# CAUSES INFLUENCING SUNFLOWER (Helianthus annus) SEED QUALITY FROM HARVESTING TO SOWING

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## Summary

The effects of harvesting, conditioning, chemical treatments and storage on seed quality were studied in sunflower cultivars, hybrids and inbred lines.

It was found that during harvesting and conditioning 10-13% of seeds are damaged due to the mechanical impact, the most frequent lesion pattern being represented by seeds with cracked coat and seeds with partly missing coat. As compared to the intact seeds, the germination rate of the damaged seed was also reduced from 88-92% to 12-20%, in terms of the damaging level.

It was also observed that the decrease of both efficiency and proportion of intact seeds is proportional to the intensity of conditioning, i.e., the number of successive passages through the machines and the mesh size of the sieves, respectively.

Seed treatment with Fundazol had a positive effect on germination and emergence, particularly so when suboptimal conditions (low temperatures and soil infected with fungi) prevailed.

The trials with seeds stored in different types of bags, revealed that when plastic bags were used seed germination decreased significantly after 509 days of storage, but with paper and plastic cloth bags this only occurred after 896 days, whereas with jute bags it did not occur even after a storage period of 1,279 days.

## Introduction

Seed harvesting and postharvest conditioning in order to clean, disinfect and obtain as uniformly sized seeds as possible, may sometimes have adverse effects on the quality of the planting material and its storage quality.

This has been shown for seeds of Glycine max (L) Merril (Moore 1957; Stanway 1974; Stanway 1977) Trifolium subterraneum L (Flood, 1977), Triticum aestivum L. (Spreafico 1965).

Favorable and unfavorable seed storage conditions may also affect germination positively or adversely. Thus, for instance, excessive humidity brings about several processes in the mass of stored seeds, which eventually affect their germination and viability, a fact mentioned by Pustovoit (1961). Seeds can be stored for longer periods of time and under better conditions if they are first treated chemcially, a situation reported for instance for corn. (Smrz and Pitrik, 1976; Pana and Cseresnyes, 1976).

In order to improve the technologies of seed harvesting, conditioning and storage with a view to producing top quality planting material, studies were conducted, the results are being presented below.

## Materials and Methods

A. The studies on the way in which mechanical harvesting affects the integrity of sunflower seeds as well as their germination were conducted on three lots each of cultivar Record and the hybrid Romsun 53 harvested in 1975 and 1976. Representative samples of unconditioned seeds were taken from these lots; after determining the physical purity, the gravimetric proportion was established for the seeds with different types of mechanical injury. The following four types of injury were used in increasing order of their severity: seeds with cracked coat, seeds with missing portions of the coat, seeds with mission portions of the coat and kernel, and seeds with completely missing coats (coatless kernels). Further, by using the BP method (rolled towels) at $20^{o}$- $30^{o}$ C, germination was determined separately for the intact seeds and the four types of damaged seeds.

B. For the study of the effects arising from conditioning, use was made seeds of the same six lots mentioned above, which were conditioned simultaneously using two types of machines: SU-4 and MCS-5.

Conditioning included the following technological stages and quality classes of seeds.

- Unconditioned raw seed such as it resulted from harvesting.

- Precleaning. The raw seed was passed under an air current in machines equipped with sieves having rectangular slits of 3.00 mm, the fraction left on the sieve being the precleaned seed.

- Conditioning. The precleaned seed was again introduced in machines using three distinct sieve variants with slits of 3.50, 3.25 and 3.00 mm respectively. Two qualities resulted from each variant: the selected seed left on the sieve and so-called valuable offals which fell through the sieve.

- Reconditioning. Each one of the two seed qualities obtained in the previous step was then passed for the third time in the machines, the operation called reconditioning being carried out for each one, separately. The selected seed was reconditioned with three distinct sieve variants (3.50, 3.25 and 3.00 mm) and the valuable offals with the sieve variants of 3.25, 3.00 and 2.75 mm.

The product obtained in the first case is called reconditioned finished seed and in the second case seed reconditioned from offals. All the conditioning operations described above were carried out industrially with large quantities from the same lot of seeds. Representative samples were collected from each technological stage and quality class of the seeds, and the following

characteristics were determined in the laboratory: efficiency of conditioning, gravimetric percentage of intact and mechanically injured seeds (separately for the four types of injury mentioned under A), germination and percentage of abnormal seedlings. To check the adverse effects of seed injury in germination, the proportion of normal and abnormal seedlings was also determined for an additional number of 14 different samples.

