INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 6, No. 2, p. 209-215, 2015

RESEARCH PAPER OPEN ACCESS

# Effect of polishing and washing on germination quality and viability of sugar beet seed

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**Key words:** Sugar beet seed, germination, polish, washing, viability.

http://dx.doi.org/10.12692/ijb/6.2.209-215 Article published on January 27, 2015

## Abstract

Effect of seed polishing as well as washing was done to see germination quality of sugar beet seed. For this purpose, a three factorial experiment was carried out within a randomized completely design in laboratory condition. The first factor was six amounts of seed polishing (0, 5, 10, 15, 20 and 25% removing of seed coat or rubbing). The second factor included seven levels of washing duration (0, 30, 60, 90, 120, 150 and 180 minutes) by distilled water. And the third factor was viability of seeds after polishing and washing where their germination was tested immediately after those treatments as well as after storage of them in a room temperature for six months. The experiment was run both in laboratory. The result showed that germination traits were significantly affected both by seed polish and washing. Polishing in amount of 10 and 15% increased germination percentage. Washing of seeds for 60 and 150 minutes also improved germination percentage as well. Investigation of viability demonstrated that no significant difference was observed between the storage times after the treatments.

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## Introduction

Uniformity in harvest, maturity and product size of sugar beet seed is directly related to uniformity of seedling emergence. Therefore, germination synchrony is the first essential step to achieve uniform plant growth and development (Taylor, 1997). A sugar beet seed is botanically a fruit that is generically termed a 'Seed ball' (Hayward, 1938). Due to existing of germination inhibitors and mucilage material on sugar beet seed, germination can be prevented if seed polish and washing procedure do not run during seed process. There are three major seed factors that negatively influence beet germination: (i) A mucilaginous layer that can surround the seed ball; (ii) The ovary cap tenacity; and (iii) The presence of phenolic chemical inhibitors. A mucilaginous layer has been observed on sugar beet seeds and those cultivars with greater incidence of mucilage had lower germination potential (Duan and Burris, 1997). The ovary cap or operculum is a morphological dome that covers the embryo. The operculum is composed of the non embedded portion of the ovary and remnants of the stigma-style. Ovary caps act as barriers to oxygen diffusion (Heydecker *et al.*, 1971; Coumans *et al.*, 1976). Finally, a number of inhibitors are found in the seed coverings of beet seeds and several phenolic compounds have been isolated and identified (Chiji *et al.*, 1980). Collectively, these physio-chemical barriers interact to reduce the germination potential of beet seeds. Furthermore, environment influences beet germination potential and seeds are most sensitive under wet conditions, which limits oxygen availability (Perry and Harrison, 1974). This, beet seeds have non-synchronous germination, even under ideal environmental conditions. For this reason, as well as others, sugar beet (*Beta vulgaris* L.) seed varieties are produced mostly as mono-germ and the seeds are polished and washed during seed process. Moreover, washing can rapid germination for a 2.5 days which might be due to removing of inhibitors from the seed surface (Longden, 1971). For this reason, removing those inhibitors either by washing or polishing of the seed (which also helps to loosening of hard seed coat of sugar beet seed) may be done during seed process. The objective of this study was to investigate the effect of different amount of polish as well as washing, or in other words priming of sugar beet seed.

## Materials and methods

*Experimental design*

This experiment was done as a three factorial experiment within a completely randomized design in laboratory as well as green house condition. The first factor was six amounts of seed polishing (0, 5, 10, 15, 20 and 25% removing of seed coat). The second factor included seven levels of washing duration (0, 30, 60, 90, 20, 150 and 180 minutes); And the third factor was viability of seeds after polishing and washing, where their germination was tested immediately after those treatments as well after storage in a room temperature for six months.

