VolumArticle/EN_172_6.pdf

33. Tatić M, Balešević-Tubić S, Vujaković M,Nikolić Z. Changes of germination during natural and ascelerated ageing of soybean seed. Proceedings the Second PSU-UNS International Conference on BioSci. Food, Agric. Environ. Serbia, 2009; 256-259.

http://www.doiserbia.nb.rs/img/doi/1018-1806/2012.

34. Arefi H M,AbdiN. Study of variation and seed deterioration of *Festucaovina*germplasm in natural resources genebank. Iranian J. Rangelands and Forests Plant Breeding and Genetic Res. 2003; 11: 105-125.

http://www.google.com.eg/#hl=ar&site=&source=hp&q=Charjan%2C+S

35. Hou HJ,Chang KC. Yield and quality of soft tofu as affected by soybean physical damage and storage. Journal of Agricultural and Food Chemistry. 2004; 46: 4798-4805.

http://cigr.ageng2012.org/documentos/posters/P-PF.p

36. Jamro GH, HatamM, JamaliLA, Agha SK. effect of storage conditions on emergence of healthy seedlings of soybean. Agri. Mech. in Asia, Africa and Latin America. 2005; 36:15:17.

http://archive.org/stream/fishbycatchbonus034836mbp/fishbycatchbonus034836mbp_djvu.txt

37. Erandes RD, Leda RDF, LuizAP, Macro TC. Influence of soybean storage conditions on crude oil quality. RevistaBrasileira de Engenharia Agricola. 2010; 14 (3): 303-308.

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http://www.scielo.br/pdf/rbeaa/v14n3/v14n03a10.pdf

38. El-Abady MI, El-EmamAAM, SeadhSE,YousofFI. Soybean Seed Quality as Affected by Cultivars, Threshing Methods and Storage Periods. Research Journal of Seed Science. 2012; 3:1-11.

http://scialert.net/abstract/?doi=rjss.2012.115.125.

39. Doijoide SN. Comparison of storage containers for storage of French bean seeds under ambient conditions. Seed Research. 1988; 16: 245-247.

http://eurekamag.com/research/001/782/comparison-storage-containers-storage-french-bean-seeds-ambient-conditions.php

40. Muhammad A. Effect of planting dates and storage on yield and quality of indigenous land races and improved varieties of soybean. Ph.D. Thesis, Agri. Uni. Peshawar, Pakistan 2008.

http://eprints.hec.gov.pk/2503/1/2408.htm

41. Vieira RD, TekronyDM, EgliD B,Rucker M. Electrical conductivity of soybean seeds after storage in several environments. Seed Science and Technology. 2001; 29:599-608.

http://www.google.com.eg/#hl=ar&site=&source=hp&q=Electrical+conductivity+of+soybean+seeds+after+storage+in+several+environments.+Seed+Science+and+Technology%2C+29:599.

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Table 1: Means of germination percentage (%), germination index (%), energy of germination (%) and emergence rate (%) as affected by storage periods, soybean cultivars, storage conditions, package materials and their interactions.

Treatments / Characters	Final germination percentage (%)	Germination index (%)	Energy of germination (%)	Emergence rate (%)
S- Storage periods (months)				
Before storage	94.30	-	87.15	22.83
3 months	91.36	95.07	77.51	21.52
6 months	84.95	88.88	73.52	20.27
9 months	76.50	80.48	53.70	17.25
12 months	69.97	69.97	44.90	15.20
LSD 5%	0.71	0.73	1.23	0.192
V-Soybean cultivars:				
Giza 21	83.40	83.78	62.92	18.87
Giza 22	83.42	81.08	64.71	19.26
Giza 35	83.92	83.72	65.47	19.26
Giza 111	83.30	84.06	72.38	19.92
Crawford	83.03	85.36	71.28	19.76
LSD 5%	NS	0.82	1.23	0.192
C-Storage conditions:				
Ambient conditions	81.40	81.08	63.18	18.63
Refrigerator conditions (10^0C±1)	85.43	86.12	71.53	20.20
F- test	**	**	**	**
P-Package materials:				
Pods in plastic bags	83.38	83.47	68.01	19.46
Pods in cloth bags	83.16	83.37	65.67	19.37
Seed in plastic bags	83.52	83.81	67.29	19.36
Seed in cloth bags	83.61	83.75	68.46	19.47
LSD 5%	NS	NS	1.00	NS
F-test Interactions:				
V×S	**	**	**	**
S×C	**	**	**	**
V×C	NS	NS	**	**
V×C×S	NS	NS	*	*
S×P	NS	NS	**	*
V×P	NS	NS	**	**
V×S×P	**	**	NS	NS
C×P	**	**	**	NS
S×C×P	NS	NS	**	NS
V×C×P	NS	NS	**	**
V×C×S×P	NS	NS	**	NS

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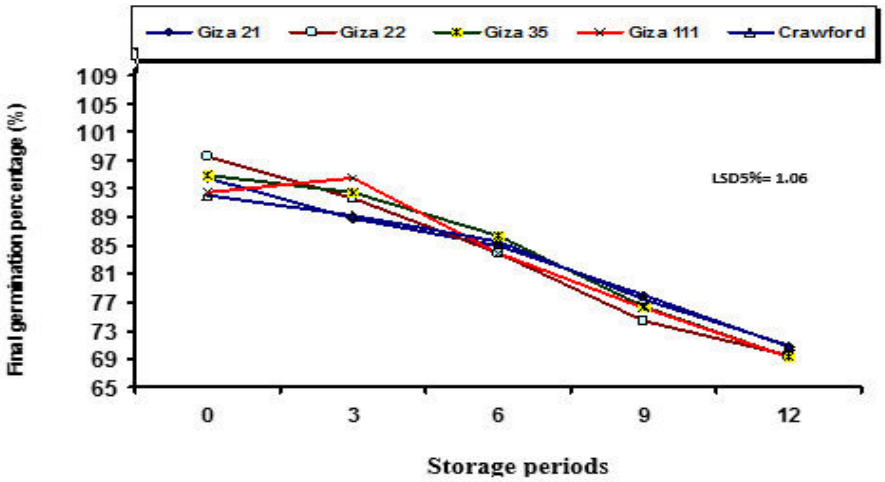

Fig. 1. Averages of final germination percentage as affected by the interaction between soybean cultivars and storage periods.