C. For the evaluation of the effects of fungicidal treatments applied to the seeds, 25 different samples of sunflower seeds were used. Half of each sample remained untreated, while the other one was treated with Fundazol, (at 200g/100kg of seeds). Then, both treated and untreated samples were placed for germination simultaneously under the same standard conditions.

Germination under suboptimal conditions (cold-test) was also determined concommittently in 8 samples, using the following method: rollers of blotting paper with a soil and sand mixture (2:1) were kept for 13 days at 10°C and then for 2 days at 25°C.

D. The effects of long term seed storage was studied on real lots stocked and kept under production conditions, using seed of the cultivar Record harvested in 1973.

With a view to estimating the effects of both duration of storage and various packing materials, equal amounts from the same lot were stored in the following variants: unpacked seeds stored in bulk, seeds packed in jute bags, in plastic cloth bags, in plastic foil bags, and in paper bags. The initial germination and then its evolution over 7 successive storage stages were examined in each variant.

In order to find the storage stage at which germination begins to decrease, the differences were calculated between initial germination and germination during the successive stages. The significance level of these differences was determined according to the ISTA tolerances (Seed Science and Technology, 1976, Vol. 4, No. 1, Table 5C).

As regards the effects of storage, studies were also made on the adverse influence of the sprouting processes occurring when the seeds with too high humidity levels are stored for short time periods. Actually, this was an attempt to determine the time interval (in hours) elapsing from the onset of the sprouting process in a mass of moist seeds to the moment of their drying (by winnowing or other procedures) without the germinating ability of the seeds being significantly affected.

To this end the seeds were germinated on wet blotting paper, then the sprouting process was arrested and the seeds dried. After drying, the seeds were again germinated normally and the results obtained were compared to the germination of the control sample not subjected to simulated self-warming. The experiment was carried out on 6 lots of sunflower belonging to 2 cultivars, 1 hybrid and 3 inbred lines.

## Results

### A. Effects of Harvesting.

Table 1 shows the percent rate of intact and injured Record and Romsun 53, seeds obtained after combine-harvesting. It appears that harvesting can greatly effect the integrity of seeds, this resulting in a high proportion of seeds with various types of injury.

It is worth mentioning that, on the one hand, the percentage of injured seeds is much more constant from lot to lot in Romsun 53 and on the other one that the percentage of injured seeds is on the whole higher in cultivar Record in the lots examined.

As regards the frequency of the various types of injured seeds it should be noticed that the seeds with cracked coat and missing portions of coat rank first, and that those with missing portions of both coat and kernel are the last. The injured seed adversely affects the quality of the planting material both directly, by reducing the purity index, and indirectly, by affecting germination, as seen in the next table.

Table 2 shows the germination of intact seeds and separately of seeds with various types of injury. It should be noted that the injuries caused by combine - threshing greatly reduce germinating ability, beginning even with the slightest injuries represented by the mere cracking of the seed coat. Germination is very strongly affected in the seeds with missing portions of their coat and kernel, and in those that lost the whole coat during threshing (coatless kernels), in which germination represents but 17-23 percent. It should be mentioned that both the coatless kernels and the seeds with missing portions of the coat and kernel are included in the pure seed category and thus their poor germination affects negatively the proportion of useful seed obtained.

Anyway it should be emphasized that the harvesting methods and equipment can impair the integrity of the seeds and reduce the germination to an unacceptably great extent.

### B. Effects of Conditioning

Table 3 shows the percentage of intact and injured sunflower seeds found in the pure seed obtained in the various stages of the conditioning process carried out by 2 different machines.

Both the total proportion of injured seeds and its distribution by injury types are given for each conditioning stage.

The data presented show that after the conditioning operation, seed integrity is at least as strongly affected as after combine - harvesting.

The percentage of injured seeds found in the pure seed after conditioning averages 10.7, ranging from 9.2 to 14.7 for the different stages and intensities of conditioning. In connection with this aspect, it should be noticed that no difference was found between the two conditioning machines tested either on the whole, or for any one of the stages of the conditioning process. As re-

gards the proportion in which the various types of injured seeds occur, it should be noticed that in the precleaned, selected, and finished reconditioned seeds those with cracked coat prevail, whereas in seeds reconditioned from offal material, the type of coatless kernels is the most frequent.

