

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

Kandil, A. A.; A. E. Sharief and M. S. Sheteiwy

Department of Agronomy, Faculty of Agriculture, Mansoura University, Egypt.

Corresponding author: Mohamed Salah Sheteiwy Agronomy Dept., Fac. of Agric., Mansoura University, Egypt, El-Mansoura, Egypt Tel: +201063635425 Fax: +2052228688,

salahco_2010@mans.edu.eg

ABSTRACT

Aims: This investigation aimed to study response of some soybean CVS, 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 $10 \pm 1^{\circ}\text{C}$ as well as storage materials, on germination characters.

Study design: Treatments were arranged in factorial experimental in completely randomized design, consisted of totally 160 treatments combinations involving two storage conditions, i.e. ambient and refrigerator conditions at $10 \pm 1^{\circ}\text{C}$, four different 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 CVS, i.e. Giza 21, Giza 22, Giza 35, Giza 111 and Crawford.

Place and duration of study: Laboratory experiment was conducted in Agronomy Department, Fac. of Agric. Mansoura Univ., Egypt during 2011 and 2012.

Methodology: Soybean CVS were harvested in October 2011, cleaned, then dried and processed for storage. Every three months, from a total 12 months of storage, germination characters were evaluated.

Results: Seed germination characters were decreased with increasing period of ageing. Giza 111 exceeded other CVS in energy of germination, emergence rate. Giza 21 cultivar exceeded other CVS in germination index. Giza 35 cultivar exceeded other CVS in final germination percentage. Storage under refrigerator conditions at $10 \pm 1^{\circ}\text{C}$ surpassed under ambient conditions in final germination percentage, germination index, energy of germination, emergence rate. Energy of germination significantly affected by storage materials. Final germination percentage, germination index, energy of germination and emergence rate significantly affected by the various interactions.

Conclusion: It could be concluded that storage Giza 111 cultivar under refrigerator conditions ($10 \pm 1^{\circ}\text{C}$) of soybean seed with cloth bags for 3 months enhanced germination properties.

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32 **Key Words:** *Soybean, storage, viability, deterioration, seed viability and storage periods.*

33 **1. INTRODUCTION**

34 Storage conditions and duration are important factors affecting germination parameters. Seed
35 vigor is used as a measure of accumulated damage in seed as viability declines. Preservation of seed
36 viability depended on storage condition and duration [1]. The decline of germination is much more
37 acute under tropical conditions. These environmental conditions make very difficult to maintain its
38 viability during storage [2]. Seed deteriorated during storage is one of the basic reasons for low
39 productivity in soybean. Changes that occur in seed during ageing are significant in terms of seed
40 quality among other things, also implies seed longevity [3]. Different periods of seed storage, as well
41 as ageing conditions adversely affected the seed vigor [4]. Arif et al. [9] concluded that seed viability
42 gradually decreased from 64.5 to 39.2% as the time of storage increased, from 2 to 12 months.
43 Changes occurring in seed during ageing are very significant with regard to quality and longevity of
44 seed. Seed composition characteristics of oily plants are related to specific processes occurring in seed
45 during storage [5].

46 The soybean seed generally deteriorated with storage and deterioration was particularly strong for
47 grains stored with initial moisture contents of 12.8 and 14.8 % at 40°C. The grains stored with initial
48 moisture contents of 14.8 % at 30 and 40°C were classified as out of market standard after 135 and 90
49 days respectively [6]. Differences in oil percentage that affected by storage longevity were significant
50 among tested crops and genotypes. Storage longevity was negatively associated with oil content. At
51 storage conditions at 12°C/60%, decreasing of seed oil content than in storage conditions at 25°C/75%
52 [7]. In addition, [3] and [1] showed that preservation of seed viability depended on storage condition and
53 duration. Khaliliaqdam et al. [8] suggested that variations occurred with the viability constants of a
54 seed deterioration model between the soybean cultivars. Different periods of seed storage, as well as
55 storage conditions adversely affected the seed vigor [8]. Similar conclusions were reported by [8, 10
56 and 11]. Seed stored at 4°C recorded highest germination percentage than ambient
57 temperature [9]. Similar results were indicated by [5, 12 and 13]. Vijay et al. [11] incubated soybean seeds
58 at two different temperatures of 34 °C and 40 °C for varying times. They indicated that soybean
59 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. Singh et al. [15] reported that soybean seeds stored in cloth bag maintained satisfactory germination only for 4 months of storage. Wheat seed stored in gunny, cloth and plastic bags were in good moisture content levels and recorded higher germination percentage in comparison with those stored 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 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 after seed ageing. These differences between genotypes might be due to the genetic factors and seed chemical composition influence the seed manifestation and vigor [4]. Khaliliaqdam et al. [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. Soybean germination and vigor varied among cultivars and M-351 had the highest mean germination parameters [16]. Similar conclusions were reported by [7, 19 and 20]. Sorghum seeds stored inside 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 and 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.

2. 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 $10 \pm 1^{\circ}\text{C}$ 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.

3. 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 (27°C and RH 90 %) and refrigerator conditions at $10 \pm 1^{\circ}\text{C}$, 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. Giza 21, Giza 22, Giza 35, Giza 111 and Crawford. Soybean (*Glycine Max* L. Merr.) cultivars which were harvested in 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.

4. Studied characteristics:

The following germination characters were studied as following:

4.1 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 for germination in rolled rowels in a germinator maintained at $25 \pm 7^{\circ}\text{C}$ and 95 % relative humidity. The normal seedlings was counted, 5th and 8th day. Then final germination percentage was calculated according to [27 and 28] as the follows equation:

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

4.2 Germination index (GI):

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

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

3.3 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].

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

Emergence rate = $\frac{1}{2}$ (number of seedling emerged on 5th day after planting + number of seedling emerged on 8th day after planting).

3-Results and discussion

3.1 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 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 percentage of pre storage treatment. Increasing storage periods from 6, 9 and 12 months decreased germination index percentage by 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 percentage by 11.06, 15.63, 38.38 and 48.47 %, respectively compared with energy of germination percentage of pre storage treatment. Increasing storage periods from 3, 6, 9 and 12 months decreased emergence rate percentage by 5.73, 11.51, 24.44 and 33.42%, respectively compared with emergence rate percentage of pre storage treatment. In this respect, Arif et al.[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 increased from 2 to 12 months. In addition, Balesevic- Tubic et al.[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, Mohammadi et al.[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 and 37].

3.2 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 111 surpassed Giza 21, Giza 22, 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, Giza 35 and Crawford cultivars in emergence rate percentage by 5.27, 3.31, 3.31 and 0.80 %, respectively.

Crawford cultivar surpassed Giza 21, Giza22, Giza 35 and Giza 111 cultivars in germination index percentage by 1.85, 5.01, 1.92 and 1.52 %, respectively. In this respect, Tatic et al.[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, Doijoide et al.[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, 36and 37].

3.3 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 trend, [9]recorded that highest germination percentageswere in seed stored at 4⁰C than room temperature. These results are in good harmony with those obtained by[8, 31, 32, 36, 37 and 41].

3.4 Storage package materials effects:

The resultsshowed that a significant effect of package materials on the means of energy of germination percentage as shown in (Table 1).The results showed that energy of germination percentage significantly 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 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 and 37].

3.5 Interaction effects:

3.5.1 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 (at 0.05) differences between them. Highest germination index percentage was produced from storage for 3 months of Giza 111 cultivar. The lowest germination index percentage was recorded from storage Giza 35 and Giza 111 cultivars after 12 months without significant (at 0.05) differences between them (Fig. 2). Highest energy of germination percentage was recorded from pre storage of Giza 111 cultivar followed with Giza 111 cultivar when storage for 3 months. The lowest energy of germination percentage was recorded from storage Giza 21 cultivar after 12 months (Fig. 3). The results clearly indicated that highest emergence rate percentage was 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 (at 0.05) between them (Fig. 4). These results are in harmony with those reported by [1, 8, 22, 23 and 34].