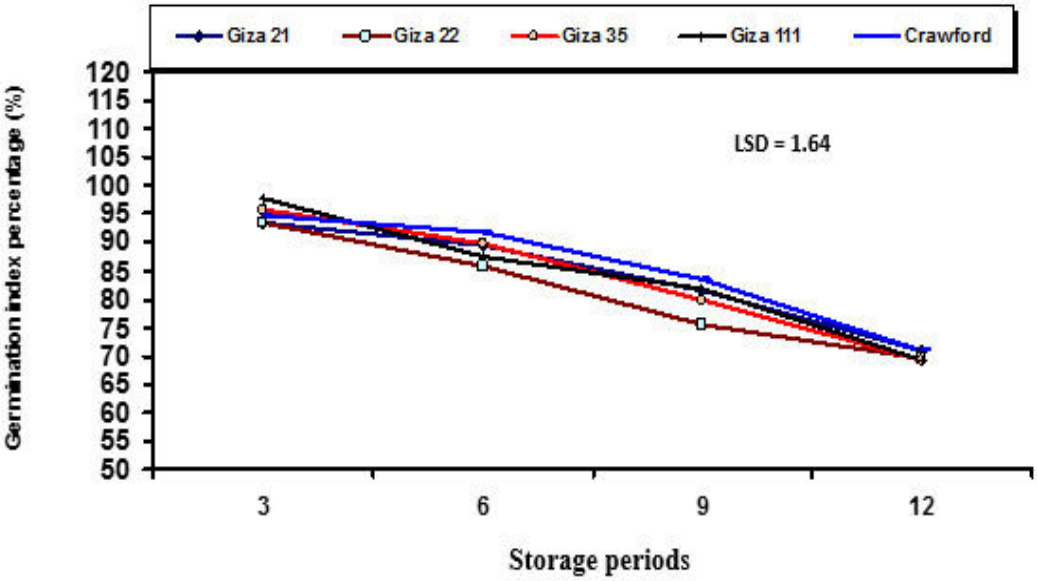

Fig. 2. Averages of germination index percentage as affected by the interaction between storage periods and soybean cultivars.

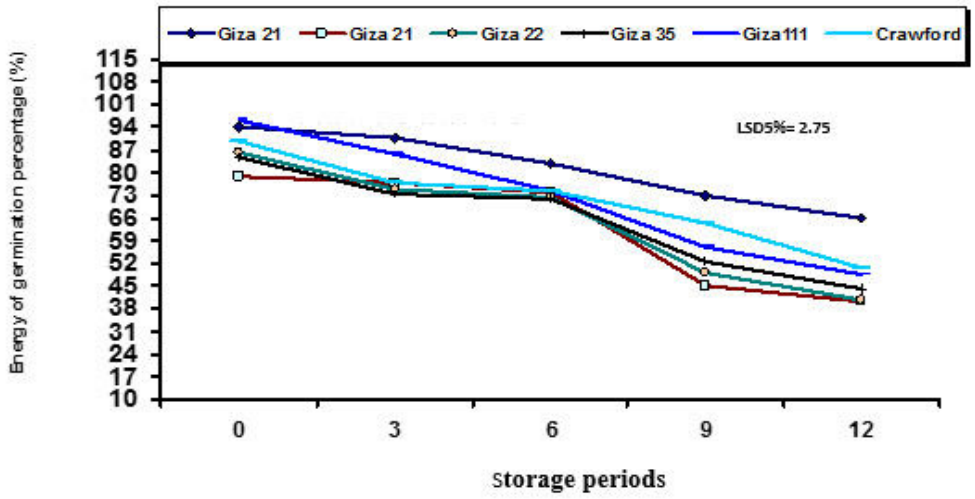

Fig. 3. Averages of energy of germination percentage as affected by the interaction between storage periods and soybean cultivars.

