STUDY OF SUNFLOWER "SEED" DORMANCY (1)

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Summary

Sunflower, as an oil seed , shows fast deterioration, requiring specific storage conditions. In addition, sunflower crop usually produces dormant "seeds", therefore requiring special conditions for germination. This paper reports a study on dormant sunflower "seeds" with respect to some germination and storage conditions.

Various treatments were applied on a stock of sunflower "seeds": a) germination under different temperatures and light regimes; b) intermittent rinsing during different periods of time; c) scarification with concentrated sulfuric acid during different periods of time; d) "seed" storage and conservation.

The best results were obtained with the germination at 35°C and with "seed" rinsing in running water for at least 15 h; the "seed" conservation at 10°C induced a dormancy release of about 50% after 20 days. At 15°C or 20°C, that value was reached only after more than 2 mounths of storage.

Introduction

Germination is a distinct quality of seeds. So, a living seed may not germinate when placed in conditions optimum for germination. It can be incapable to germinate due to some inherent deficiency or condition in which germination is temporarily suspended by some internal control mechanism (Neme, 1963) which is called dormancy.

The seed coat may have an important role in dormancy due to its hardness or resistance to water imbibition, gas exchange or embryo expansion (Neme, 1963; Mattos, 1970; Almeida et al, 1972). The seed coat may also act by blocking the removal of inhibitors from the cotyledons and from the embryonic axis (Sreeramula, 1968; Rao et al, 1972). Inhibitors may be present in the tegument itself (Bonner and Galston, 1952; Khan, 1977). In these cases, when the tegument is a barrier, release of the dormant condition may be obtained either by scarification or just by rinsing the tegument in water to remove germination inhibitors.

The embryo itself could also be responsible for dormancy of the seed due to its physical or physiological immaturity. In these cases, release of dormancy is obtained by storing the seed for some time after harvest (Rogler, 1960;Villiers, 1972). Sometimes the seeds are just hight sensitive, or they require preservation at a special temperature for a prompt germination (Sharir, 1978).

In research work dealing with sunflower, there is sometimes the need to plant the "seeds" immediately after harvest. Since fresh-harvested sunflower "seeds" are often dormant, there appears frequently the immediate need to break this dormancy rapidly. In 1984, a "seed" lot of sunflower was found having a high dormancy level. So, in order to find out a quick way to break this dormancy, and to qualify the type of dormancy, "seeds" of this lot were tested for germination under different temperatures, illumination, rinsing in water, scarification, and after varying storage periods.

OBS: (1) the "seeds" (what are commonly called seeds, are of course, achenes, consisting of the true seed, surrounded by the pericarp or hull).

Materials and Methods

"Seeds" of the commercial sunflower variety IAC-Anhandy, harvested in 1984 from a field at the Tatui Experiment Station, Agronomic Institute of the State of São Paulo, exhibited a high level of dormancy. After the initial tests of germination and moisture content (Brasil, 1976), the "seeds" were planted in rolled paper towels and placed to germinate at constant temperatures of 5, 15, 20, 25, 30 35, and 40°C, and at alternate temperatures of 20-30°C (16 h at 20°C and 8 h at 30°C). The effect of light (presence or absence) was studied by planting the "seeds" on filter paper inside Petri dishes wrapped with a black plastic film (dark treatment) or a transparent one (light treatment) and germinating them at 15°C or 35°C.

In another experiment the "seeds" were rinsed in running water inside a Soxhlet apparatus for 0, 3, 8, 15, 24, 48, 72, and 96 h and then placed to germinate in rolled paper towels at constant 15°C.

A third experiment consisted of chemical scarification with commercial H_2SO_4 (98%) for 0, 1, 3, 5, 15, and 30 minutes. After rinsing in water for about 5 minutes the "seeds" were germinated the same way as after the rinsing treatments.