3.5.2 Interaction between storage periods and storage conditions effects:

The results clearly indicated that pre 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 percentage was recorded from storage for 12 months of storage under ambient conditions. The results clearly showed that after 3 months of storage treatment under refrigerator conditions at 10°C recorded highest germination index percentage followed by storage after 6 months under refrigerator conditions at 10°C (Fig. 6). The lowest germination index percentage was recorded from storage for 12 months under ambient conditions. The results clearly showed that pre 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 percentage was recorded for 12 months of storage under ambient conditions. The results clearly indicated that pre 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 and 41].

3.5.3 Interaction between soybean cultivars and storage conditions effects:

The results clearly indicated that highest energy of germination percentage was obtained from storage Giza 35 and Giza 111 cultivars under refrigerator conditions ($10 \pm 1^\circ\text{C}$). The lowest energy of germination percentage was obtained from storage Giza 21 and Giza 22 cultivar under ambient conditions without significant (at 0.05) differences between them (Fig. 9). Highest emergence rate percentage was obtained from Crawford followed by Giza 111 cultivars when storage under refrigerator conditions ($10 \pm 10^\circ\text{C}$). The lowest emergence rate percentage was obtained from storage Giza 21 and Giza 22 cultivars under ambient conditions without significant (at 0.05) differences between them (Fig. 10). These results are in conformity with those reported by [1, 8, 22, 23, 34 and 40].

3.5.4 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

229 Giza 21 under ambient and or refrigerator conditions for 12 months without significant (at 0.05)
230 differences between them (Fig. 11). Highest emergence rate percentage was obtained from before
231 storage of Giza 22 cultivar. The lowest emergence rate percentage was obtained from storage Giza 22
232 cultivar under ambient and refrigerator conditions for 12 months without significant (at
233 0.05) differences between them (Fig. 12). These results are in good agreement with those reported by [8,
234 31, 32, 36, 37 and 41].

235 **3.5.5 Interaction between storage periods and package materials:**

236 The results clearly indicated that energy of germination percentage and emergence rate
237 percentages significantly affected due to the interaction between storage periods and package materials.
238 It could be noticed that highest energy of germination percentage was obtained from pre storage
239 treatment followed by storage soybean cultivars seeds in cloth bags for 3 months (Fig. 13). The lowest
240 energy of germination percentage was obtained from storage soybean pods in cloth bags for 12
241 months. The results showed that highest emergence rate percentage was obtained from pre storage
242 treatment followed by storage of studied soybean cultivars seeds in cloth bags for 3 months (Fig. 14).
243 The lowest emergence rate percentage was obtained from storage soybean pods in cloth bags for 12
244 months. These results are in conformity with those reported by [8 and 40].

245 **3.5.6 Interaction between soybean cultivars and package materials:**

246 The results clearly showed that highest energy of germination percentage were produced from storage
247 Giza 111 cultivar seeds in cloth bags (Fig. 15). The lowest energy of germination percentage were
248 obtained from storage Giza 21 cultivar pods in cloth bags or seeds in plastic bags without significant
249 (at 0.05) differences between them. Highest emergence rate percentage were produced from storage
250 Giza 111 cultivar pods storage in plastic bags or seeds in cloth bags (Fig. 16). The lowest emergence
251 rate percentage were obtained from storage Giza 21 cultivar pods in cloth bags or seeds in plastic
252 bags without significant (at 0.05) differences between them. These results are in conformity of those
253 reported by [8, 31, 32, 36 and 37].

254 **3.5.7 Interaction between storage periods, soybean cultivars and package materials:**

255 The results clearly indicated that highest final germination percentage was obtained from before
256 storage of Giza 22 cultivar. The lowest energy of germination percentage was obtained from storage
257 Giza 35 cultivar pods in plastic bags for 12 months (Fig. 17). Highest germination index percentage was
258 obtained from Giza 35 cultivar before storage. The lowest germination index percentage was obtained
259 from storage Giza 35 cultivar pods in plastic bags for 12 months (Fig. 18). These results are in good
260 agreement with those reported by [8, 31, 32, 36, 37 and 41].

261 **3.5.8 Interaction between storage conditions and package materials:**

262 The results clearly showed that highest final germination percentage was obtained from storage
263 soybean cultivars pods in plastic bags under refrigerator conditions ($10 \pm 1^{\circ}\text{C}$). The lowest final
264 germination percentage was 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 $(10 \pm 1^{\circ}\text{C})$. 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 $(10 \pm 1^{\circ}\text{C})$. The lowest energy of germination percentage was obtained from storage soybean cultivars seeds in plastic bags under ambient conditions (Fig. 21). These results are in good agreement with those reported by [8, 31, 32, 36and 37].

3.5.9Interaction between storage periods, storage conditions and packagematerials:

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 $(10 \pm 1^{\circ}\text{C})$ for 3 months. The lowest energy of germination percentagewas obtained from storage soybean seeds cultivars in plastic bags under ambient conditions(Fig. 22). These findingsare in good conformity with those reported by [8, 31, 32, 36and 37].

3.5.10Interaction between soybean cultivars, storage conditions and package materials:

The results clearly indicated that highest energy of germination parentagewas obtained from storage Giza 111 cultivarunder refrigerator conditions $(10 \pm 1^{\circ}\text{C})$ 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 $(10 \pm 1^{\circ}\text{C})$ 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 are in good agreement with those reported by [8, 31, 32, 36and 37].

4.conclusion

This investigation was revealed that for maximizing soybean seed germinationparameters, it should be storage Giza 111 cultivar under refrigerator conditions $(10 \pm 1^{\circ}\text{C})$ as pods or seeds with cloth bags for 3 months.

ACKNOWLEDGMENTS

Mr. M. S. Sheteiwy wishes to express his most sincere and gratitude to Prof. Dr. Ahmed A. Kandiland Prof. Dr. Ali E. Sharief, Agronomy Dep., Faculty of Agriculture, Mansoura University, for possible help and extraordinary effort during the achievement of this investigation. Their guidance and encouragement during theextraordinary effort during writing this manuscript.

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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°C±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:					
S×V		**	**	**	**
S×C		**	**	**	**
V×C		NS	NS	**	**
V×C×S		NS	NS	*	*
S×P		NS	NS	**	*

V×P	NS	NS	**	**
S×V×P	**	**	NS	NS
C×P	**	**	**	NS
S×C×P	NS	NS	**	NS
V×C×P	NS	NS	**	**
S×V×C×P	NS	NS	**	NS

399 NS=Not significant, *= significant at 5%, **= significant at 1%, LSD= least significant differences.

400 **Figures Captions:**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

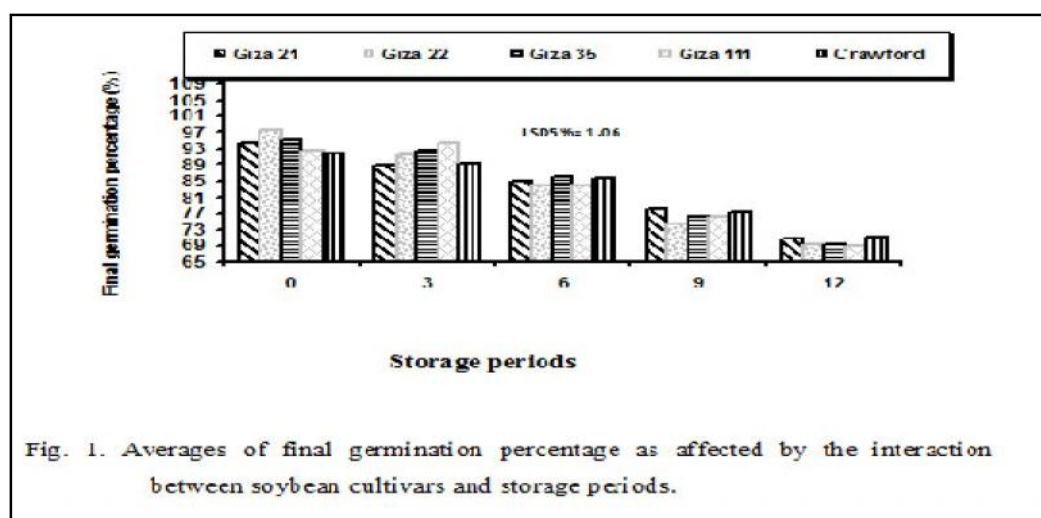
437 Fig. 20. Averages of germination index percentage as affected by the interaction between
438 storage conditions and package materials.

