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# EFFECT OF SEED PRIMING ON GERMINATION AND SEEDLING GROWTH OF *FESTUCA ARUNDINACEA* SCHREB AND *AGROPYRON DESERTORUM* (FISCH. ex LINK) J.A. SCHULTES

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**Effect of seed priming on germination and seedling growth of *Festuca arundinacea* Schreb and *Agropyron desertorum* (Fisch. ex Link) J.A. Schultes**. – **Tilaki Ghasem Ali Dianati, Behtari Behzad, Alizadeh Mohammad Ali, and Jafari Ali Ashraf**. – A study was made on two major forage plants *Festuca arundinacea* Schreb and *Agropyron desertorum* (Fisch. ex Link) J.A. Schultes in laboratory conditions. Hydropriming (distilled water) and osmopriming ($KNO_3$, PEG-6000) were used in the study to prime seeds. The results indicated that priming improved the germination percentage, mean germination time, uniformity, and vigor index in *F. arundinace*. None of the priming treatments tested showed a beneficial effect on *A. desertorum*, but its primed seeds enhanced the mean of shoot and root length, and fresh weight seedling of the treated seeds. This study suggests that PEG (2.2 MPa) with 1-day duration is the most suitable seed priming to improve the germination percentage, uniformity, and vigor index, especially in *F. arundinace*. In addition, 3-day priming with $KNO_3$ (2.2 MPa) is recommended as the best one to enhance the mean shoot and root length, and fresh weight seedling of treated seeds.

*Key words*: *Festuca arundinacea*, *Agropyron desertorum*, hydropriming, osmopriming, germination.

**Влияние предпосевной обработки семян на их прорастание и начальный рост проростков овсяницы тростниковой *Festuca arundinacea* Schreb и житняка пустынного *Agropyron desertorum* (Fisch. ex Link) J.A. Schultes**. – **Тилаки Хасем Али Дианати, Бехтари Бехзад, Ализаде Мохаммед Али, Джафари Али Ашраф**. – В лабораторных условиях исследовали влияние предпосевной обработки семян двух основных кормовых растений *Festuca arundinacea* Schreb и *Agropyron desertorum* (Fisch. ex Link) J.A. Schultes. Семена замачивали в дистиллированной воде и в растворах ($KNO_3$, полиэтиленгликоль (ПЭГ)-6000). Выявлено, что замачивание улучшает долю прорастания, среднее время прорастания, однородность и индекс силы роста *F. arundinace*. Ни одна из испытанных обработок не показала положительного влияния на *A. desertorum*, но у замоченных семян увеличились средняя длина побега и корня, а также сырой вес сеянцев. Для улучшения доли прорастания, однородности и индекса силы роста, особенно у *F. arundinacea*, наиболее приемлемо замачивание в растворе ПЭГ (осмотическое давление 2.2 МПа) на сутки. Кроме того, замачивание в растворе $KNO_3$ (2.2 МПа) на трое суток рекомендуется как лучший способ для увеличения средней длины побега и корня, а также сырого веса сеянцев из обработанных семян.

*Ключевые слова*: *Festuca arundinacea*, *Agropyron desertorum*, замачивание в воде, замачивание в осмотическом растворе, прорастание.

## INTRODUCTION

Seed germination is a critical stage in the life of plants (Yang et al., 2008). Such a seed technology as priming has been developed and used extensively to improve germination and seedling emergence in a wide range of crop species (McDonald, 2000). A wide variety of priming treatment has been used to enhance seed germination. Hydropriming and osmopriming are commonly used methods to prime seeds (McDonald, 1999).

Hydropriming is the simplest method to hydrate seeds and to minimize the use of chemical materials (McDonald, 1999). Hydropriming consists in soaking seeds in pure water and redrying them before complete germination. Osmopriming is a pre-sowing treatment that consists of the incubation of seeds in an osmoticum solution (Pill, 1995). Polyethylene glycol is a commonly used osmotic priming material because it is readily available and has no physiological reaction with seeds. The very large molecules of this substance do not pass through seed cell membranes. Osmotic priming of seeds before sowing is used to accelerate germination (Heydecker et al., 1973).

Any priming (Osmo/Hydro) provides controlled hydration of seeds to a level that allows pre-germination metabolic activity to proceed, but prevents the actual emergence of the radicle after priming, the seeds can be dried back to the initial moisture content (Bradford, 1986). Therefore, the seeds treated before sowing germinate faster than non-prime controls.