The data in Table 3 only show the proportion of injured seeds remaining in the pure seed after conditioning, but they do not record the proportion of injured seeds that were actually removed as a result of the conditioning process. For this reason, the values in Table 3 do not differ greatly from those in Table 1. However, conditioning has two effects that take place simultaneously: on the one it removes part of the injured and broken seeds, and on the other one it injures a rather high percentage of seeds as a result of their passing through the machines and sieves. Thus, in the pure seed and, consequently, in Table 3 only the proportion of injured seeds resulting from the 2 parallel effects of conditioning could be given.

In order to understand to what extent the integrity of the seeds is actually affected by the conditioning operation, both the conditioning efficiency and the part of seeds removed by the machines as offals is to be taken into account. This aspect is presented in Table 4 where the progressive reduction of the proportion of intact seeds as a result of the conditioning process is shown, taking as a basis for calculation (100 percent) the percentage of intact seeds present in the material produced by the combines.

It was noticed that the passing through the machines and sieves reduces heavily the proportion of intact seeds and the more so as the conditioning is more intense, i.e., as the number of passages through the machines grows and depending on the size of the sieve slits.

It is worth mentioning that the same conclusion was drawn in connection with thrashing.

The data in Table 5 show the extent to which germination was affected in the several types of injured seeds resulting from conditioning.

Since germination was affected to practically the same extent in Record and Romsun, the results are presented as an average for both varieties.

As it is seen, injury to conditioned seeds affects germination to the same extent as in the case of threshing, both in general, and for each particular type of damage. Germination losses are very high and start from the slightest injuries, i.e., from a mere crack in the seed coat which reduces the germination by up to 21 percent. As in the case of threshing, germination is affected most seriously in those seeds which have lost portions of the coat and kernel, and in those which have lost all the seed coat (coatless kernels). It should be noted that in any injury type, germination was the more severely affected as the conditioning was more intense in terms of the number of passages through machinery and the sieve slits size. Thus, for instance, at the injury type "cracked-coat", germination drops from 76 percent in the selected seed to 72 percent in the reconditioned finished seed, and to 70 percent in the seed reconditioned from offals. In the "coatless kernels" type, it drops from 26 to 23 and 16 percent, respectively. Also in any injury type from any class of

conditioned seed, the germination loss was generally the higher as the sieves used had smaller slits.

Table 6 gives details about the adverse effects of seed injury on germination and presents comparative results concerning the germination and the percentage of abnormal seedlings in intact seeds, in seeds with cracked coats, and in seeds with missing portions of coat and kernel, separated from 14 sunflower samples. It appears that germination decreases and the proportion of abnormal seedlings increases in the injured seeds as compared to the intact ones and the more markedly so where the type of injury is more severe.

C. Effects of Chemical Seed Treatments.

Table 7 presents the effects on the germination of sunflower seeds receiving Fundazol treatments.

Thus the values of the germination obtained were practically identical in the treated and untreated seeds.

This shows that the tested chemical has no adverse effects on the seedlings as such, and that therefore it can have a favorable effect at emergence in the field if the seedlings are attacked by certain soil fungi. The latter aspect is proved by the cold-test results obtained simultaneously in soil infested with fungi and at low temperatures, which are favorable to the fungi but retard the growth of the seedlings. As it results from Table 8, the cold-test analyses yielded, on the whole, markedly better results for Fundazol-treated seeds than for untreated ones.

These results show that the treated seeds were almost immune to the fungal attack, while in the untreated ones the germination decreased by about 7 percent.

D. Effects of Seed Storage.

Table 9 presents the evolution of germination in seeds kept in 5 storage variants over 7 storage periods.

Thus, the seeds retained their original germination for practically one year (350 days), irrespective of the storage method and the packing material used. After one year, germination began to drop significantly, though in a differentiated way, depending on the packing material.

The first to show quality losses were the seeds kept in plastic foil bags; their germination began to drop significantly after 509 days of storage. Follow in decreasing order the bulk storage (germination decreased after 896 days) and storage in paper and plastic - cloth bags (germination began to drop after 1,279 days). The only variant in which germination did not decrease significantly by the end of the experiment (although it was very close to the limit of significance) is that of the storage in jute bags.