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

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

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

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



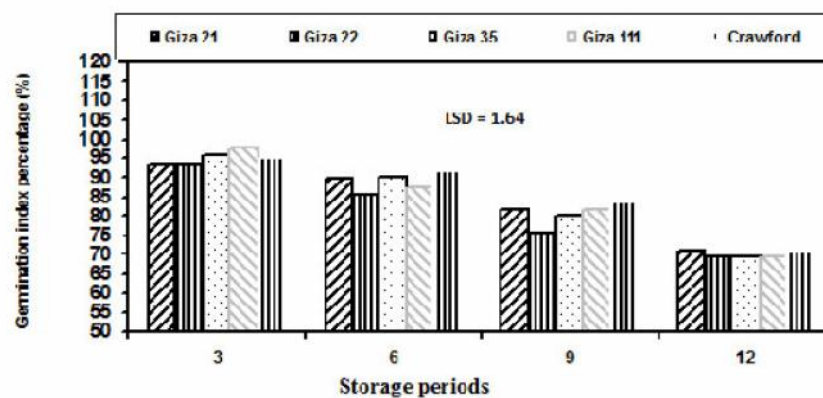
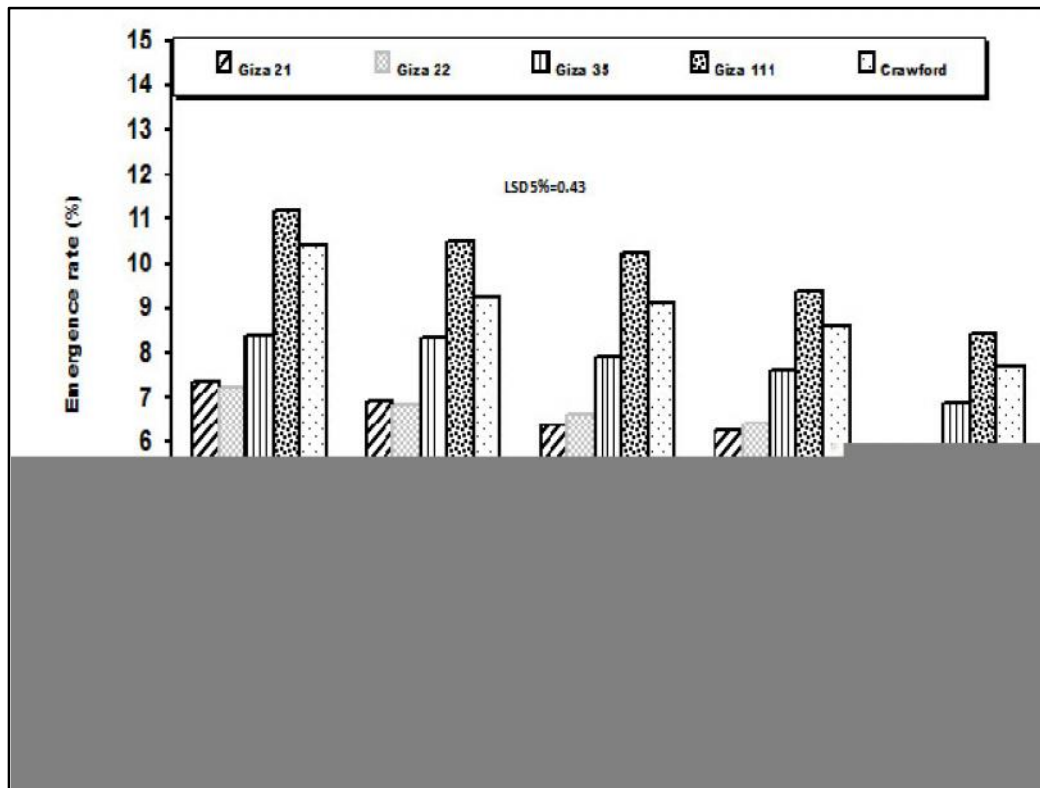
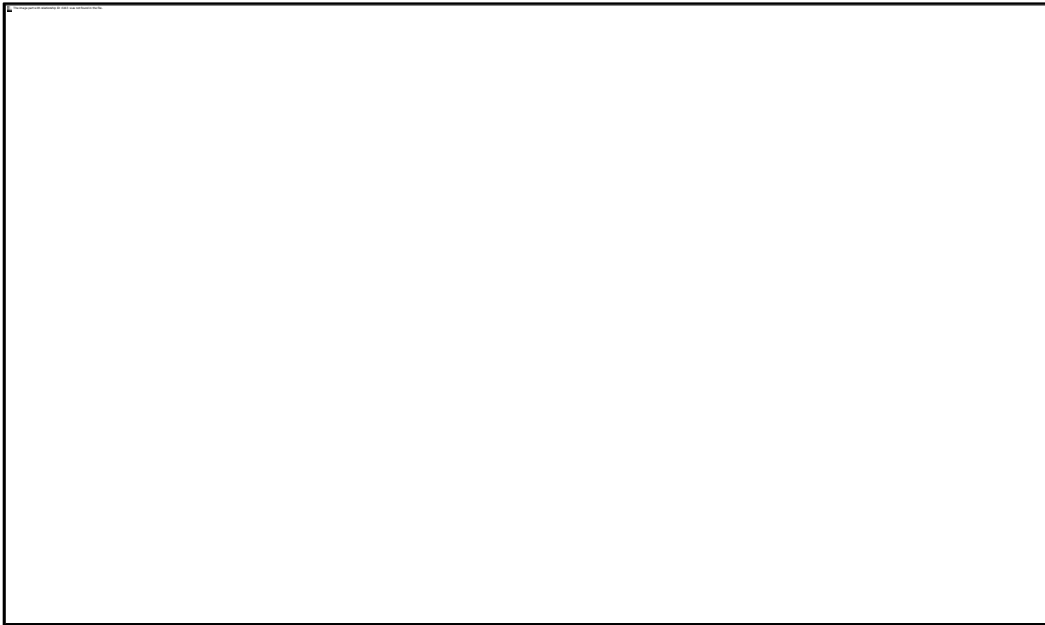


Fig. 2. Averages of germination index percentage as affected by the interaction between storage periods and soybean cultivars.