In a fourth experiment "seeds" were placed inside paper bags and stored at 10, 15, 20, 30, and 40°C for varying periods up to 180 days. At each period the "seeds" were tested for germination the same way as before. The use of constant 15°C in the germination tests was due to the fact that in the temperature experiment, that value was the best to maintain the dormancy, so the effects of other treatments could be studied. Counts were made at 3 and 7 days after planting (Brasil, 1976).

All experiments were conducted in a complete randomized design, using 8 replications of 25 "seeds" each. The data obtained were transformed into arc sin $\sqrt{\%}$ (Snedecor, 1962) and the means were compared using the Tukey test (Gomes, 1966).

Results

The 35°C germination temperature provided the highest level of normal seedlings and dormancy release (Table 1); 40°C was too high temperature, leading to an increase in dead seeds. The dormancy release was directly proportional to the temperature increase up to 35°C. There was no statistical difference between germination in light or darkness, there having been only a tendency of the germination to be better in darkness, at 35°C. Insignificant percentages of infected seedlings (data not shown) were found in some treatments, having no influence in the results.

Rinsing the seeds caused an increase in germination level up to 15 h of treatment, due to dormancy release (Table 2). Rinsing times longer than 15 h did not decrease the dormancy level. There was no viability loss due to rinsing. Infected seedlings were not found.

The results of chemical scarification are presented on Table 3. There was no statistical differences among scarification treatments. The decrease in percentage of dormant seeds was due to an increase in abnormal seedlings.

The seeds had different rates of dormancy release when stored at different temperatures (Figure 1). Dormancy release was faster at 10°C. Storage at 30°C provided a dormancy release curve similar to that at 10°C, but with a lower rater of dormancy release, mainly during the first 70 days of storage.

The initial moisture content of the seeds was 7.5%. At the end of the storage period, the moisture contents of the seeds stored at 10°C, 15°C, 20°C, 30°C, and 40°C were 9.6%, 9.9%, 8.6%, 6.0% and 4.1%, respectively.

Temperature (°C)	Normal seedlings	Dormant seeds	Dead seeds
5	5.0 g	89.75 a	5.25 bc
15	9.0 fg	87.5 ab	3.5 c
15 - light	15.0 ef	80.0 b	5.0 bc
15 - dark	15.75 ef	80.25 b	4.0 c
20	25.75 e	66.25 c	8.0 bc
25	69.5 bc	25.75 d	3.75 c
30	61.0 cd	32.5 d	3.75 c
35	75.5 ab	7.75 f	12.75 b
35 - light	74.75 ab	13.0 ef	9.75 bc
35 - dark	82.25 a	6.5 f	10.0 bc
40	46.75 d	12.0 f	41.25 a
20-30	70.0 bc	22.0 de	6.5 bc
C.V. (%)	8.07	7.08	21.21
F Test	131.26*	239.79*	21.99*
D.M.S.(arc sin √%)	8.30	7.11	8.60

OBS:Means followed by the same letter,in the same column,are not statistically different(Tukey 5%).

Table 1. Average germination percentage of sunflower "seed" under different temperatures and light regimes.

Rinsing period (h)	Normal seedlings	Dormant seeds	Dead seeds
0	6.5 d	90.0 a	3.5 ab
3	10.0 cd	86.5 ab	3.5 ab
5	17.0 bc	80.0 ab	3.0 ab
8	25.5 b	75.5 b	2.0 b
15	65.0 a	32.0 c	3.0 ab
24	71.0 a	25.5 cd	3.5 ab
48	70.5 a	24.0 cd	5.5 ab
72	63.0 a	32.0 c	5.0 ab
96	71.5 a	18.5 d	10.0 a
C.V. (%)	8.88	7.93	32.22
F Test	107.88*	107.93*	2.73*
D.M.S.(arc sin √%)	8.57	8.76	8.71

OBS:Means followed by the same letter,in the same column,are not statistically different(Tukey 5%).

Table 2. Average germination percentage of sunflower "seed" submitted to intermittent rinsing in water.

