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# Research Article
# Improvements on Physiological Seed Quality of *Festuca arundinacea* Schreb by Encrusting Technology: Products and Storage Effects

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## Abstract

**Background:** The natural or artificial ageing reduces seed germination rate and seedling growth tolerance to adverse conditions. Some pre-germinating treatments, such as seed pelletting and encrusting can improve seed performance during storage and maintain this benefit until the end of this period. **Objective:** The aim of this study was to determine the impact of encrusting seeds before or after a storage period for 9 months on physiological seed quality of tall fescue (*Festuca arundinacea* Schreb.). **Materials and Methods:** The treatments applied before and after storage were: Tall fescue seeds treated with insecticide, treated with fungicide, treated with water, treated with micro nutrients, treated with dye, encrusted with talc+adhesive polymer or encrusted with insecticide+fungicide+micronutrients+talc+adherent polymer+dye. Response variables were germination and vigor in 2 experiments. Complete randomized block design was applied and data was analyze by ANOVA. The DGC test ($p<0.05$) was used to separate significant means. **Results:** Germination of encrusted seeds was significantly higher than control before and after storage. Seed encrusted before storage showed higher germination in comparison to seeds encrusted after storage. Insecticide commercially dosage generated negative effects on germination and vigor but this negative effect was diluted when it was part of the encrusted. **Conclusion:** It is concluded that a new combination of products that study as seed enhancement was achieved for tall fescue. This encrusting technology improves germination without affecting seedlings vigor of tall fescue whether performed before or after 9 months of storage. It is recommended to encrust seeds before storage (with lower levels of natural deterioration) than encrusting them after storage (with higher levels of natural deterioration) to not affect germination performance. Negative effects of imidacloprid on germination and mean daily germination are not transfer to encrusted seeds.

Key words: Tall fescue, encrusting, germination, vigor, seed enhancement

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

The natural or artificial aging reduces seed germination rate and seedling growth tolerance to adverse conditions[1]. Poaceae seeds are sensitive to improper storage conditions[2] that decrease germination capacity. According to Tekrony[3] there are some pre-germinating treatments, such as seed pelletting, that could improve seed performance during storage and maintain this benefit until the end of this period. The international seed testing association[4] defines pelleted seeds as more or less spherical units developed for precision sowing, usually incorporating a single seed with its size and shape no longer readily evident. Furthermore, encrusted seeds are units more or less retaining the original shape of the seed with its size and weight changed to a greater or lesser extent. The pelleting and encrusting may contain dyes, micronutrients, beneficial microorganisms and crop protection agents, including systemic insecticides used in high dosages[5] that can improve the performance of seeds[6].

Literature shows differences in the effects of these products on seed quality during storage. In this sense, Pereira *et al.*[7] reported that the application of carbofuran and/or metalaxil did not affect the physiological quality of corn seeds (*Zea mays* L.) during storage for 6 months. But Kuhar *et al.*[8] found phytotoxic effect of imidacloprid applied before storage to sweet corn seeds had. In this regard, Dan *et al.*[9] recommended the application of imidacloprid, carbofuran and thiametoxan after storage to improve germination, germination speed and seedling growth of soybean (*Glycine max* L. Merr).

When these products are used together to obtain an encrusted seed, they may exhibit a behavior that differs from individual application. Szemruch and Ferrari[10] verified an adverse effect of insecticide plus fungicide upon sunflower (*Helianthus annus* L.) germination when they were applied individually, although it seemed that encrusting blocked the negative effect of these pesticides when encrusted seeds were stored for 8 months. Yan *et al.*[11] observed high germination, enhanced root growth and root dry weight of seedlings of encrusted rape seed (*Brassica napus* L.) after 6 months of storage. Ferreira *et al.*[12] noted that encrusting corn (*Zea mays* L.) seeds with thiabendazole, thiram, deltamethrin, dye polymer and micronutrients did not affect germination and vigor either before or after 6 months of storage.

The natural ageing of the seeds could be influenced by an interaction between encrusting moment and the natural or artificial level of deterioration of the seed. In this sense, encrusting technology could operate improving seed quality and maintaining it after storage[11,13,14]. So the aim of this study was to determine the impact of encrusting seeds before or after a storage period for 9 months on physiological seed quality of tall fescue (*Festuca arundinacea* Schreb.).