The results show that sunflower seeds, when stored under optimal conditions, retain unaltered their original germination for three years if kept in jute, paper or plastic-cloth bags. Storage in plastic-foil bags is totally unadvisable, and the bulk storage should be adopted only for shorter time periods.

Table 10 gives the results of an experiment simulating the sprouting process.

It can be seen that all the samples resisted, with no alteration of their germination, for six hours after the onset of the process, but that in no sample was germination satisfactory if the process lasted for 24 hours or more. There are marked differences among the samples for an intermediate period of 18 hours. Cultivar VNIIMK and line LC 2 showed a remarkable resistance, retaining a germination of 85%, whereas in all other cultivars and lines, there was a breakdown of germination.

## Conclusion

The following conclusions can be drawn:

1. Combine-harvesting greatly affects the integrity of sunflower seeds, resulting in a high proportion of seeds with various types of injuring. As regards the frequency of the four types of injured seeds, the seeds with cracked coat and missing portions of coat rank first, while the seeds with missing portions of both coat and kernel rank last.

2. All types of injured seeds resulting from combine-harvesting reduce greatly the germination ability.

The germination is especially affected in the seeds with missing portions of the coat and kernel and in those with completely missing coats (coatless kernels), in which the germination represents only 17-23 percent.

3. After the conditioning operation, the integrity of the seeds is at least as strongly affected as after combine-harvesting.

In this respect, no difference was found between the two conditioning machines, in any one of the stages of the conditioning process.

Of the four types of injured seeds, those with cracked coat are prevalent among the precleaned, selected and finished reconditioned seeds, whereas among the seeds reconditioned from offals the most frequent is the coatless kernel type.

4. The passage through the machines and sieves reduces severely the proportion of intact seeds, the more so as conditioning is more intense, i.e., as the number of passages through the machines increases and depending on the sieve-slits size. In the cultivar Record, the proportion of intact seeds is always smaller than in Romsun for any one of the stages of the conditioning process. It should also be noticed that injuries in Record seeds are far more serious when conditioning is done with the MCS-5 machine.

5. Injury to conditioned seeds affects germination to the same extent as in the case of threshing, both, in general and for each particular type of injuries. In any of the injury types, germination was the more strongly affected as conditioning was more intense, in terms of the number of passages through the machinery and the sieve-slit size.

6. The tested chemical (Fundazol) has no adverse effects on the seedling as such, and it can therefore have a favorable effect at sprouting in the field if the seedling are attacked by certain soil fungi. The latter aspect is proved by the cold-test results.

7. The germination of sunflower seeds began to drop significantly after a one year storage, though in a differentiated way, depending on the packing material. The first to show quality losses were the seeds kept in plastic-foil bags; their germination began to drop significantly after 509 days of storage, followed in order by bulk storage (germination decreased after 896 days) and storage in paper and plastic-cloth bags (1,279 days).

The only variant in which germination did not decrease significantly by the end of the experiment is that of the storage in jute bags.

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TABLE 1. Sunflower Seed Integrity as Affected by Combine-Harvesting (% of Pure Seed)

| Specification | Lot No. | Intact Seeds | Injured Seeds of Which With: Total | Cracked Coat | Missing Portions of Coat | Missing Portions of Coat and Kernel | Coatless Kernels |
|---|---|---|---|---|---|---|---|
| Record | 350 | 78.14 | 21.86 | 11.27 | 8.73 | 1.08 | 0.78 |
| Record | 432 | 89.50 | 10.50 | 5.30 | 3.60 | 0.60 | 1.00 |
| Record | 478 | 93.90 | 6.10 | 2.00 | 2.60 | 0.30 | 1.20 |
| Record average: | | 87.18 | 12.82 | 6.19 | 4.98 | 0.66 | 0.99 |
| Romsun 53 | 604 | 88.00 | 12.00 | 7.80 | 1.60 | 0.40 | 2.20 |
| Romsun 53 | 615 | 89.40 | 10.60 | 3.90 | 2.80 | 0.80 | 3.10 |
| Romsun 53 | 618 | 91.40 | 8.60 | 3.00 | 2.00 | 0.70 | 2.90 |
| Romsun average: | | 89.60 | 10.40 | 4.90 | 2.13 | 0.63 | 2.74 |
| General average: | | 88.39 | 11.61 | 5.55 | 3.55 | 0.65 | 1.86 |