Scarification period (min.)	Normal seedlings	Abnormal seedl.	Dormant seeds	Dead seeds
0	6.5	0 c	90.0 a	3.5 c
1	12.5	1.5 c	71.5 bc	14.5 a
3	15.5	1.0 c	74.5 b	9.0 b
5	20.5	1.0 c	68.5 bc	10.0 ab
15	15.0	14.5 b	62.5 c	8.0 b
30	6.0	33.0 a	48.5 d	12.5 b
C.V. (%)	33.56	33.25	5.85	11.10
F Test	2.47ns	35.97*	29.62*	16.92*
D.M.S.(arc sin √%)	15.45	9.29	7.50	4.40

OBS:Means followed by the same letter,in the same column,are not statistically different(Tukey 5%).

Table 3. Average germination percentage of sunflower "seed" submitted to chemical scarification with H_2O_4 at 98%.

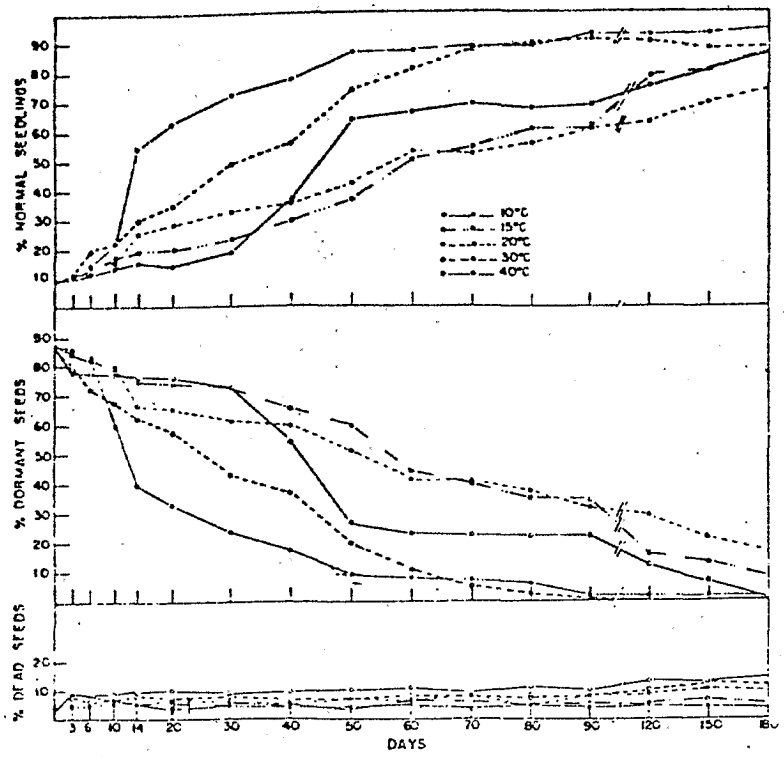

Figure 1. Effects of different temperatures of storage on sunflower "seed" germination.

Discussion

A viable seed needs for its germination water, adequate temperature, oxygen and, in some cases, light. Each species has an optimum temperature which varies with the seed physiological conditions. Using different temperatures and light combinations, the physiological conditions leading the seeds to dormancy can be achieved or maintained (Mayer and Poljakoff-Mayber, 1963; Devlin, 1970; Schultz and Kinch, 1976; Knapp and Wiesner, 1978).

Using constant temperatures in grape seeds germination, Costacurta (1969) found better results when the dormant seeds were submitted to temperatures above 25°C. The results of this paper indicates that sunflower "seeds" had better germination when submitted to 25°C or above. This explain why some lots of "seeds" do not germinate well in the field when the soil temperature is low; however, there is an imediate germination when the temperature arises.

Rollier et al.(1977) observed that in any temperatures the increase in germination levels of sunflower seeds is directly proportional to the storage period of them, and that some varieties, immediately after harvest germinate in very strict temperature intervals; otherwise, with the increase of the conservation period, this interval increases. With the increase of temperature up to 25°C(the highest temperature tested for those authors) occurred a proportional increase in germination.