## MATERIALS AND METHODS

Pure seeds ISTA[4] of *Festuca arundinacea* Schreb cv Martin II were used. At 5 month from harvest (Before storage: BS) and at 9 month after storage period (After storage: AS) seeds were treated with 5 mL of insecticide (imidacloprid 60%), treated with 3 mL of fungicide (carbendazim 10%+thiram 10%), treated with 20 mL of water, treated with 12 g of dye, treated with 0.2 g of micronutrients (Cu, Mo, Mn, Fe, Zn, Bo, Mg and Co), encrusted with 1000 g talc+450 mL adherent polymer Equate® (Encrusted-A) and with 5 mL insecticide+3 mL fungicide+0.2 g micronutrients+1000 g talc+450 mL of adhesive polymer+12 g dye (Encrusted-B). Untreated seeds were considered as control. Dosages were calculated to reach a total slurry of 20 mL $kg^{-1}$ of seed[15]. All treatments were performed with experimental equipment (*Cimbria heid*). Artificially dry of treated and encrusted seeds was not necessary. Seeds treated BS and control was stored in polyethylene bags at 25°C and 60% relative humidity.

### Response variables

**Germination:** Germination test was carried out according to International Seed Testing Association[4]. Fourteen days after sowing date the final count of normal seedlings (NS), abnormal seedlings (AD) and dead seeds (DS) were performed and the corresponding percentages were calculated. The final data of percentage of normal seedlings was considered as germination percentage (G%).

**Vigor:** Normal seedlings were recorded every day during the germination tests in order to calculate Mean Daily Germination (MDG)[16] expressed in seedlings per day.

$$\text{MDG} = \sum \frac{\text{Gi}}{\text{Ti}} \left( \frac{\text{Seedlings}}{\text{Day}} \right)$$

where, MDG is the number of seedlings per day, Gi is germination percentage occurred in each day i and Ti is the time in days from sowing.

Normal seedlings were measured at the end of germination test to determine Seedling Aerial Length (SAL) and Seedling Root Length (SRL) in centimeters. Then they were dried at 60°C and weighted in grams to determine Seedling Dry Weight (SDW) adapted from Peretti[17].

**Two experiments were performed**

**Experiment 1:** Seeds were treated or encrusted (BS). Germination tests were performed. Immediately, treated or encrusted and control seeds began a storage period of 9 months.

**Experiment 2:** After this storage period, a portion of the control seeds were treated or encrusted (AS). Other portion remained as control. At this moment germination and vigor tests were performed to seeds BS and AS.

Complete randomized block design was applied and data (transformed by arcsine) was analyzed by ANOVA using INFOSTAT statistical software[18]. The DGC test ($p<0.05$) was used to separate significant means.

## RESULTS

### Experiment 1

**Germination:** Seeds treated or encrusted BS showed no significant differences with control for germination previously to storage period (Table 1). Differences to 100% corresponded to abnormal seedlings, majorly retarded roots.

### Experiment 2

**Germination:** Table 1 indicated significantly differences for moment of treatment and treatment. Seeds encrusted or treated with micronutrients, dye, fungicide or water shows significantly higher G% than control, but insecticide promote lower G%. Otherwise, both encrusting seeds treatments shows significantly higher G% when performed BS than AS, related to low AS% in encrusted-A and AS% and DS% in encrusted-B. In each moment of treatment both encrusted seeds and the other treatments showed significantly higher values than control except for the Insecticide. Insecticide treatment promote signicantly higher values for AS% independently the moment of treatment, BS also promote the higher DS%. The abnormality found for seeds treated with insecticide was retarded primary root. Control only shows deformed coleoptile.

When mean germination was compared between experiment I and II (statistical differences not shown) by means of DGC ($p<0.05$) control seeds decreased from 94-67% ($p = 0.001$) but encrusted-B seeds decreased from 95-81% ($p = 0.02$).