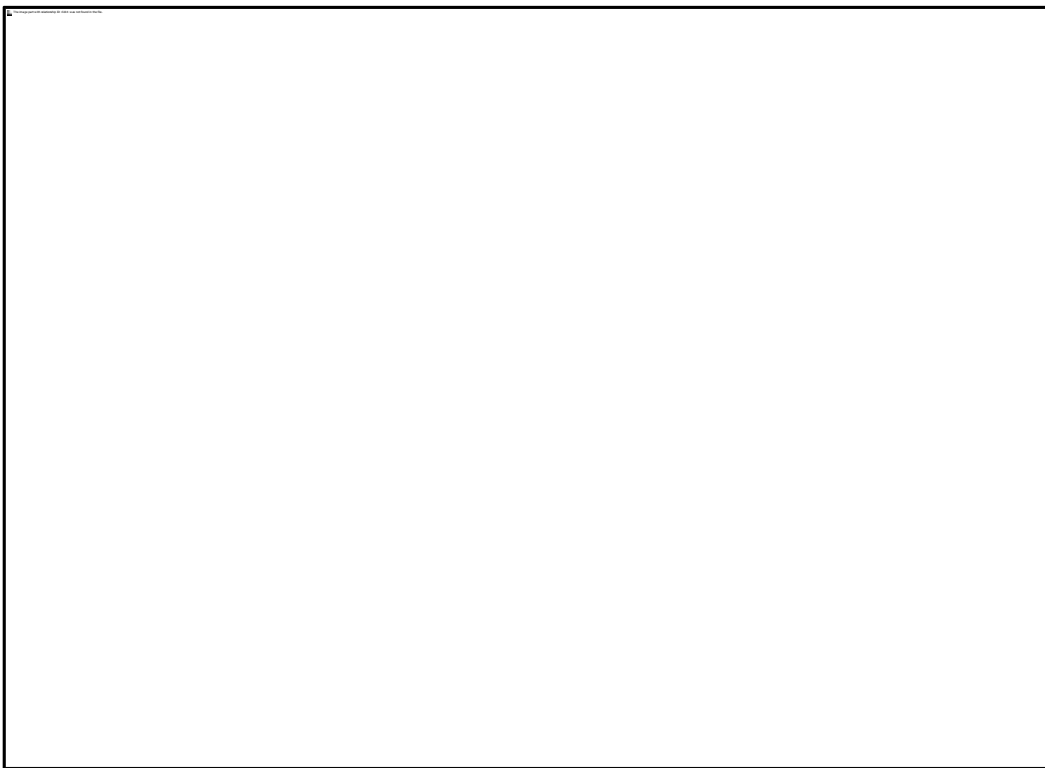


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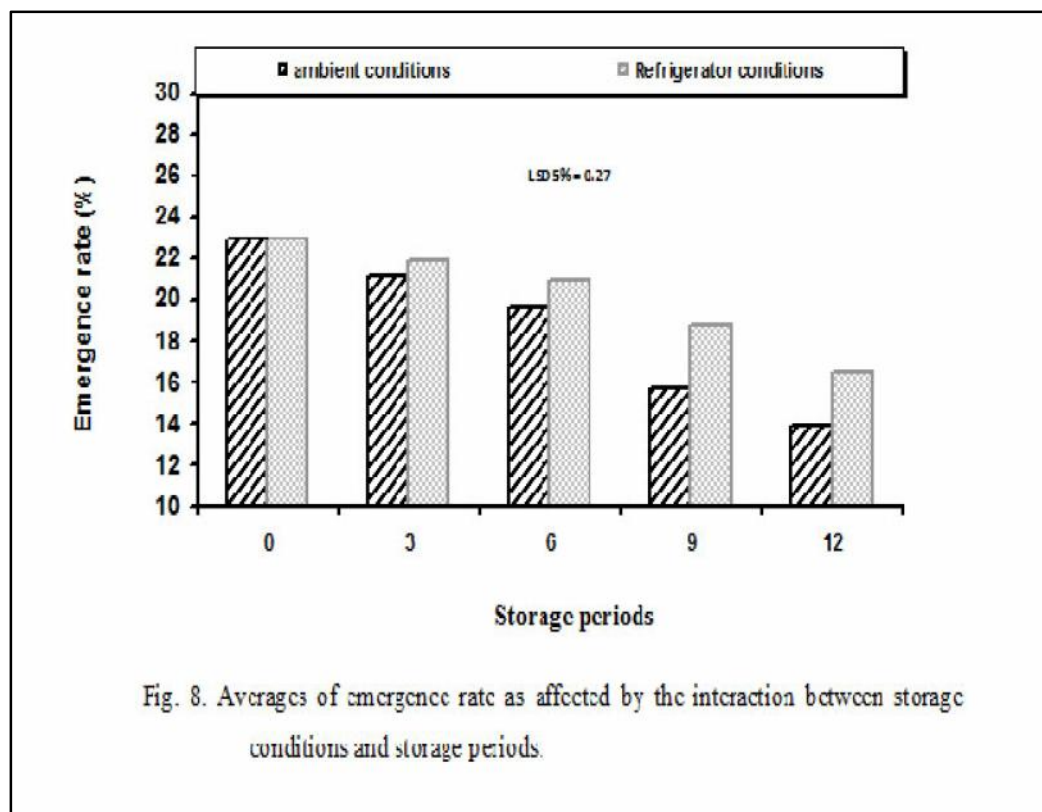


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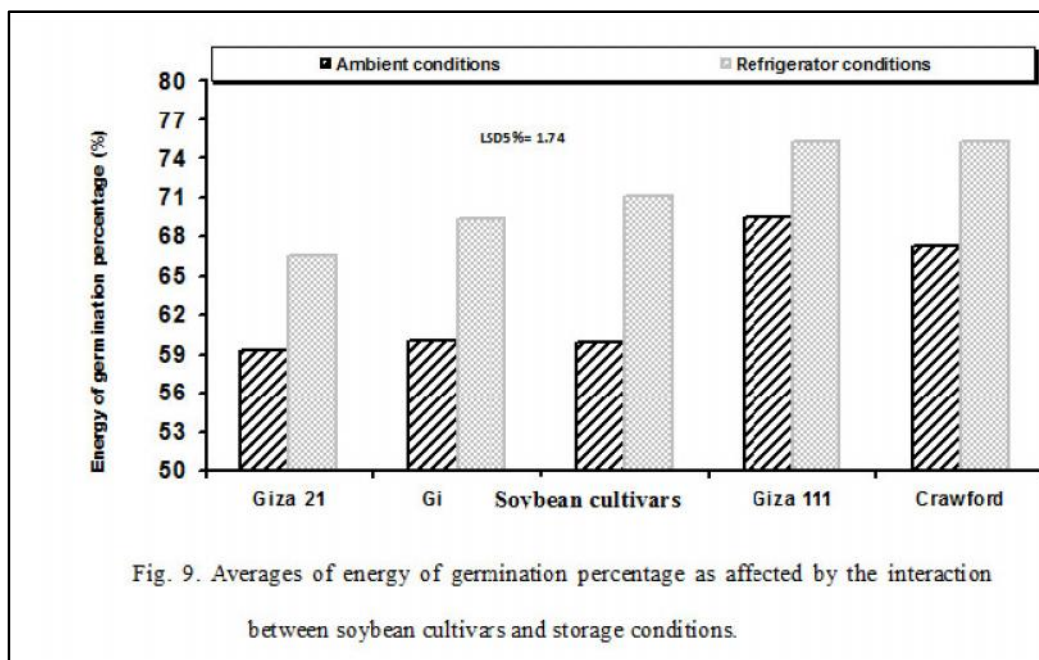