Seed priming has been proved to advance germination for many agricultural plant species (Helsel et al., 1986; Alvarado et al., 1987; Evans and Pill, 1989; Bradford et al., 1990; Khan et al., 1992). However, limitations exist for forage plants. Germination of grasses is typically poor and hard to establish because of the high seed dormancy and slow seedling establishment (Hsu et al., 1985; Beckman et al., 1993). This study was carried out in two major forage plants *Festuca arundinaceous* Schreb and *Agropyron desertorum* (Fisch. ex Link) J.A. Schultes. In this work, we consider the effect of osmopriming and hydropriming on the germination and growth of *Festuca arundinacea* and *Agropyron desertorum*.

## MATERIAL AND METHOD

This study was carried out in the seed technology laboratory of the Faculty of Natural Resources, Tarbiat Modares University of Iran. Hydropriming and osmopriming were used in this study to prime seeds. The water potential for osmopriming was between -1.5 and -2.2 MPa, and the seeds were imbibed in an osmotic solution of $KNO_3$ and polyethylene glycol (PEG 6000) for 1, 3, and 6 days at 20°C, then the seeds were rinsed with distilled water for two minutes and seed were air dried until the moisture level comes back to its original.

Germination testes were conducted in a germinator maintained within 15 – 25°C during a 16-hour light period and an 8-hour dark one with a light intensity of 38u $molm^{-2}s^{-1}$ provided by cool-white fluorescent lamps (ISTA…, 1985). Fifty seeds with four replications were placed on two layers of filter paper moistened with 5 ml of distilled water in covered 9 cm Petri dishes. To prevent fungal contamination, Thiram (0.09 kg per 25 kg grass seed) was added to each Petri dish. Germination was monitored every day for 21 days, and the seeds were counted when they exhibited a radicle extension of ≥ 2 mm.

(Hardegree and Van Vactor, 2000). MGT was calculated using the formula of D.J. Cantliffe (1991), and the vigour index (*VI*) of the seedlings was calculated according to the formula by A.A. Abdul-Baki and J.D. Anderson (1973):

$$VI = RL+SL\times GP,$$

where *RL* is the root length (cm), *SL* is the shoot length (cm), and *GP* is the germination percentage. The coefficient of uniformity of germination was also calculated using the equation suggested by J.D. Bewley and M. Black (1994).

Analysis of variance of the data was computed using the MSTAT – C Program (Michigan State University). The LSD test at a 5% level of probability was used to evaluate the differences among means.

## RESULTS

*Germination*. Analyses of variance showed that the interaction between species × priming was significant ($P < 0.01$) for the germination percentage, the mean germination time, and the coefficient of uniformity of germination in *F. arundinacea* (Table).

Effect of the priming ion one the germination percentage, mean germination time (MGT), coefficient of uniformity of germination (CUG), and vigor index of *Festuca arundinaceous* (*F*) and *Agropyron desertorum* (*A*)

| Priming | Species | Germination, % | MGT, days | CUG | Vigor index |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Water 1 day | *F* | 94.0 | 4.232 | 0.001733 | 66.73 |
| | *A* | 83.5 | 2.890 | 0.001398 | 88.97 |
| Water 3 days | *F* | 92.5 | 3.874 | 0.001627 | 83.07 |
| | *A* | 79.5 | 3.751 | 0.001597 | 60.65 |
| Water 6 days | *F* | 92.0 | 4.488 | 0.001782 | 63.39 |
| | *A* | 92.5 | 3.542 | 0.001535 | 81.05 |
| $KNO_3$ 1.5 MPa 1 day | *F* | 84.5 | 4.245 | 0.001725 | 70.12 |
| | *A* | 78.5 | 4.961 | 0.001902 | 82.23 |
| $KNO_3$ 1.5 MPa 3 days | *F* | 80.0 | 3.627 | 0.001557 | 64.18 |
| | *A* | 78.5 | 4.780 | 0.001877 | 87.05 |
| $KNO_3$ 1.5 MPa 6 days | *F* | 84.5 | 3.245 | 0.001485 | 72.68 |
| | *A* | 42.0 | 5.433 | 0.002025 | 78.39 |
| $KNO_3$ 2.2 MPa 1 day | *F* | 93.5 | 3.578 | 0.001560 | 69.54 |
| | *A* | 53.5 | 4.562 | 0.001765 | 89.07 |
| $KNO_3$ 2.2 MPa 3 days | *F* | 90.0 | 3.462 | 0.001535 | 81.32 |
| | *A* | 67.5 | 5.834 | 0.002087 | 80.93 |
| $KNO_3$ 2.2 MPa 6 days | *F* | 83.0 | 4.100 | 0.001708 | 54.95 |
| | *A* | 29.0 | 6.152 | 0.002108 | 79.17 |
| PEG 1.5 MPa 1 day | *F* | 87.5 | 5.954 | 0.002117 | 73.16 |
| | *A* | 84.0 | 5.105 | 0.001862 | 87.00 |
| PEG 1.5 MPa 3 days | *F* | 90.5 | 5.274 | 0.001940 | 93.05 |
| | *A* | 76.5 | 6.913 | 0.002277 | 71.10 |
| PEG 1.5 MPa 6 days | *F* | 95.0 | 6.415 | 0.002098 | 89.62 |
| | *A* | 46.5 | 8.081 | 0.002225 | 79.32 |
| PEG 2.2 MPa 1 day | *F* | 88.5 | 7.787 | 0.002317 | 76.70 |
| | *A* | 79.0 | 6.042 | 0.002095 | 78.96 |
| PEG 2.2 MPa 3 days | *F* | 89.0 | 6.674 | 0.002177 | 98.73 |
| | *A* | 87.5 | 5.435 | 0.002005 | 62.51 |