**Vigor:** Significantly differences were found for MDG and SRL between treatments and for SDW between treatments or moments of treatment (Table 2). Neither encrusted-A or encrusted-B enhanced MDG compared with the control. Insecticide always manifested lower significant MDG than control and the other treatments. The SRL showed significantly differences between treatment either BS or AS. Encrusted with encrusted-A enhanced large of roots in both moments like fungicide, water or micronutrients. As all treatments with exception of insecticide enhanced SRL compared with control. Encrusted-B developed heavier seedlings (SDW) than control when performed BS.

Table 1: Experiment 1: Percentage of germination (G%) of tall fescue seeds treated or encrusted and control before storage (BS). Experiment 2: Percentage of germination (G% = Normal seedlings), abnormal seedlings (%) and dead seeds (%) of tall fescue seeds treated or encrusted before (BS) or after storage (AS) and control, following 9 months of storage

| | | Experiment 1 | Experiment 2 | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | G% = Normal seedlings (%) | G% = Normal seedlings (%) | | Abnormal seedlings (%) | | Dead seeds (%) | |
| Treatments | | BS | BS | AS | BS | AS | BS | AS |
| Non treated seeds | Control | $94^{a}$ | $67^{b}$ | $67^{b}$ | $16^{b}$ | $16^{b}$ | $17^{b}$ | $17^{a}$ |
| Treated seeds | Insecticide | $94^{a}$ | $58^{cA}$ | $53^{cA}$ | $23^{aB*}$ | $34^{aA*}$ | $19^{aA}$ | $13^{bB}$ |
| | Fungicide | $93^{a}$ | $75^{aA}$ | $69^{aA}$ | $9^{cB}$ | $19^{bA}$ | $16^{bA}$ | $12^{bB}$ |
| | Water | $100^{a}$ | $74^{aA}$ | $69^{aA}$ | $10^{cB}$ | $18^{bA}$ | $16^{bA}$ | $13^{bB}$ |
| | Dye | $96^{a}$ | $81^{aA}$ | $78^{aA}$ | $7^{cB}$ | $15^{bA}$ | $11^{cA}$ | $7^{cB}$ |
| | Micronutrients | $94^{a}$ | $83^{aA}$ | $79^{aA}$ | $10^{cA}$ | $8^{cA}$ | $7^{dB}$ | $13^{bA}$ |
| Encrusted seeds | Encrusted 1 | $96^{a}$ | $82^{aA}$ | $76^{aB}$ | $7^{cB}$ | $13^{bA}$ | $11^{cA}$ | $10^{bA}$ |
| | Encrusted 2 | $95^{a}$ | $81^{aA}$ | $70^{aB}$ | $14^{bB}$ | $17^{bA}$ | $5^{dB}$ | $13^{bA}$ |

Same lower cases indicate no significant differences among treatments within columns for each moment (BS or AS) and capital letters between moments for each treatment (DGC $p<0.05$), *Retarded primary root by ISTA, encrusted 1: Talc+adherent, encrusted 2: Insecticide+fungicide+micronutrients+talc+adherent polymer+dye

Table 2: Experiment 2: Mean Daily Germination (MDG), Seedling Aerial Length (SAL), Seedling Root Length (SRL) and Seedling Dry Weight (SDW) of tall fescue seeds treated or encrusted before (BS) or After Storage (AS) and control, following 9 months of storage