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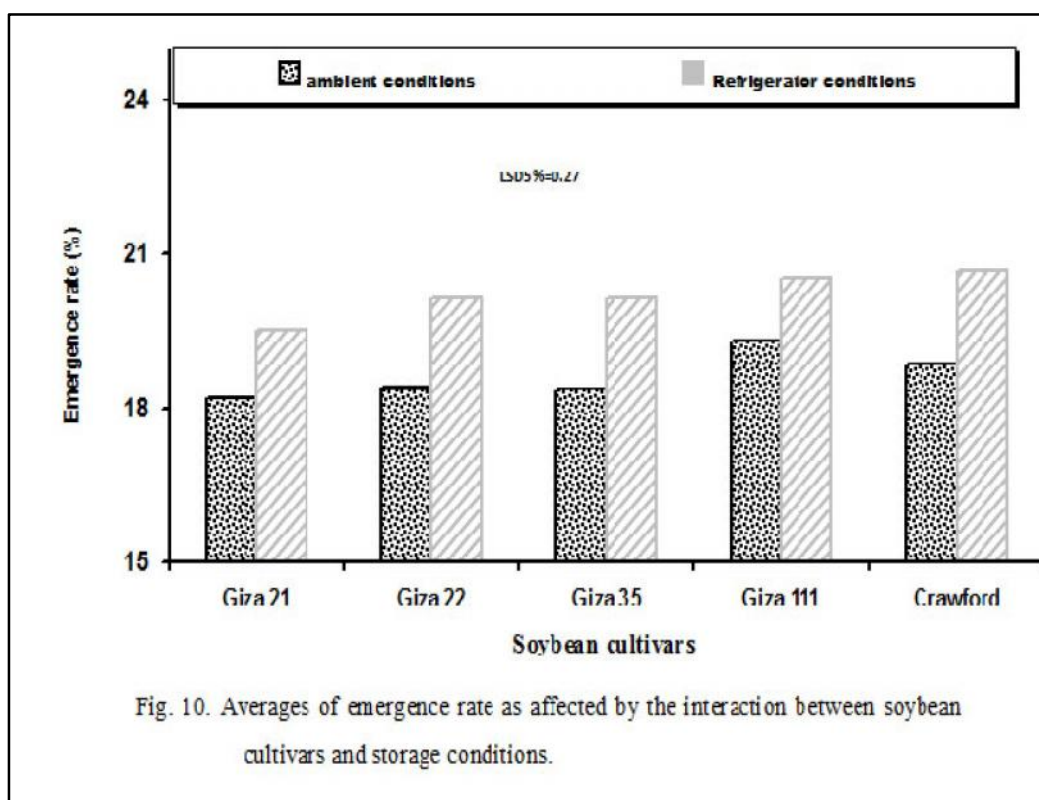
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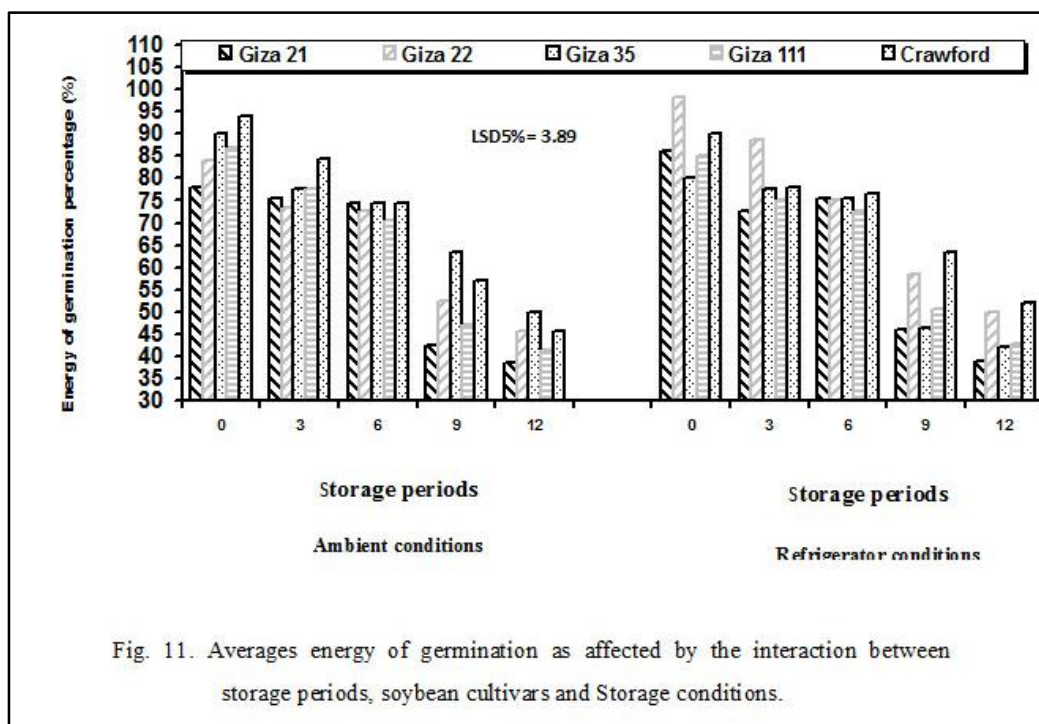
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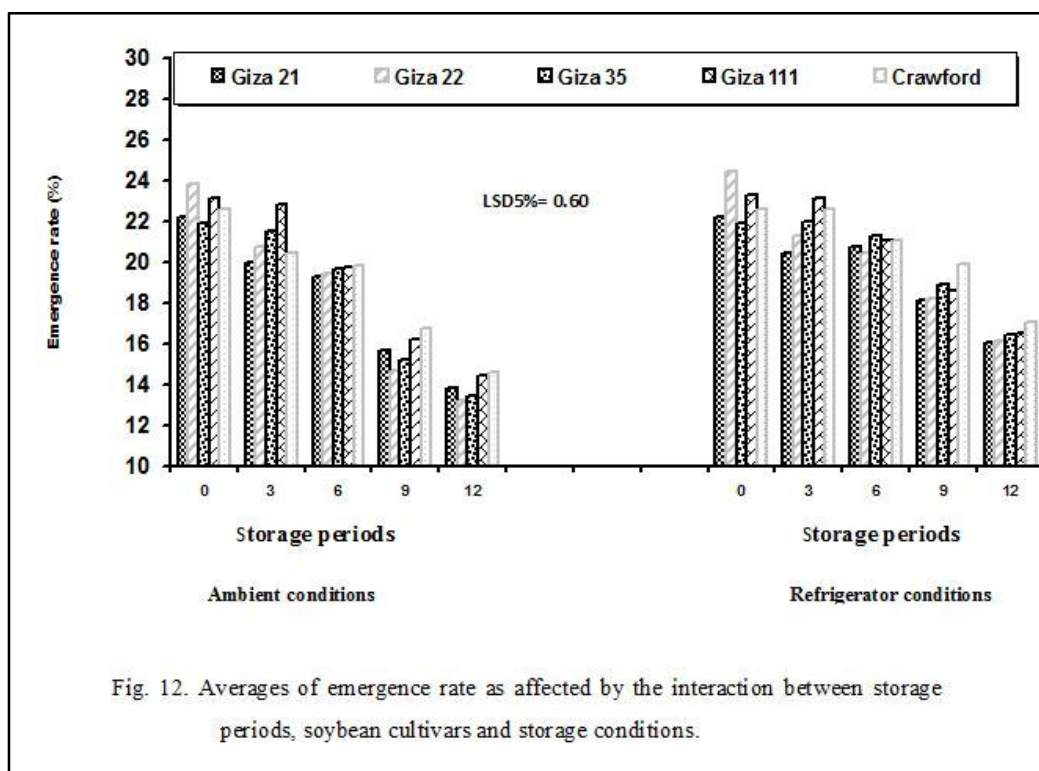
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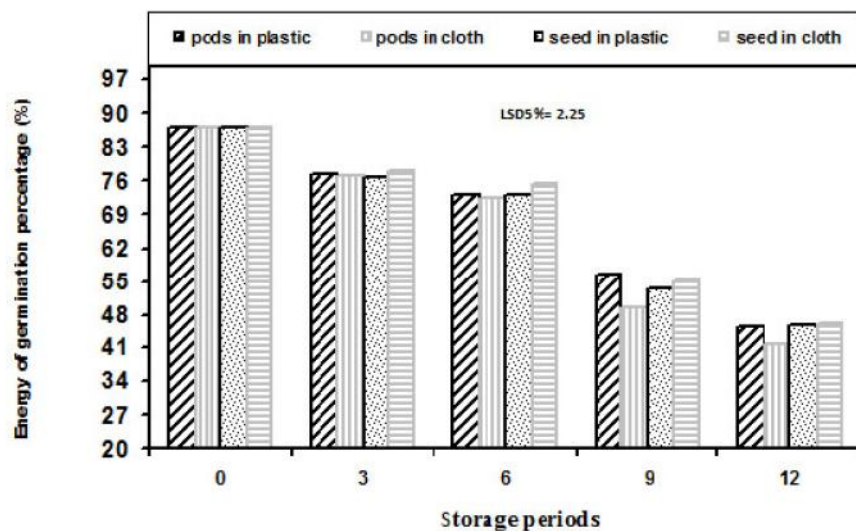


Fig. 13. Averages of energy of germination percentage as affected by the interaction between storage periods and package materials.