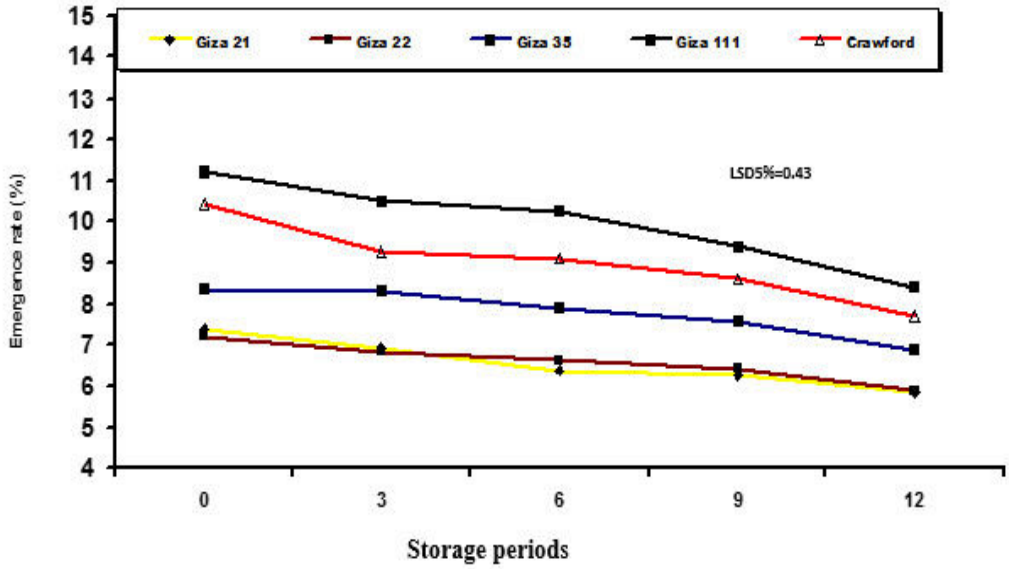

Fig. 4. Averages of emergence rate as affected by the interaction between soybean cultivars and storage periods.

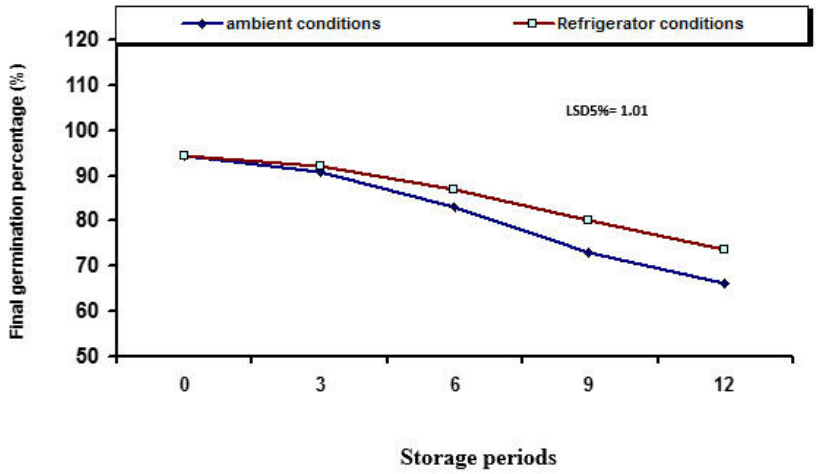

Fig. 5. Averages of final germination percentage as affected by the interaction between storage conditions and storage periods.

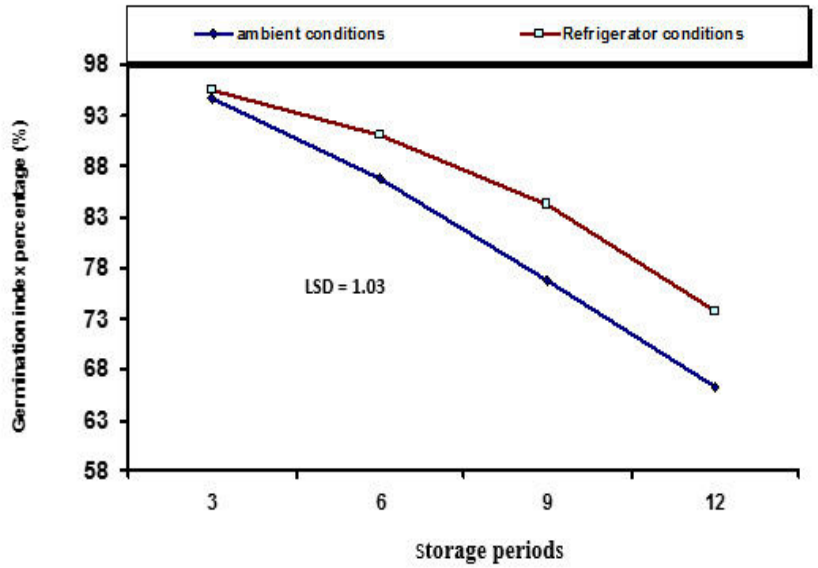

Fig. 6. Averages of germination index percentage as affected by the interaction between storage conditions and storage periods.

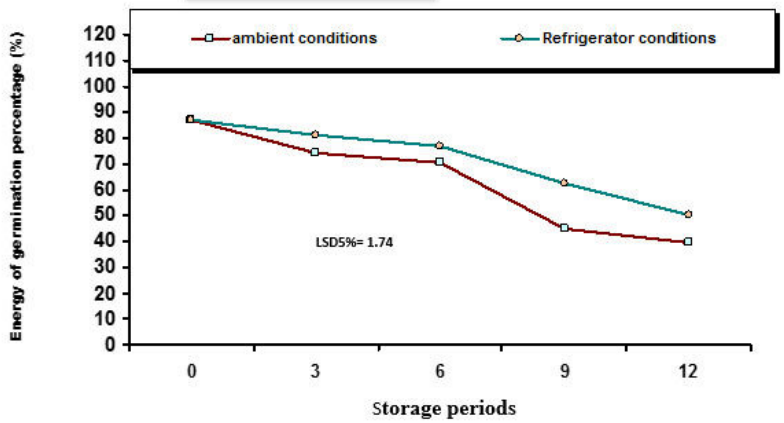

Fig. 7. Averages of energy of germination percentage as affected by the interaction between storage periods and storage conditions.