| | | MDG (seedlings day$^{-1}$) | | SAL (cm) | | SRL (cm) | | SDW (g seedling$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|
| Treatments | | BS | AS | BS | AS | BS | AS | BS | AS |
| Non treated Seeds | Control | $9.1^{b}$ | $9.15^{a}$ | $7.9^{a}$ | $7.9^{a}$ | $5.3^{b}$ | $5.3^{c}$ | $16.5^{b}$ | $16.5^{a}$ |
| Treated seeds | Insecticide | $7.8^{cA}$ | $7.98^{bA}$ | $8.4^{aA}$ | $7.9^{aA}$ | $4.6^{bA}$ | $4.8^{cA}$ | $16.2^{bA}$ | $15.2^{aA}$ |
| | Fungicide | $11.1^{aA}$ | $10.4^{aA}$ | $8.7^{aA}$ | $7.7^{aA}$ | $6.7^{aA}$ | $5.7^{bA}$ | $15.9^{bB}$ | $17.2^{aA}$ |
| | Water | $11.4^{aA}$ | $10.1^{aA}$ | $8.6^{aA}$ | $7.7^{aA}$ | $6.3^{aA}$ | $6.0^{bA}$ | $20.0^{aA}$ | $14.8^{bB}$ |
| | Dye | $11.9^{aA}$ | $11.1^{aA}$ | $7.8^{aA}$ | $7.9^{aA}$ | $5.6^{bA}$ | $5.7^{bA}$ | $13.6^{cB}$ | $17.1^{aA}$ |
| | Micronutrients | $10.6^{aA}$ | $11.1^{aA}$ | $8.6^{aA}$ | $7.9^{aA}$ | $6.6^{aA}$ | $6.7^{aA}$ | $14.4^{cB}$ | $16.8^{aA}$ |
| Encrusted seeds | Encrusted 1 | $9.6^{bA}$ | $11.6^{aA}$ | $7.8^{aA}$ | $8.0^{aA}$ | $6.6^{aA}$ | $5.9^{bA}$ | $16.1^{bA}$ | $17.0^{aA}$ |
| | Encrusted 2 | $9.6^{bA}$ | $11.4^{aA}$ | $8.0^{aA}$ | $8.4^{aA}$ | $5.5^{bA}$ | $6.0^{bA}$ | $17.7^{aA}$ | $17.5^{aA}$ |

Same lower cases indicate no significant differences among treatments within columns for each moment (BS or AS) and capital letters between moments for each treatment (DGC $p<0.05$), encrusted 1: Talc+adherent, encrusted 2: Insecticide+fungicide+micronutrients+talc+adherent polymer+dye

## DISCUSSION

When comparing germination between experiment I and II, all treatments and control decreased their physiological quality but encrusted seems to operate as a barrier, perhaps against changes in relative humidity that could decrease the rate of natural and artificial deterioration.

Regardless of the moment application, encrusting increased germination when compared with control according to Yan *et al.*[11]. So, it is provably that encrusting technology could operate as a pre-germinating treatment, improving physiological quality of seeds. Several researchers Delouche[6], Kim *et al.*[13], De Almeida *et al.*[14] and Tekrony[3] indicated those positive effects for pelleted technology.

Although, the insecticide dosage applied was that commercially recommended for Poaceae forage seeds, it generated a deleterious effect on germination by the increased of abnormal seedlings and also and increased in dead seeds when performed before storage (Table 1). The application of the products with deleterious effects to seeds could generate retarded primary root according to ISTA[4]. But the most significant finding was that this negative effect was not transfer to encrusted (Encrusted-B). This result suggests that encrusting blocked the negative effect of insecticide as findings by Szemruch and Ferrari[10] for sunflower and Ferreira *et al.*[12] for corn. Only encrusting showed differences between moments of treatment, improving seed performance when applied before storage in agreement with Kuhar *et al.*[8] for sweet corn seeds treated with imidacloprid.

In Table 1, when compared between encrusted seeds BS and AS, suggested that encrusting seeds with lower levels of natural deterioration (BS) could be better than encrusting them after storage with a higher level of natural deterioration to not affect germination performance.

The Mean Daily Germination (MDG) of encrusted seeds did not differ from control. This result shows that the highest MDG found in treatments BS with fungicide, water, dye and micronutrients neither the lowest MDG found for insecticide was transfer to encrusted seeds (Encrusted-B). But encrusted-B seeds showed longer root seedling (SRL) AS and heavier seedlings (SDW) BS, comparing with control and insecticide treatment. So it may be said that insecticide thas not affect the development of the seedling once the germination and growing of a normal seedling progessed.

Encrusted seeds vigor (MDG, SAL, SRL and SDW) was not affect by the products applied neither before or after storage (Table 2). Those results expressed a trend that was consistent with the statements made by Yan *et al.*[11] and differ from those of Dan *et al.*[9] who recommend to treat soybean seeds after storage. This could be due to the specie, seeds coats in Fabaceae could be more sensible to chemical products in comparison to Poaceae which lemma and palea could protect more effectively the embryo. Our findings also shows that applied of fungicide, dye and micronutrients AS improves the SDW.