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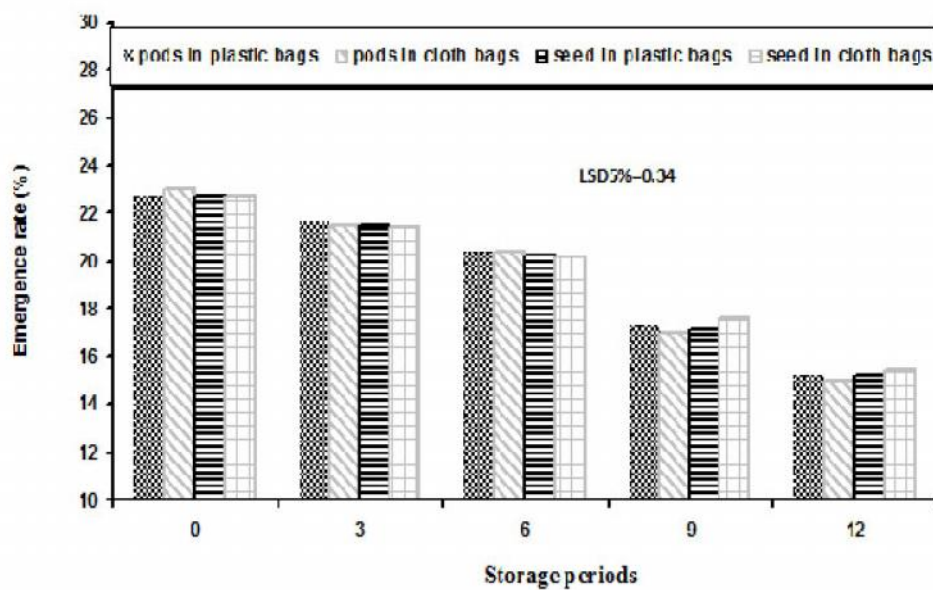
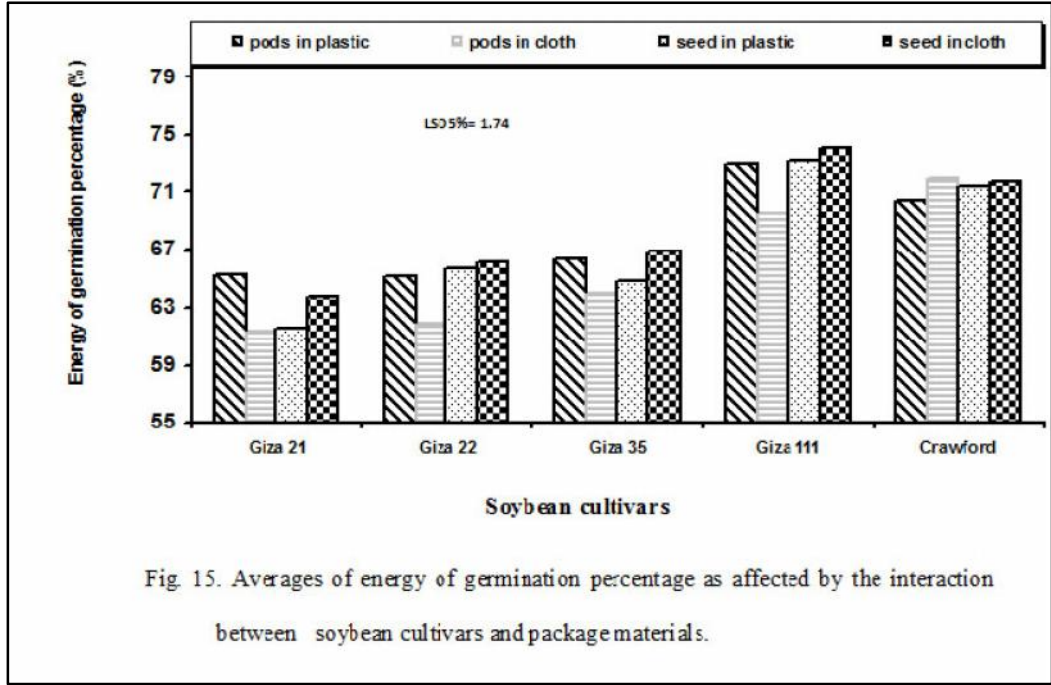


Fig. 14. Averages of emergence rate as affected by the interaction between storage periods and package materials.