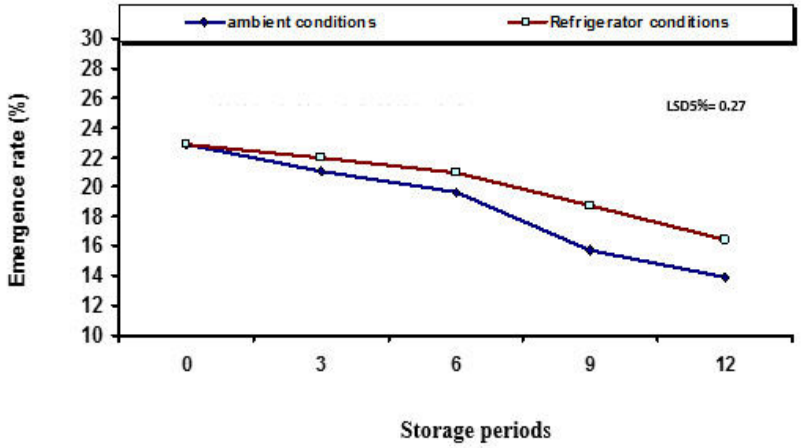

Fig. 8. Averages of emergence rate as affected by the interaction between storage conditions and storage periods.

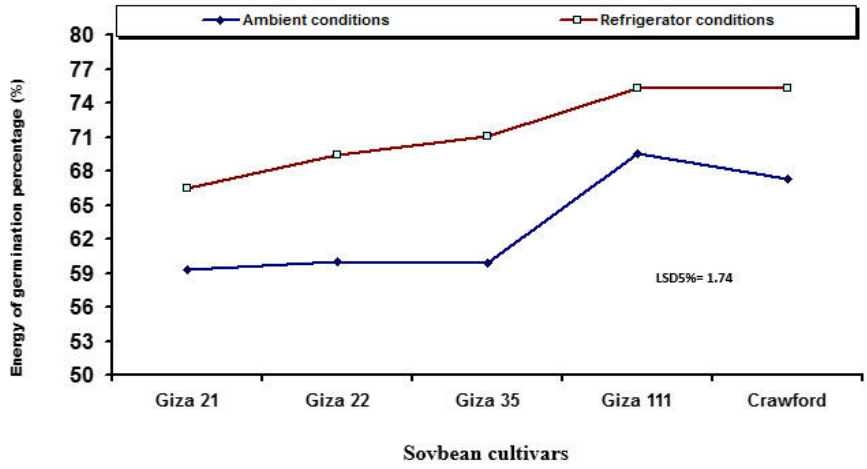

Fig. 9. Averages of energy of germination percentage as affected by the interaction between soybean cultivars and storage conditions.

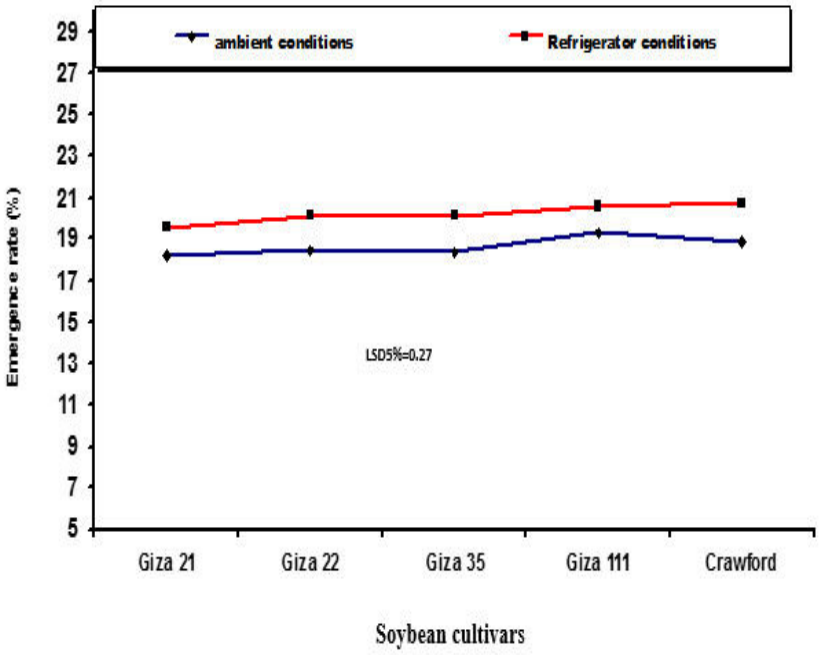

Fig. 10. Averages of emergence rate as affected by the interaction between soybean cultivars and storage conditions.

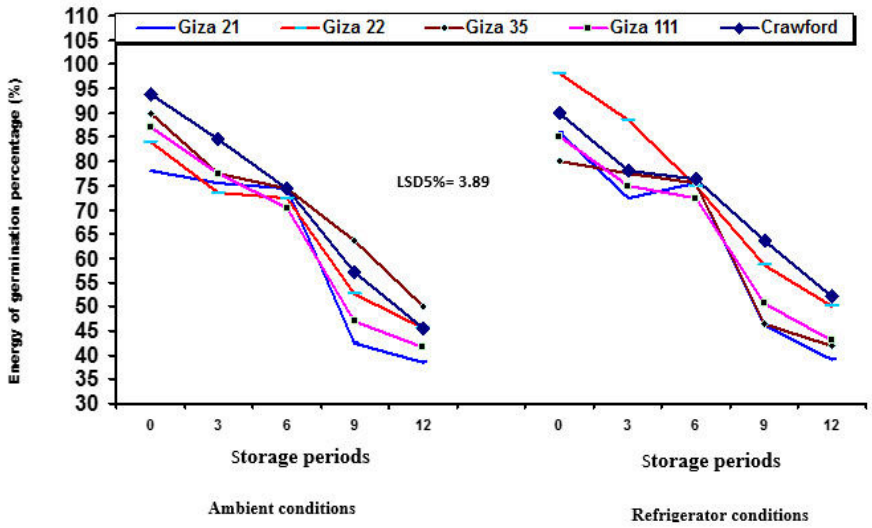

Fig. 11. Averages energy of germination as affected by the interaction between storage periods, soybean cultivars and Storage conditions.