TABLE 2. Reduction of Germination in the Seeds Category, Injured During Combine-Harvesting

| Specification | Lot No. | Germination Percent | | | | |
|---|---|---|---|---|---|---|
| | | Intact Seeds | Seeds with Cracked Coat | Seeds with Missing Portions of Coat | Seeds with Missing Portions of Coat and Kernel | Coatless Kernels |
| Record | 350/1975 | 86 | 94 | 68 | 26 | 24 |
| Record | 432/1976 | 92 | 80 | 48 | 8 | 8 |
| Record | 478/1978 | 92 | 72 | 68 | 16 | 24 |
| Record average: | | 90 | 82 | 61 | 17 | 19 |
| Romsun 53 | 604/1976 | 84 | 76 | 72 | 16 | 36 |
| Romsun 53 | 615/1976 | 84 | 64 | 48 | 16 | 8 |
| Romsun 53 | 618/1976 | 92 | 60 | 88 | 36 | 24 |
| Romsun average: | | 87 | 67 | 69 | 23 | 23 |
| General average: | | 88 | 74 | 65 | 20 | 21 |

TABLE 3. Sunflower Seed Integrity as Affected by Conditioning with Two Types of Machine (Percent of Pure Seed)

| Stage of Conditioning | Number of Passages Through Machines | Type of Machine | Intact Seeds | Total | Injured Seeds of Which With: Cracked Coat | Missing Portions of Coat | Missing Portions of Coat and Kernel | Coatless Kernels |
|---|---|---|---|---|---|---|---|---|
| Precleaned Seeds | 1 | SU-4 | 89.9 | 10.1 | 5.0 | 3.2 | 0.6 | 1.3 |
| Precleaned Seeds | 1 | MCS-5 | 90.1 | 9.9 | 4.8 | 3.2 | 0.4 | 1.5 |
| Selected Seeds | 2 | SU-4 | 90.7 | 9.3 | 5.2 | 3.0 | 0.4 | 0.8 |
| Selected Seeds | 2 | MCS-5 | 90.7 | 9.3 | 5.4 | 2.8 | 0.3 | 0.8 |
| Finished Reconditioned Seeds | 3 | SU-4 | 90.8 | 9.2 | 5.3 | 2.9 | 0.4 | 0.6 |
| Finished Reconditioned Seeds | 3 | MCS-5 | 90.6 | 9.4 | 5.5 | 2.9 | 0.2 | 0.8 |
| Seeds Reconditioned from Offals | 3 | SU-4 | 86.2 | 13.8 | 4.3 | 3.8 | 0.6 | 5.1 |
| Seeds Reconditioned from Offals | 3 | MCS-5 | 85.3 | 14.7 | 4.2 | 4.0 | 0.6 | 5.9 |
| Average: | | SU-4 | 89.39 | 10.61 | 4.97 | 3.22 | 0.47 | 1.95 |
| | | MCS-5 | 89.18 | 10.82 | 4.97 | 3.22 | 0.38 | 2.25 |

TABLE 4. Reduction of the Proportion of Intact Seeds in Relation to Intensity of Conditioning

| Class of Seeds | Number of Passages Through Machine | Sieve Slits (mm) | Percent of Intact Seeds | |
|---|---|---|---|---|
| | | | Record | Romsun |
| Rough Material from Combine | 0 | - | 100.00 | 100.00 |
| A. SU-4 MACHINE | | | | |
| Precleaned Seeds | 1 | 3.00 | 84.15 | 90.25 |
| Selected Seeds | 2 | 3.50 | 40.46 | 70.86 |
| Selected Seeds | 2 | 3.25 | 50.64 | 79.09 |
| Selected Seeds | 2 | 3.00 | 72.09 | 84.04 |
| Finished Recond. Seeds | 3 | 3.50 | 33.06 | 65.87 |
| Finished Recond. Seeds | 3 | 3.25 | 43.59 | 74.53 |
| Finished Recond. Seeds | 3 | 3.00 | 63.08 | 80.69 |
| Seeds Recond. from Offals | 3 | 3.25 | 26.90 | 12.16 |
| Seeds Recond. from Offals | 3 | 3.00 | 20.40 | 7.63 |
| Seeds Recond. from Offals | 3 | 2.75 | 5.32 | 3.02 |
| B. MCS-5 MACHINE | | | | |
| Precleaned Seeds | 1 | 3.00 | 70.51 | 84.76 |
| Selected Seeds | 2 | 3.50 | 37.06 | 73.40 |
| Selected Seeds | 2 | 3.25 | 48.58 | 77.44 |
| Selected Seeds | 2 | 3.00 | 56.83 | 80.55 |
| Finished Recond. Seeds | 3 | 3.50 | 30.66 | 69.46 |
| Finished Recond. Seeds | 3 | 3.25 | 44.46 | 72.56 |
| Finished Recond. Seeds | 3 | 3.00 | 50.67 | 75.60 |
| Seeds Recond. from Offals | 3 | 3.25 | 17.96 | 6.38 |
| Seeds Recond. from Offals | 3 | 3.00 | 13.67 | 3.85 |