*Seed preparation and Measurements*

The experiment was run in seed laboratory of Sugar Beet Seed Institute, Karaj, Iran. Shirin mono-germ variety with a middle germination capacity considered for this experiment to see a possible prime effects. The seed was cleaned by towel machine and then the debris of the seed was first separated by a sieve size 2.75 mm. Afterwards, the seeds were polished by hand in a cotton bag to reach a correct amount of treatment. The amount of polishing was achieved by continuously weighing of the polished seed lot during rubbing. To become more exact, the thousand seed mass were then measured to achieve different polish percentages as well. Later, the seeds were imposed to the wash treatments after ISTA rule using flow distilled water with 35°C. Then, the seeds were either immediately imposed to germination or rinsed to its first moisture and stored in room temperature to the test their viability after six months storage. Germination tests were done based on the International seed testing rules (ISTA, 2011). Seedling normality as well as abnormality was also judged using ISTA rule. Statistical analysis was done by SAS software. Mean comparison was done using Duncan multiple range test.

**Results and discussion**

*Effect of polish on normal & abnormal seedlings*

The result showed that generally polishing and washing has affected germination and consequently normal as well as abnormal seedling. Table 1 shows the statistical classification of normal and abnormal seedlings after germination. As it shown, polishing of sugar beet seed and removing a part of woody cover of the seed by 15% increased normal seedling and consequently reducing abnormality. Where, less or more polishing than the mentioned amount either reduced normal seedling or increased abnormality. Khan (1983) also mentioned that primed seed showed a uniform emergence when they are used in an unfavorable soil condition.

**Table 1.** Effect of polish content on normal & abnormal seedlings.

| Polish (%) | Normal seedling (%) | Abnormal seedling (%) |
|---|---|---|
| 0 | 54.42 c | 9.52 c |
| 5 | 56.52 b | 16.22 b |
| 10 | 57.22 ab | 15.46 b |
| 15 | 58.05 a | 16.30 b |
| 20 | 56.36 b | 19.16 a |
| 25 | 56.55 b | 20.20 a |

Means with similar letters are not statistically significant, based on Duncan test.

**Table 2.** Effect of washing on normal and abnormal seedlings.

| Washing (minutes) | Normal seedling (%) | Abnormal seedling (%) |
|---|---|---|
| 0 | 53.05 d | 18.08 a |
| 30 | 55.16 c | 16.47 b |
| 60 | 57.27 ab | 15.75 b |
| 90 | 57.44 ab | 16.09 b |
| 120 | 58.68 a | 15.22 b |
| 150 | 57.22 ab | 15.81 b |
| 180 | 56.83 b | 15.59 b |

Means with similar letters are not statistically significant, based on Duncan test.

**Table 3.** Effect of seed storage on normal & abnormal seedling after polish and washing.

| Storage (month) | Normal seedling (%) | Abnormal seedling (%) |
|---|---|---|
| 0 | 56.15 a | 15.991 a |
| 6 | 58.69 a | 16.30 a |

Means with similar letters are not statistically significant, based on Duncan test.

*Effect of washing on normal and abnormal seedlings*

Table 2 is related to the result of washing on seed germination. Washing of seed by 120 minutes improved normal seedlings and decreased abnormality. However, washing by 60 minutes showed no significant difference to 120 minutes. Washing over to 120 minutes caused higher abnormality. This might be due to leaching of nutrition material from seed which is needed for germination, or removing of seed cap and consequently harming of embryo. This addresses that washing of seed in a wright amount, on one hand remove inhibitors and on the hand, helps the woody sugar beet seeds to absorb enough water and become prime which is interest of plant growers to reach fast and uniform emergence. Longden (1971) discussed also the improvement of beet seed germination after washing and consequently removing of inhibitors. Durant (1983) also mentioned washing of seeds increased germination percentage when they were posed to a cold seed bed.

*Effect of seed storage on normal & abnormal seedlings*

Evaluation of seed viability after washing and storage of them for six months was another objective of this experiment which is presented in Table 3. As it is demonstrated, there was no difference between those seeds which were either imposed to germination immediately after washing or stored for six months, regarding normal and abnormal seedling. Both were located in the same group, showing capability of beet seed storage after washing if the seeds are smoothly dried by a good temperature in shadow. Although, in this experiment the washed seeds were dried in the laboratory condition, however, it seems drying of the seed in a temperature lower than 40C which is recommended in seed industry (Copelanf and McDonald, 2001) can faster seed drying and consequently avoiding environmental hazards before sowing, if it is applied. This finding address that the seed companies can wash and store them at least for a while without any harming. However, the method must be modified exactly.