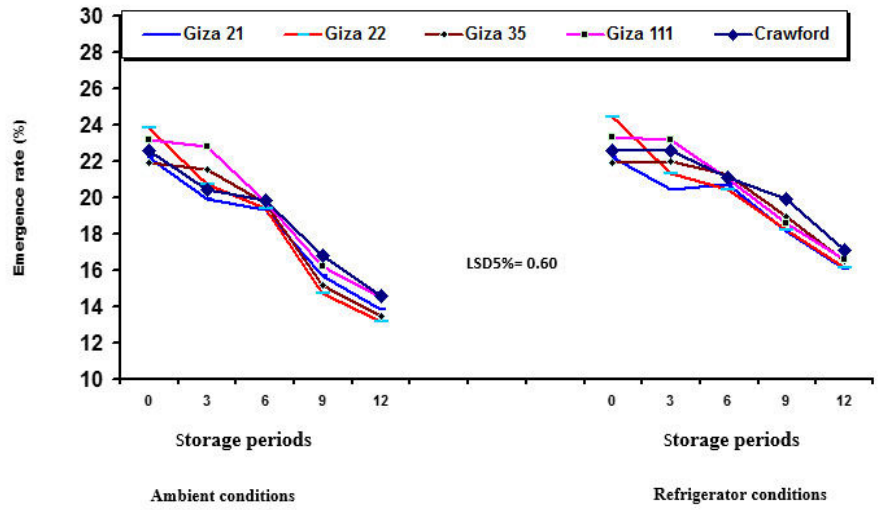

Fig. 12. Averages of emergence rate as affected by the interaction between storage periods, soybean cultivars and storage conditions.

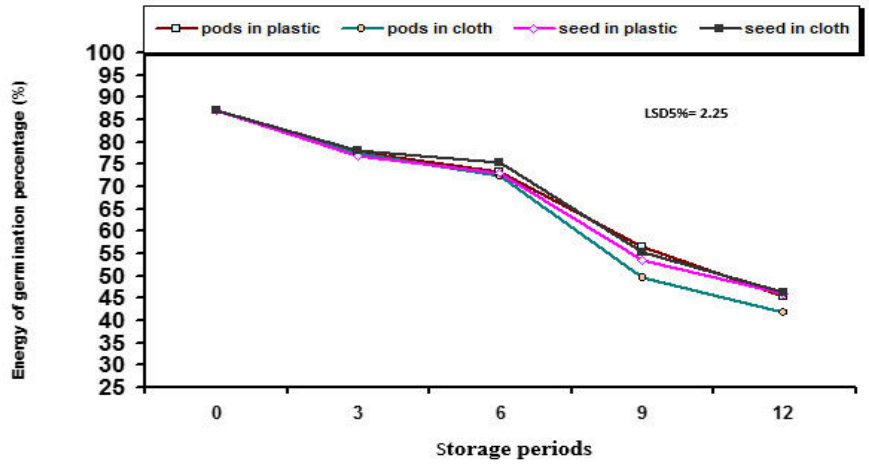

Fig. 13. Averages of energy of germination percentage as affected by the interaction between storage periods and package materials.

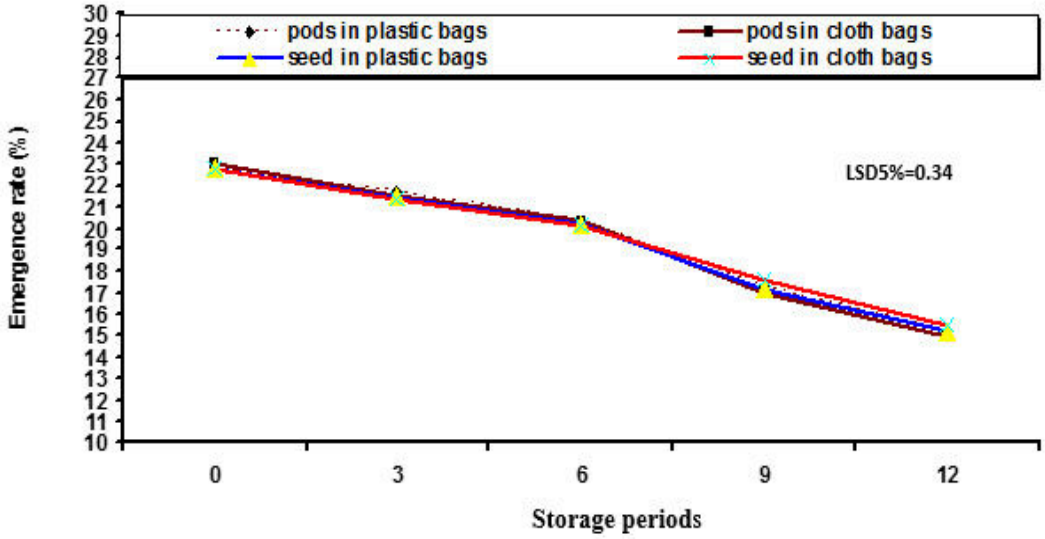

Fig. 14. Averages of emergence rate as affected by the interaction between storage periods and package materials.