## CONCLUSION

It is concluded that a new combination of products that study as seed enhancement was achieved for tall fescue. This encrusting technology improves germination without affecting seedlings vigor of tall fescue whether performed before or after 9 months of storage. It is recommended to encrust seeds before storage (with lower levels of natural deterioration) than encrusting them after storage (with higher levels of natural deterioration) to not affect germination performance. Negative effects of imidacloprid on germination and mean daily germination are not transfer to encrusted seeds.

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## REFERENCES

1. Cruz-Perez, A.B., V.A. Gonzalez-Hernandez, M.C. Mendoza-Castillo and M.L. Ortega-Delgado, 2003. [Physiological markers for seed ageing tolerance in maize]. Agrociencia, 37: 371-381.
2. Bewley, J.D. and M. Black, 1994. Seeds Physiology of Development and Germination. Plenum Press, New York, London, pp: 137.
3. Tekrony, D.M., 2006. Seeds: The delivery system for crop science. Crop Sci., 46: 2263-2269.
4. ISTA., 2009. International rules for seed testing. International Seed Testing Association, Bassersdorf, Switzerland, Pages: 500.
5. Halmer, P., 2006. Seed technology and seed enhancement. Acta Hortic., 771: 17-26.
6. Delouche, J.C., 1995. Germinacion, deterioro y vigor de semillas. Revista SEED News, Vol. 6.
7. Pereira, C.E., J.A. Oliveira and J.R.E. Evangelista, 2005. [Performance of corn seeds treated with furazin and maxin in association with polimers, during storage]. Ciencia e Agrotec, 29: 1201-1208.
8. Kuhar, T.P., L.J. Stivers-Young, M.P. Hoffmann and A.G. Taylor, 2002. Control of corn flea beetle and Stewart's wilt in sweet corn with imidacloprid and thiamethoxam seed treatments. Crop Protect., 21: 25-31.
9. Dan, L.G.D.M., H.D.A. Dan, A.L.D.L. Barroso and A.D.L. Braccini, 2010. [Effect of storage on the physiological quality of soybean seeds treated with insecticides]. Revista Brasileira de Sementes, 32: 131-139.
10. Szemruch, C.L. and L. Ferrari, 2013. Encrusting offers protection against phytotoxic chemicals and maintains the physiological quality of sunflower (*Helianthus annuus*) seeds. Seed Sci. Technol., 41: 125-132.
11. Yan, Z.B., J.G. Dong and X.Y. Mu, 2007. Effects of a novel encrustation on germination and seedling growth of oilseed rape. Acta Agric. Boreali-Occidentalis Sin., 16: 180-183.
12. Ferreira, L.A., J.A. Oliveira, E.V.D.R. von Pinho and D.L. De Queiroz, 2007. [Treatment of corn seeds with biostimulant and fertilizer]. Revista Brasileira de Sementes, 29: 80-89.
13. Kim, D.H., M.M. Pavon and D.J. Cantliffe, 2000. Germination of primed, pelleted and film-coated lettuce seeds before and after storage. Proc. Florida State Hortic. Soc., 113: 256-259.
14. De Almeida, C., S.C.D.S. Rocha and L.F. Razera, 2005. [Polymer coating, germination and vigor of broccoli seeds]. Sci. Agricola, 62: 221-226.
15. Olivera, M.E. and L. Ferrari, 2013. Tratamiento de semillas de festuca alta (*Festuca arundinacea* Schreb.): Importancia de los volumenes de agua y adherentes aplicados. Chil J. Agric. Anim. Sci., 29: 121-127.
16. Maguire, J.D., 1962. Speed of germination-aid in selection ane evaluation for seedling emergence and vigor. Crop Sci., 2: 176-177.
17. Peretti, A., 1994. Manual Para Analisis de Semillas. 1st Edn., Editorial Hemisferio Sur, Buenos Aires, Argentina, Pages: 281, (In Spanish).
18. Di Rienzo, J.A., C.W. Robledo, M.G. Balzarini, F. Casanoves and M.L. Gonzalez Tablada, 2008. Infostat software estadistico. Grupo InfoStat, Universidad Nacional de Cordoba, Cordoba.