TABLE 5. Reduction of Germination in Relation to the Injury Degree of the Seeds During the Conditioning Process.

| | Class of Conditioned Seeds | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Selected Seed | | | | Finished Reconditioned Seed | | | | Seeds Reconditioned From Offals | | | |
| Sieve-Slits (mm): | 3.50 | 3.25 | 3.00 | Avg. | 3.50 | 3.25 | 3.00 | Avg. | 3.50 | 3.25 | 3.00 | Avg. |
| Category of Seeds | | | | | | | | | | | | |
| Intact Seeds | 92 | 92 | 91 | 91 | 92 | 92 | 92 | 92 | 93 | 90 | 90 | 91 |
| Seeds with Cracked Coat | 77 | 77 | 74 | 76 | 74 | 73 | 69 | 72 | 72 | 69 | 68 | 70 |
| Seeds with Missing Portions of Coat | 65 | 69 | 61 | 65 | 72 | 64 | 62 | 66 | 65 | 62 | 57 | 61 |
| Seeds with Missing Portions of Coat and Kernel | 22 | 13 | 12 | 16 | 19 | 16 | 13 | 16 | 17 | 14 | 5 | 12 |
| Coatless Kernel | 30 | 32 | 16 | 26 | 22 | 24 | 23 | 23 | 22 | 15 | 12 | 16 |
| Average: | 57 | 56 | 51 | 55 | 56 | 54 | 52 | 54 | 54 | 50 | 46 | 50 |

TABLE 6. Effects of Sunflower Seed Injuries on Germination (Percent of Normal and Abnormal Seedlings)

| Number Of Sample | Categories of Injury | | | | | |
|---|---|---|---|---|---|---|
| | Intact Seeds | | Seeds With Cracked Seed Coat | | Seeds With Missing Portions of Coat and Kernel | |
| | Normal | Abnormal | Normal | Abnormal | Normal | Abnormal |
| 793 | 90 | 2 | 67 | 8 | 47 | 10 |
| 794 | 90 | 4 | 68 | 6 | 50 | 8 |
| 775 | 86 | 2 | 68 | 6 | 54 | 8 |
| 929 | 82 | 4 | 56 | 10 | 46 | 12 |
| 880 | 92 | 4 | 90 | 4 | 82 | 6 |
| 930 | 90 | 2 | 68 | 6 | 50 | 16 |
| 49 | 91 | 4 | 64 | 14 | 46 | 15 |
| 50 | 90 | 3 | 69 | 8 | 50 | 17 |
| 51 | 94 | 3 | 75 | 8 | 45 | 11 |
| 52 | 96 | 2 | 69 | 15 | 41 | 13 |
| 499 | 87 | 7 | 70 | 12 | 27 | 26 |
| 500 | 89 | 3 | 70 | 12 | 47 | 23 |
| 667 | 74 | 7 | 40 | 23 | 15 | 25 |
| 687 | 92 | 6 | 70 | 20 | 43 | 23 |
| Average: | 88.8 | 3.8 | 67.4 | 11.1 | 45.2 | 15.2 |
| Percent of Abnormal Seedlings out of Total Seedlings | | 4.1 | | 14.1 | | 25.1 |

TABLE 7. Effects of Fundazol Treatment on Germination of Sunflower Seeds.