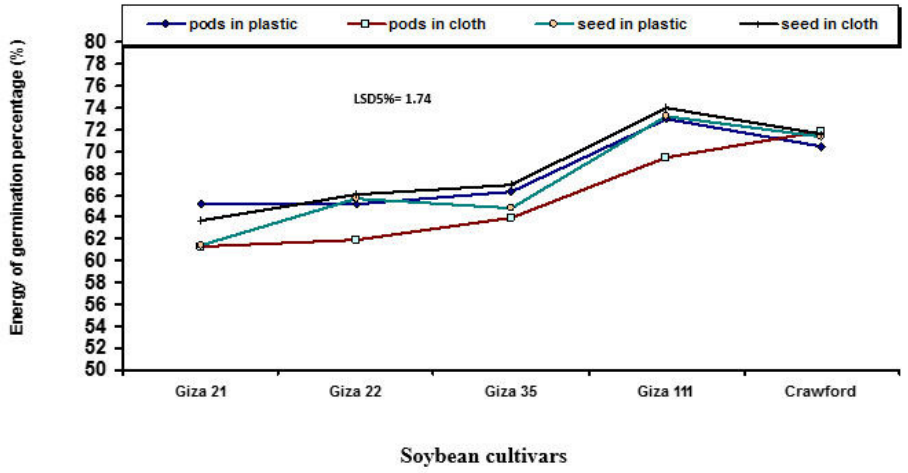

Fig. 15. Averages of energy of germination percentage as affected by the interaction between soybean cultivars and package materials.

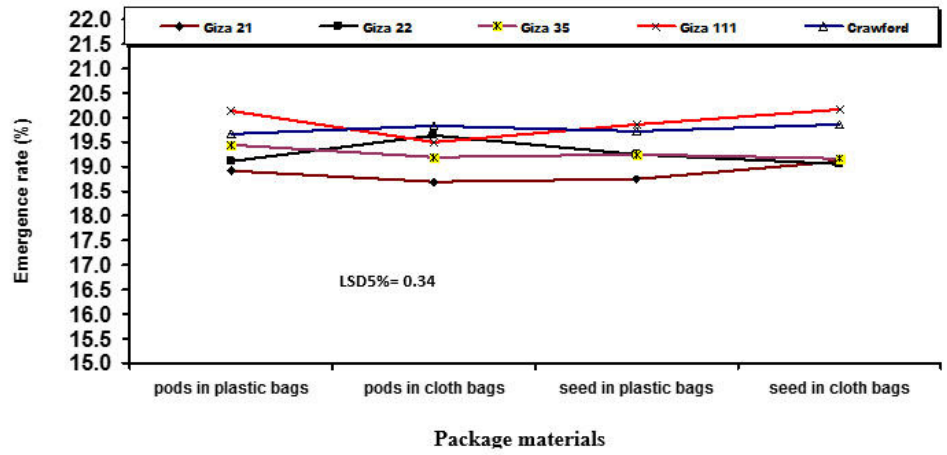

Fig. 16. Averages of emergence rate as affected by the interaction between soybean cultivars and package materials.

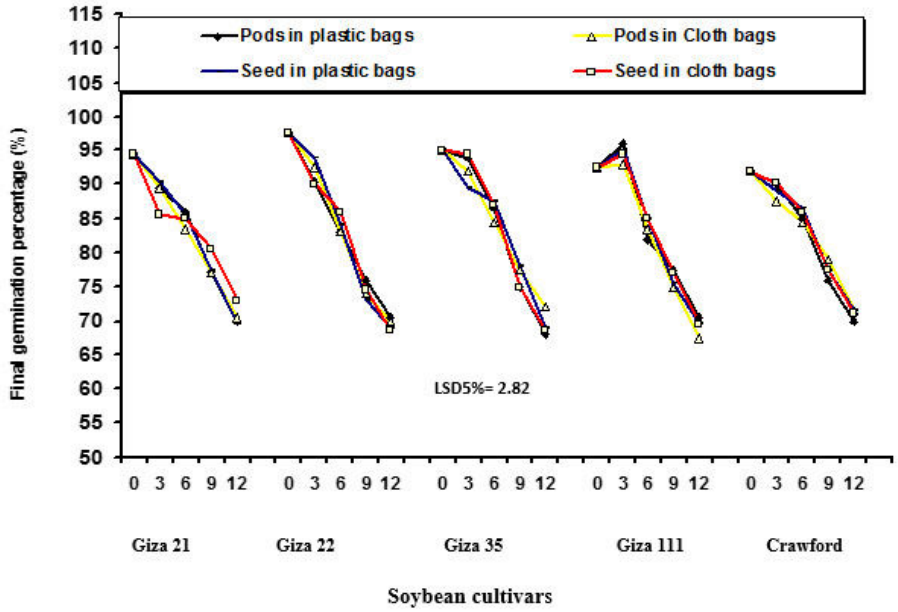

Fig. 17. Averages of final germination percentage as affected by the interaction between soybean cultivars, package materials and storage periods.