Continuation of Table

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| PEG 2.2 MPa 6 days | *F* | 84.5 | 8.102 | 0.002325 | 85.41 |
| | *A* | 61.75 | 8.603 | 0.002232 | 69.86 |
| Control | *F* | 83.50 | 5.422 | 0.001980 | 51.33 |
| | *A* | 89.00 | 5.270 | 0.001965 | 81.61 |
| $LSD_{0.05}$ | | 23.51 | 1.123 | 0.0001965 | 30.87 |
| Species (*S*) | | 1391.42** | 15.148** | $4.14\times10^{-7}$** | 207.86 |
| Priming (*P*) | | 23877.1** | 5.9** | $2.08\times10^{-7}$** | 510.16 |
| *S*×*P* | | 1053.49** | 3.761** | $1.71\times10^{-7}$** | 717.31* |

*, ** significant at the 0.01 and 0.05 level, respectively.

A higher germination percentage was observed for the PEG 1.5 MPa treatment for 6 days, that was significant (11.5%) compared to the control. Also, hydropriming for 1 day was significant compared to the control. There was no lower significance exhibited between the germination percentage of the control seeds or any of the primed seeds of *F. arundinacea*. Seed treatment by priming had no statistically significant effect on the increase in the germination percentage compared with the control in *A. desertorum*. Priming by $KNO_3$ 1.5 MPa for 3 days had statistically significant effects on the decreases in MGT compared with the control. In *F. arundinacea*, hydropriming treatment for 1 day produced a statistically lower MGT than the control seed in *A. desertorum* (Table). The seed treatment by PEG 2.2 MPa for 1 and 6 days increased the coefficient of uniformity of germination of *F. arundinacea* seeds as compared to the control. Significantly, a lower CUG was obtained in $KNO_3$ 1.5 MPa for 6 days in the control seeds. In *A. desertorum*, the maximum and significant coefficient, compared to the control from priming, was obtained in PEG 1.5 MPa for 3 and 6 days (Table).

*Seedling growth.* The interaction between species × priming was significant ($P < 0.05$) for the vigor index, but there were significant main effects for the mean shoot length, seedling fresh weight ($P < 0.01$), and mean root length. The priming treatment resulted in an increase in the vigor index by PEG 2.2 MPa for 3 days. The minimum value was observed in the control seed of *F. arundinacea*. There was no significant difference found between the vigor index of the *A. desertorum* control and the primed seeds.

The greatest and significant development in the mean shoot length was observed for $KNO_3$ 2.2 MPa for 3 days, that were 11.5 mm higher compared to the control. The mean shoot length was significantly increased to 27.71 mm when primed with $KNO_3$ 2.2 MPa for 1 day, but the numerical value was 18.96 mm in the control seeds (Fig. 1).

The seedling fresh weight significantly increased for $KNO_3$ 2.2 MPa for 3 days (0.018 g / plant), and its effect was significant compared with the control (0.011 g / plant); however, all th primed samples had numerical values higher than the control (Fig. 2).