**Table 4.** Interaction between polish and washing on normal & abnormal seedling.

| Polish (%) | Washing (minutes) | Normal seedling (%) | Abnormal seedling (%) |
|---|---|---|---|
| 0 | 0 | 54.00 g-i | 6.66 n |
| | 30 | 54.25 f-j | 7.58 mn |
| | 60 | 54.00 g-j | 11.00 l |
| | 90 | 58.50 a-f | 8.91 lmn |
| | 120 | 54.08 g-j | 10.33 lm |
| | 150 | 52.58 ij | 11.41 kl |
| | 180 | 53.58 hij | 10.75 l |
| 5 | 0 | 51.16 j | 17.83 d-i |
| | 30 | 52.83 ij | 15.75 hij |
| | 60 | 58.66 a-e | 15.91 g-j |
| | 90 | 57.50 a-h | 16.58 e-j |
| | 120 | 61.16 a | 14.16 jk |
| | 150 | 56.50 c-i | 16.66 e-j |
| | 180 | 57.83 a-h | 16.66 e-j |
| 10 | 0 | 53.08 ij | 19.25 b-g |
| | 30 | 55.58 d-i | 16.75 e-j |
| | 60 | 60.58 abc | 14.08 jk |
| | 90 | 55.91 d-i | 16.08 f-j |
| | 120 | 58.08 a-g | 15.75 hij |
| | 150 | 57.50 a-h | 14.91 hij |
| | 180 | 59.83 a-d | 11.41 kl |
| 15 | 0 | 53.83 g-j | 19.41 b-f |
| | 30 | 59.00 a-e | 16.58 e-j |
| | 60 | 58.41 a-f | 15.83 hij |
| | 90 | 58.58 a-f | 14.58 ij |
| | 120 | 60.91 ab | 14.58 ij |
| | 150 | 58.75 a-e | 16.08 f-j |
| | 180 | 56.83 b-i | 17.08 e-j |
| 20 | 0 | 51.25 j | 23.33 a |
| | 30 | 54.00 g-j | 19.83 b-e |
| | 60 | 55.66 d-i | 19.58 b-e |
| | 90 | 55.66 d-i | 20.50 a-d |
| | 120 | 61.25 a | 15.25 hij |
| | 150 | 59.16 a-e | 17.75 d-i |
| | 180 | 57.58 a-h | 17.91 d-i |
| 25 | 0 | 55.00 e-j | 22.00 ab |
| | 30 | 55.33 e-i | 22.33 ab |
| | 60 | 56.33 c-i | 18.08 c-h |
| | 90 | 58.50 a-f | 19.91 b-e |
| | 120 | 56.58 c-i | 21.25 abc |
| | 150 | 58.83 a-e | 18.08 c-h |
| | 180 | 55.33 e-j | 19.75 b-e |

Means with similar letters are not statistically significant, based on Duncan test.

*Interaction Effect of polish and washing on normal & abnormal seedling*

Interaction between treatments (polish*wash) revealed that polishing of seed for 5% and washing for 120 minutes, as well as 20% polish and 120 minutes washing caused better germination and normal

seedlings (Table 4) when compared to the others. There was also another interaction treatment like polishing seed for 15% and thereafter washing for 120 minutes which was also classified in the same group. Regarding seed health and economical aspects of the treatments, there might be an argument which leads the seed process to the amount of maximum 15% polish and 120 minutes washing. Using more polish will cost more energy and may also cause more abnormal seedlings which was also observed more or less by 25% polish and more washing duration. Hull (1970) showed that the primed seed could improve germination and consequently root yield to 10% finally. Orzeszko-Rywka and Podlaski (2003) also showed that the seed priming, especially in combination with rubbing, caused an increase in water potential and pericarp moisture.