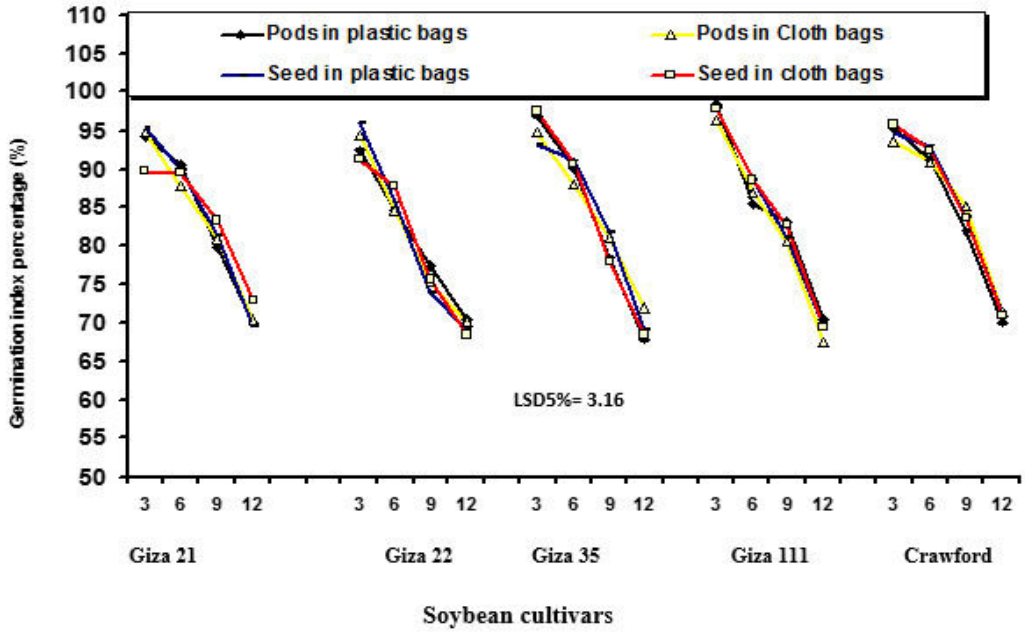

Fig. 18. Average of germination index percentage as affected by the interaction between soybean cultivars, package materials and storage.

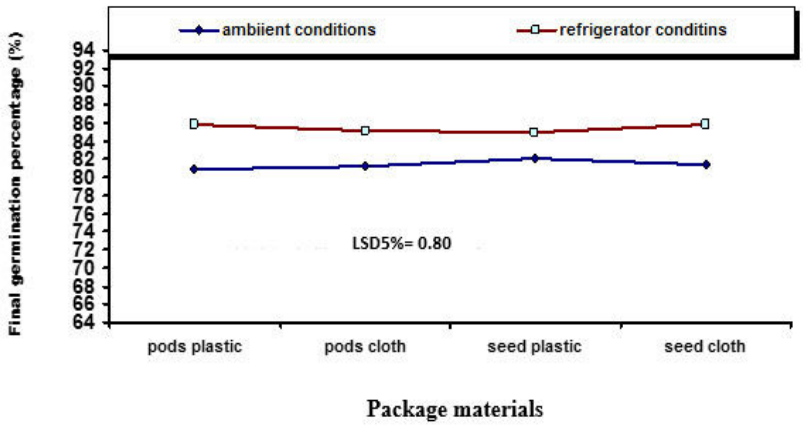

Fig. 19. Averages of final germination percentage as affected by the interaction between storage conditions and storage periods.

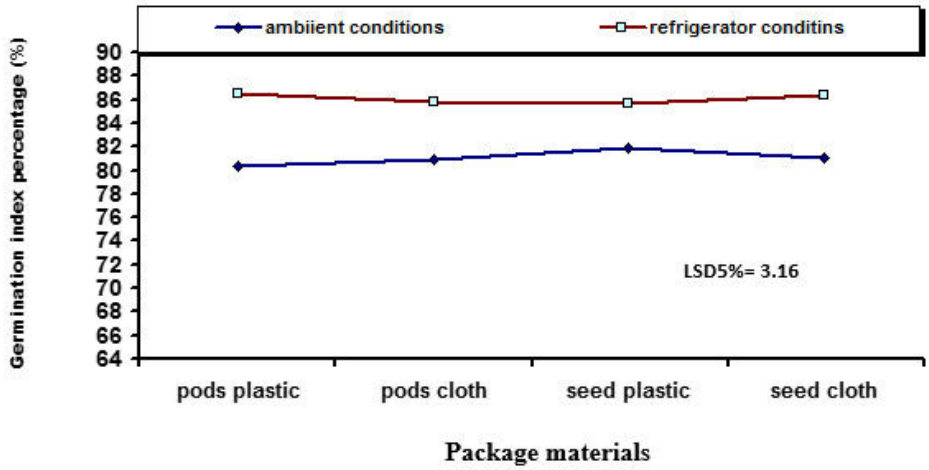

Fig. 20. Averages of germination index percentage as affected by the interaction between storage conditions and package materials.

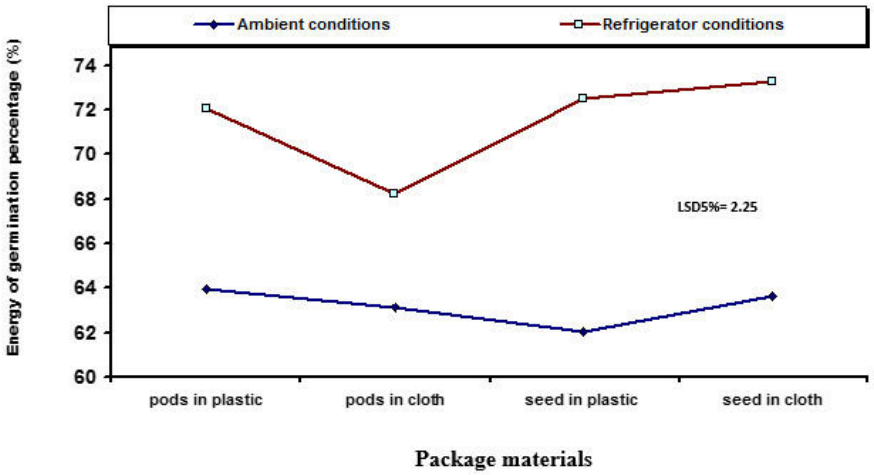

Fig. 21. Averages of energy of germination percentage as affected by the interaction between storage conditions and package materials.