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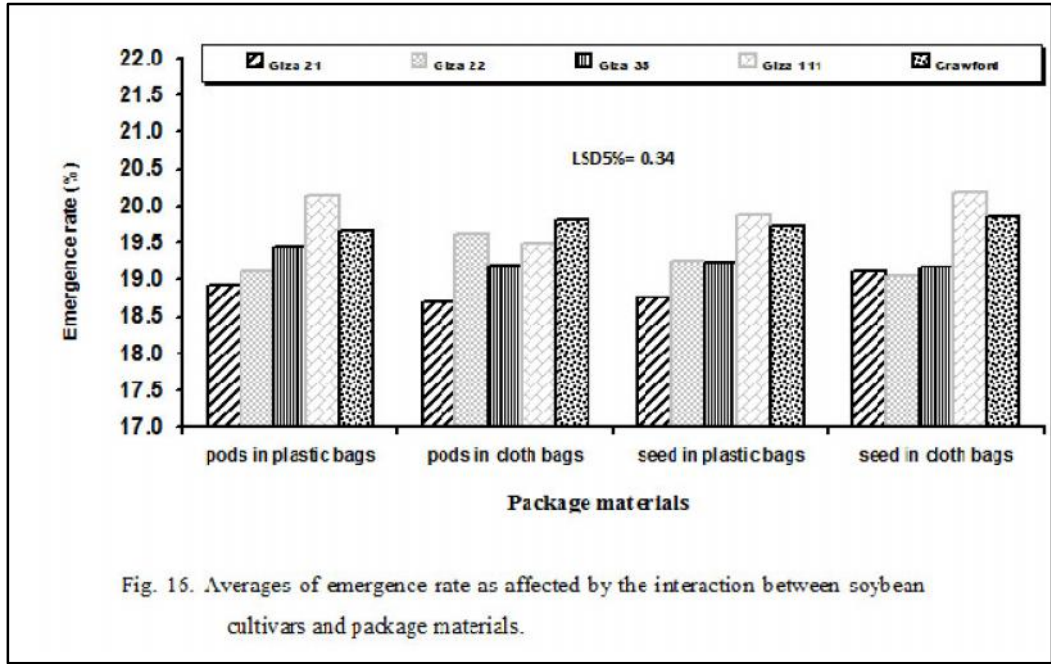
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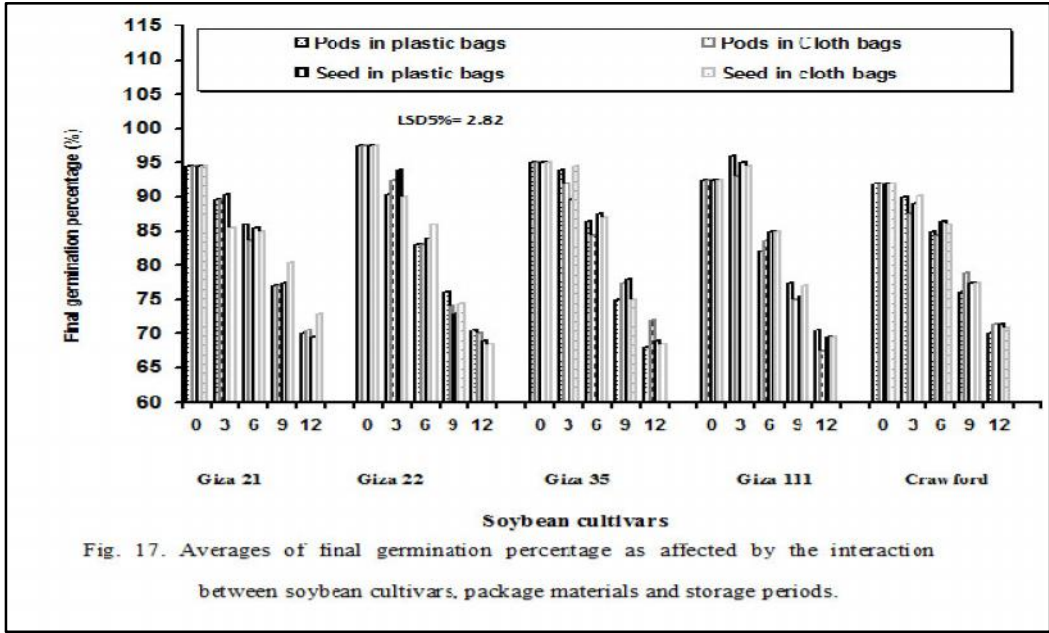
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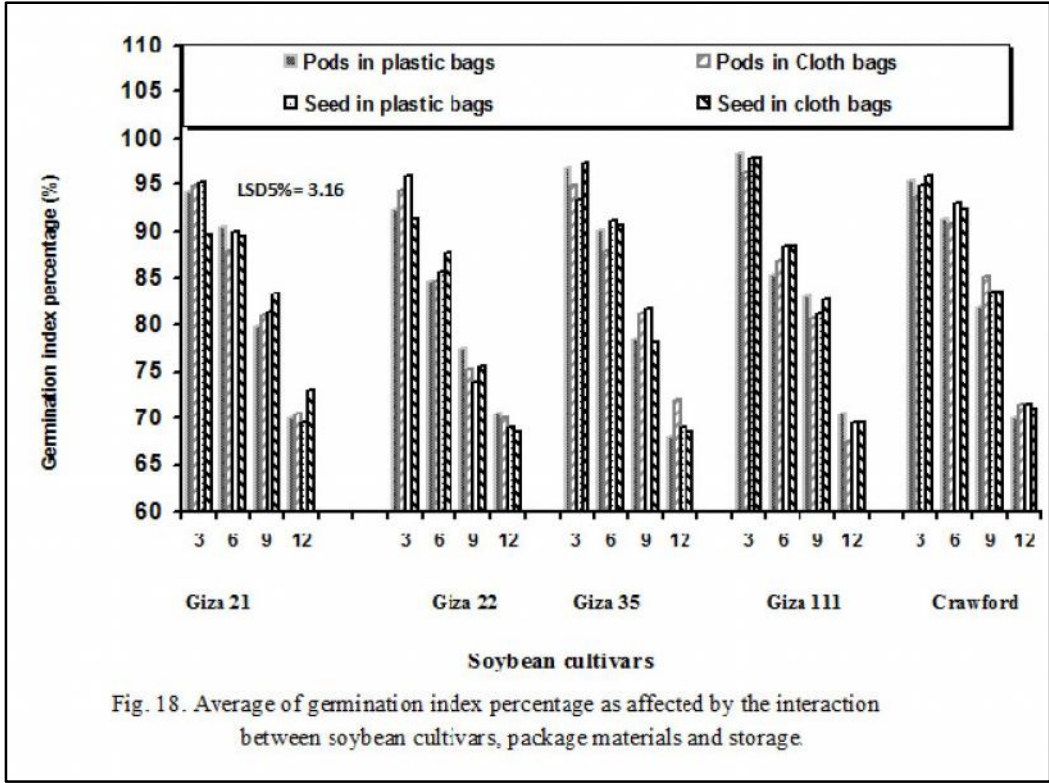
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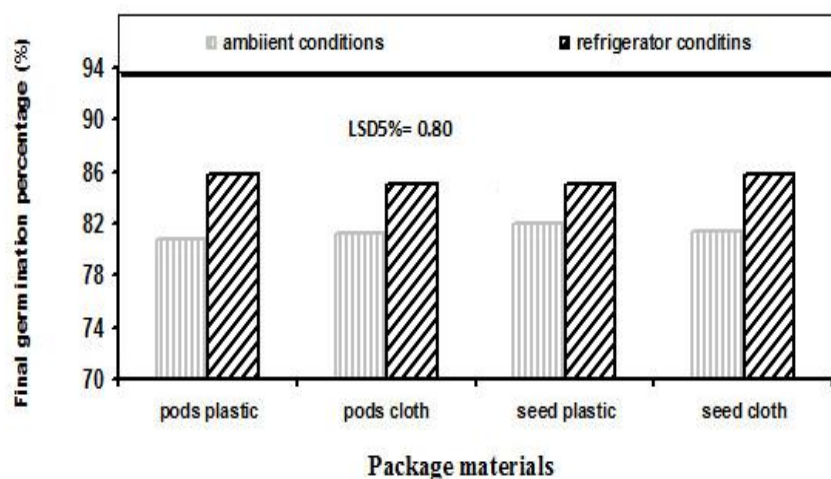


Fig. 19. Averages of final germination percentage as affected by the interaction between storage conditions and storage periods.

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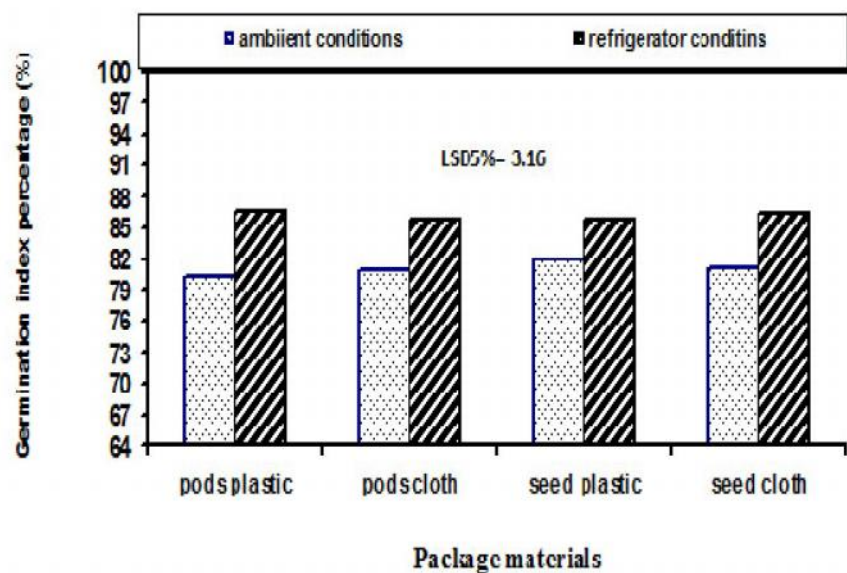
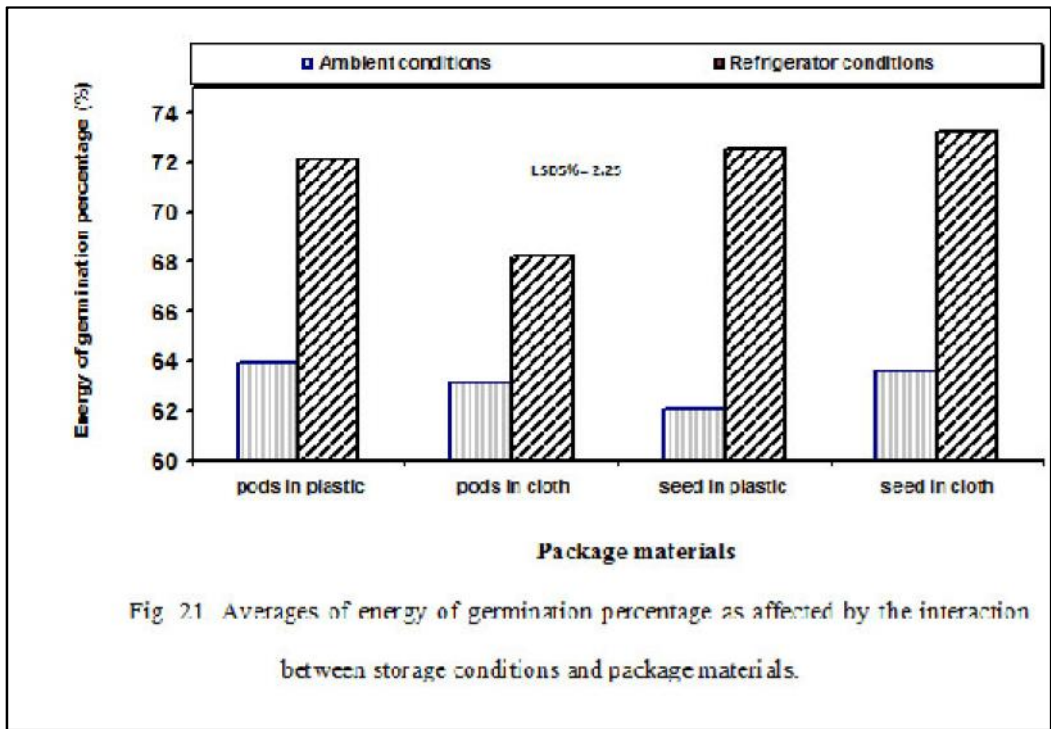


Fig. 20. Averages of germination index percentage as affected by the interaction between storage conditions and package materials.