**Table 5.** Effect of polish and storage duration on seed germination.

| Polish (%) | Storage (month) | Normal seedling (%) | Abnormal seedling (%) |
|---|---|---|---|
| 0 | 0 | 55.04 de | 6.78 f |
| | 6 | 53.80 e | 12.26 e |
| 5 | 0 | 55.83 b-e | 17.26 bc |
| | 6 | 57.21 abc | 15.19 d |
| 10 | 0 | 57.66 ab | 15.30 d |
| | 6 | 56.78 a-d | 15.61 d |
| 15 | 0 | 58.02 a | 16.07 cd |
| | 6 | 58.07 a | 16.54 bcd |
| 20 | 0 | 55.16 cde | 20.23 a |
| | 6 | 57.57 ab | 18.09 b |
| 25 | 0 | 55.21 cde | 20.28 a |
| | 6 | 57.90 ab | 20.11 a |

Means with similar letters are not statistically significant, based on Duncan test.

**Table 6.** Effect of washing and storage duration on seed germination.

| Washing (minutes) | Storage (month) | Normal seedling (%) | Abnormal seedling (%) |
|---|---|---|---|
| 0 | 0 | 51.61 g | 19.44 a |
| | 6 | 54.50 f | 16.72 bcd |
| 30 | 0 | 55.19 def | 17.36 bc |
| | 6 | 55.13 ef | 15.58 c-f |
| 60 | 0 | 57.47 a-d | 15.69 b-f |
| | 6 | 57.08 a-e | 15.80 b-f |
| 90 | 0 | 58.16 abc | 14.66 ef |
| | 6 | 56.72 a-f | 17.52 b |
| 120 | 0 | 58.5 a | 14.38 f |
| | 6 | 58.77 a | 16.05 b-f |
| 150 | 0 | 56.11 b-f | 15.27 def |
| | 6 | 58.33 ab | 16.36 b-e |
| 180 | 0 | 55.97 c-f | 15.11 def |
| | 6 | 57.69 abc | 16.08 b-f |

Means with similar letters are not statistically significant, based on Duncan test.

*Interaction Effect of polish and seed storage on normal & abnormal seedling*

Interaction between polish and seed storage after washing was another issue which were studied in this experiment. Table 5 shows that 15% polish and imposing either immediately to germinate or store for six months caused better germination and consequently normal seedling when compared to the other treatments. Thus, low amount of abnormal seedling content was seen in that treatment as well. This finding addresses that sugar beet seeds can be polishe and stored at least for a six month as it was monitored in this experiment. Regarding beet seed coat which includes mostly hard woody material it can be discussed that even after normal coat polishing the beet seed can be stored for a while. Duan and Burris (1997) reported that a mucilaginous layer has been observed on sugar beet seeds and those cultivars with greater incidence of mucilage can be stored longer.

*Interaction Effect of washing and seed storage on normal & abnormal seedling*

Table 6 is presenting the interaction between washing and seed storage. As it demonstrated washing for about 120 minutes and imposing them for germination immediately or storing them for six months released higher normal seedling when compared to the other treatments. The lowest abnormality was also observed in the same treatment. Considering those results it can be addressed that to remove seed inhibitors from the woody sugar beet seed a washing system should be planned along other seed process system. Bradford (1990) found that drying seed after absorption of water (called water absorption stage during germination phases) does not harm the seed embryo. Therefore, storage of beet seeds can be done for awhile after priming, if the correct amount is done.

## Conclusion

The out coming results of this experiment showed that sugar beet seed should be washed and polished before to be delivered to the beet growers. However, the experiment should be extended and modified to achieve the exact point which might be also different for different seed sizes or seeds with different seed coat content. However, on the basis of our findings we suggest a aximumg15% polish and 2 hours washing of sugar beet seed with distilled water before to be packed.

## Acknowledgment

This experiment was done as a cooperation research between Islamic Azad University, Karaj branch and sugar beet seed institute in Karaj-Iran. Therefore the authors would like to thank the University for the Financial Support. We also admire sugar beet seed institute for the preparation of seed and other laboratory equipments. The authors would like also thank Mr. Ghasemi the advisor of seed quality control of the institute for his scientific and practical ideas during experiment running.

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