| Sample Number | Cultivar, Hybrid | Germination Percent | | |
|---|---|---|---|---|
| | | Untreated Seeds | Treated Seeds | Difference Percent |
| 799 | HD-53 | 91 | 89 | - 2 |
| 800 | HD-53 | 86 | 96 | 10 |
| 801 | HD-53 | 85 | 85 | 0 |
| 802 | HD-53 | 88 | 92 | 4 |
| 803 | HD-53 | 80 | 82 | 2 |
| 804 | HD-53 | 90 | 90 | 0 |
| 805 | HD-53 | 91 | 96 | 5 |
| 806 | Record | 87 | 90 | 3 |
| 807 | Record | 87 | 90 | 3 |
| 808 | Record | 81 | 89 | 8 |
| 809 | Record | 88 | 94 | 6 |
| 810 | Record | 86 | 87 | 1 |
| 811 | Record | 89 | 86 | - 3 |
| 812 | Record | 80 | 92 | 2 |
| 813 | Record | 71 | 87 | 16 |
| 835 | HS-53 | 89 | 90 | 1 |
| 836 | HS-53 | 94 | 95 | 1 |
| 837 | Record | 95 | 96 | 1 |
| 838 | Record | 85 | 85 | 0 |
| 839 | Record | 93 | 93 | 0 |
| 840 | Record | 86 | 89 | 3 |
| 841 | HS-53 | 95 | 96 | 1 |
| 967 | Record | 92 | 94 | 2 |
| 929 | Romsun-53 | 92 | 94 | 2 |
| Average: | | 87.4 | 90.0 | 2.6 |

TABLE 8. Effects of Fundazol Treatment on Sunflower Seed Germination Under Optimal and Suboptimal Conditions (Cold-Test)

| Sample Number | Germination Percent | | Cold-Test Percent | |
|---|---|---|---|---|
| | Untreated Seeds | Treated Seeds | Untreated Seeds | Treated Seeds |
| 94 | 60 | 58 | 41 | 57 |
| 97 | 75 | 82 | 53 | 81 |
| 801 | 85 | 84 | 81 | 81 |
| 802 | 96 | 94 | 85 | 89 |
| 803 | 83 | 79 | 67 | 79 |
| 804 | 87 | 88 | 89 | 87 |
| 809 | 90 | 88 | 85 | 86 |
| 836 | 92 | 92 | 94 | 93 |
| Average: | 83.5 | 83.1 | 74.4 | 81.6 |

TABLE 9. Effects of Storage on the Sunflower Seeds Germination.

| Number of Days | Packing Material | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Bulk | | Jute Bags | | Plastic Cloth Bags | | Plastic Foil Bags | | Paper Bags | |
| | Ger. | Dif. | Ger. | Dif. | Ger. | Dif. | Ger. | Dif. | Ger. | Dif. |
| 0 | 95 | - | 95 | - | 95 | - | 95 | - | 96 | - |
| 78 | 93 | 2 | 96 | 1 | 93 | 2 | 95 | 0 | 96 | 0 |
| 175 | 94 | 1 | 95 | 0 | 95 | 0 | 88 | 7* | 92 | 4 |
| 350 | 95 | 0 | 95 | 0 | 95 | 0 | 94 | 1 | 94 | 2 |
| 509 | 92 | 3 | 92 | 3 | 93 | 2 | 91 | 4* | 93 | 3 |
| 695 | 94 | 1 | 95 | 0 | 93 | 2 | 73 | 22* | 94 | 2 |
| 896 | 90 | 5* | 93 | 2 | 93 | 2 | 60 | 35* | 94 | 2 |
| 1279 | 91 | 4* | 92 | 3 | 90 | 5* | 48 | 47* | 91 | 5* |

Ger. = Germination Percent
Dif. = Difference Percent

* = Significance P = 2.5%

TABLE 10. Results of Experiment Simulating the Process of Seed Sprouting.

| Number of Sample | Cultivar, Hybrid or Line | Number of Hours From Start of Sprouting to Drying | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 6 | 18 | 24 | 40 | 48 |
| 179 | Record | 91 | 96 | 32 | 8 | 4 | 1 |
| 114 | VNIIMK | 96 | 98 | 85 | 50 | 2 | 1 |
| 180 | HS-52 | 93 | 96 | 53 | 11 | 0 | 0 |
| 181 | LC-1 | 97 | 94 | 44 | 15 | 2 | 3 |
| 182 | LC-2 | 90 | 94 | 85 | 34 | 0 | 1 |
| 183 | LC-3 | 99 | 98 | 55 | 11 | 0 | 1 |
| Average: | | 94 | 94 | 59 | 22 | 1 | 1 |

## List of Tables