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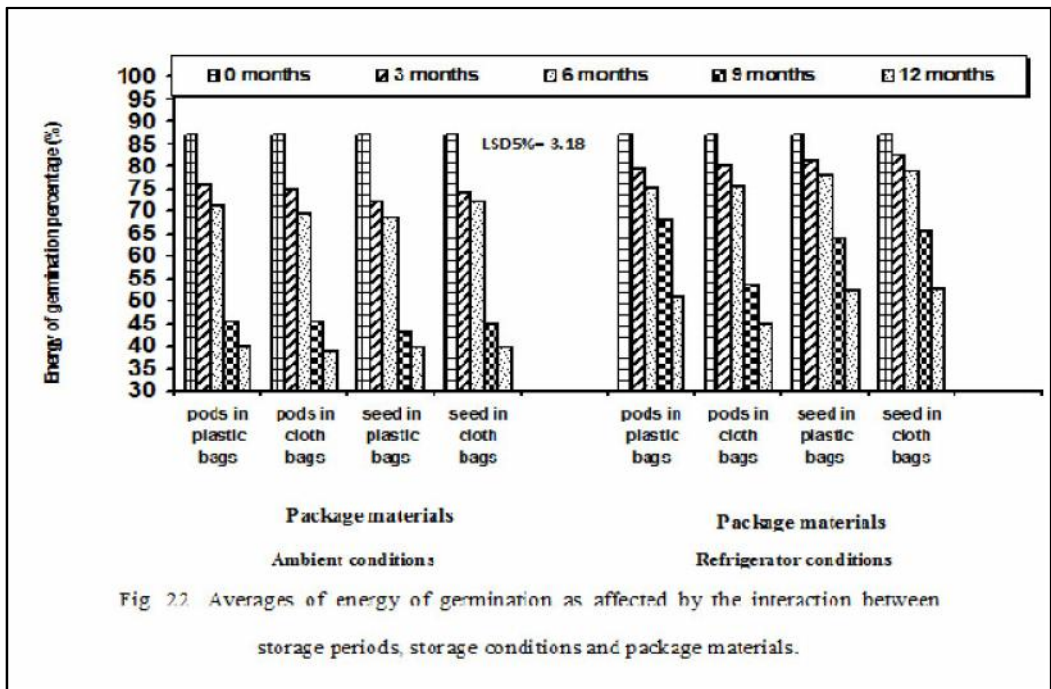
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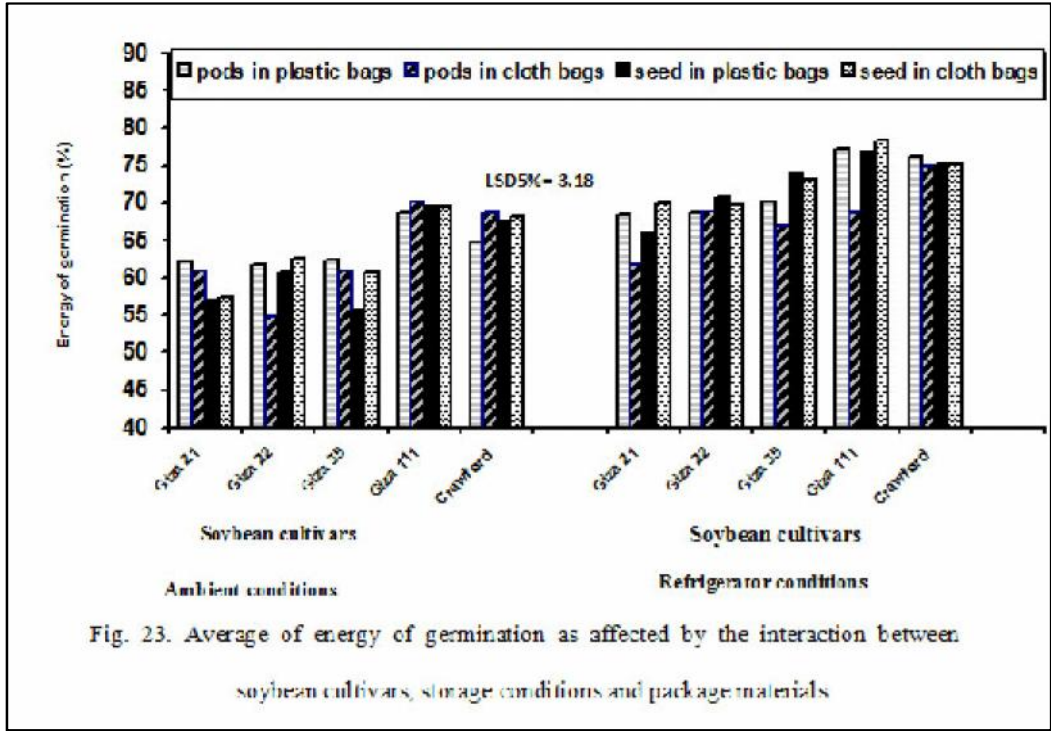


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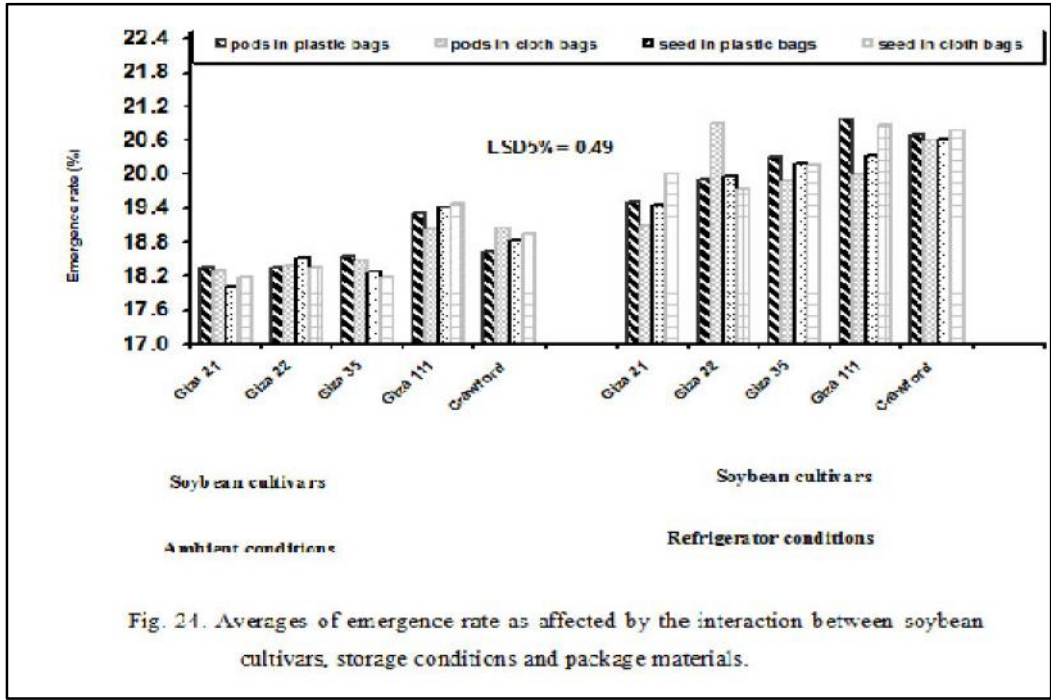
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