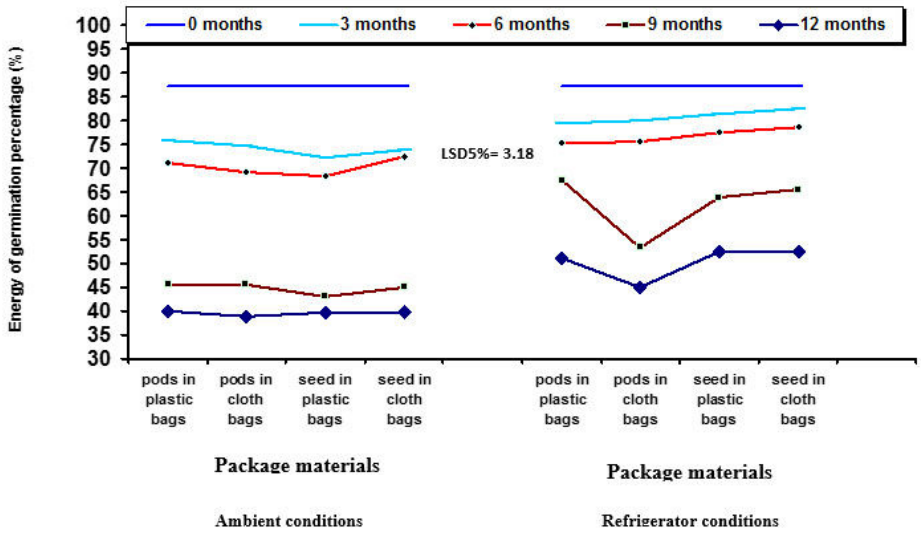

Fig. 22. Averages of energy of germination as affected by the interaction between storage periods, storage conditions and package materials.

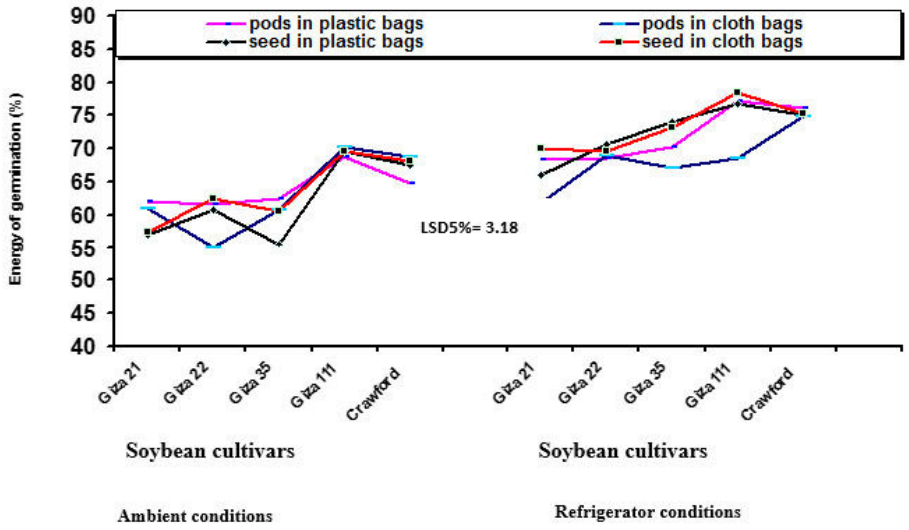

Fig. 23. Average of energy of germination as affected by the interaction between soybean cultivars, storage conditions and package materials.

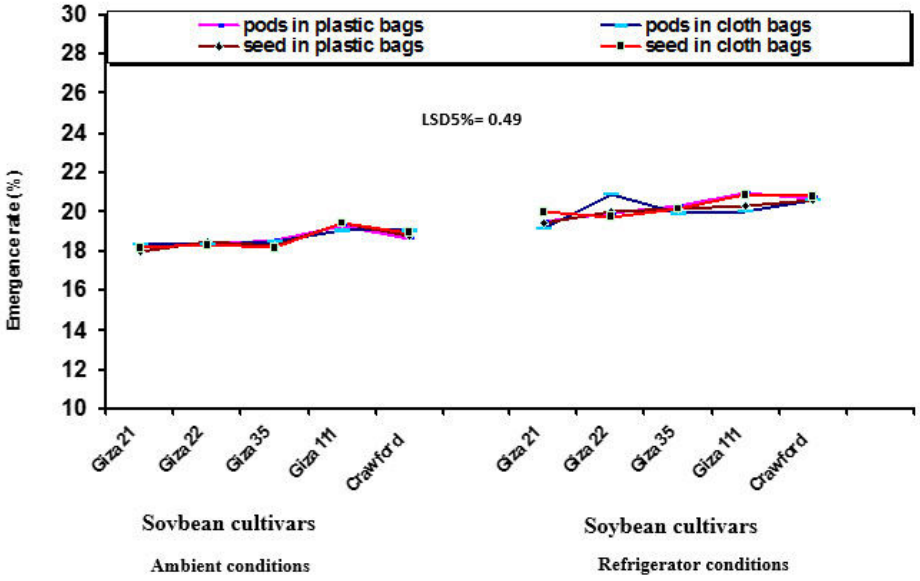

Fig. 24. Averages of emergence rate as affected by the interaction between soybean cultivars, storage conditions and package materials.