Maeda (1982) working with grape seeds found better germination when the seeds were submitted to alternate temperatures. In the present work, the sunflower "seeds" germination were also better at alternate temperature (20-30°C) rather than at constant temperature of 20°C, which also showed a tendency to be better than 30°C, agreing with Mayer and Poljakoff-Mayber (1963) observation that the germination of many dormant seeds is higher when alternation is used.

Would be interesting to test combinations of higher temperatures in future works, to check if it will give better dormancy release that at 35°C, our best result.

When the embryo itself shows physiological conditions leading to dormancy, this

type of seed should need the presence or absence of light for dormancy release (Popinigis, 1977). When light effect was tested under two temperatures, the results were non-significant, since the sunflower "seed" germination is not light affected.

Many authors noted the occurrence of growth inhibitors, which block the seed germination. Sapankevich (1964) found that an extract prepared with sunflower pericarp, linden, and other flowers, inhibited the germination and development of pine and cucumber seeds. The amount of inhibitors is a function of the physiological conditions of the seeds. Sunflower "seeds" collected from different seasons gave different values with respect to dormancy period and overall germination (Srivastawa and Dey, 1982). The inhibitors should be localized in the pericarp or seed coat, in the endosperm, or in the embryo itself (Amen, 1963). When inhibitors are present in the pericarp or seed coat, they should be washed out with running water, as verified by Went (1957) in dormant seeds of desert-plants, and Elliot and Leopold (1953) with oat "seeds". In this experiment, intermittent rinsing for 15 h decreased dormancy from 90% to 32%.

Srivastawa and Dey (1982) washing dormant sunflower "seeds" in running water, did not obtain better germination and concluded that inhibitors substances present in sunflower "seeds" were water insoluble. Our results did not support this hypothesis. Probably in their experiment the rinsing was continuous, causing death of the seeds due to lack of oxygen, making seed respiration impossible (Maeda, 1982; Rollier et al 1977). As our intermittent washing treatment lead to a decrease in dormancy percentage, the authors suggest that the pericarp has an inhibitor, which is water soluble and should be washed out by running water. This attempt could be denoted by the analysis of Rollier et al (1977) paper, in which the removal of the pericarp lead to an increase in germination. In our experiment we did not have problems with oxygenation because the water treatment was intermittent.

Scarification is the most effective method when the seed coat is responsible for dormancy. When is not required, it may greatly facilitate germination (Toole and Hendricks, 1956), as a method that permits better oxidation rate, as observed by Roberts (1964) in a type of grass in which the dormancy release was associated with the oxidation of inhibitors. This paper, otherwise, showed that the difficulty in the germination is neither due to the lack of permeability of the pericarp nor to the lack of oxidation.

The major factors known to influence the longevity of seed in storage are temperature, moisture content, and oxygen pressure, being moisture the most crucial factor in maintaining viability over long periods (Maguire, 1977).

When the internal moisture level was maintened at about 15% at 28°C, loss of germination was observed (Halder and Gupta, 1982). In this paper, the sunflower "seeds" had a low internal moisture content (average of 7.5% R.H) so they remained fully viable up to 180 days of storage.

Sunflower dormancy release takes at least 33 days during storage (Srivastawa and Dey, 1982). Our experiment also showed a high increase in germination level up to 50 days of storage.

The Seed Analysis Rules (Brasil, 1976) stablish 7 days at 5 or 10°C for the breaking of dormancy in sunflower "seeds". We found that although 10°C was the best temperature for dormancy release, 7 days was not enough.

Conclusions

1. The dormancy release is proportional to the increase of temperature up to 35°C. At 40°C, the seed viability decrease.

2. The alternate temperature (20-30°C) gives better germination level rather than the correspondent constant temperatures.

3. The germination inhibitors present in the pericarp are water-soluble.

4. The "seed" dormancy is neither due to the pericarp impermeability nor to the low oxidation level.

5. The low "seed" moisture level lead to the maintenance of total viability to more than 6 mounths at low temperatures of storage.

6. The best temperature for fast dormancy release was 10°C although under normal storage conditions, the dormancy release is complete after 70 days.

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