## DISCUSSION AND CONCLUSIONS

The results of this experiment indicated that osmo and hydropriming had a positive effect on seed germination of *Festuca arundinaceous* Schreb. in libratory conditions. Nevertheless, no advantage gained from any of the priming treatments in *Agropyron desertorum* (Fisch. ex Link) J.A. Schultes. The greatest percentage (95%) of seeds ap-

parently harvested corresponded to the 'low osmotic press for long time' treatment. W. Heydechker et al. (1975) remarked that, in addition to a hydration stimulus on germination in hydropriming, osmotic priming with PEG inhibits radicle emergence, limits the rate of water absorption preventing membrane damage, and restores germinability to aged seeds more effectively. Enhanced germination by osmopriming with PEG has also been reported in recent studies (Schrauf et al., 1995; Foster et al., 1999; Bonome et al., 2006).

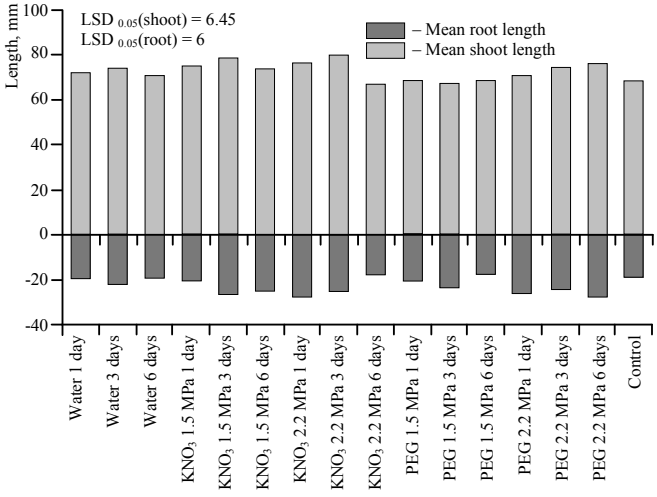


**Fig 1.** Main effect of priming treatment on the root and shoot length of *Festuca arundinaceous* and *Agropyron desertorum*

Our data show that germination of *A. desertorum* extremely decreases by $KNO_3$, it is possible that it has a detrimental effect. These results agree with those reported by L.O. Copeland and M.B. McDonald (1995) and Q.H. Yang et al. (2008) in other species however, the results are not in line with S.I. Shim et al. (2008). Priming can improve the uniformity of heterogenously matured seed lots (Olouch and Welbaum, 1996). The findings in our study show that both *F. arundinacea* and *A. desertorum* have increased the coefficient of uniformity of germination in PEG with 2.2 MPa. This might be due to a higher osmotic potential in the seeds' environment during the priming period. Therefore, the potential gradients of water uptake were lower in this treatment than in other treatments.

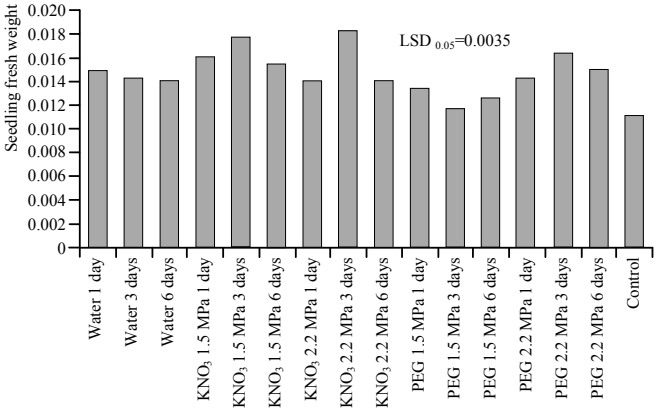


**Fig 2.** Main effect of priming treatment on the seedling fresh weight of *Festuca arundinaceous* and *Agropyron desertorum*

The resulting limitation of the rate of water absorption preventing membrane damage (Heydecker et al., 1975) and some important process are accomplished synchronic-

ally in seeds. The results of the experiment showed that osmotic priming with $KNO_3$ and hydropriming significantly decreased the MGT of *F. arundinacea* compared to PEG. The same result was obtained in *A. desertorum.* In the present case, rapid imbibitions can lead to a shorted MGT. The higher value of MGT by PEG might be due to the state of slab and mucilage of PEG, that water uptake was slower than in the other method and it resulted in less advanced metabolic processes and slower germination (Badek et al., 2006). The studies of I. Demir and H.A. Van de Venter (1999) and K.Y. Chiu et al. (2006) suggest that priming decreases MGT in the other species. The findings in our study show that osmopriming has increased the vigor index in *F. arundinacea*. Our results are in line with G.U. GongPing et al. (2000), P. Dissanayake et al. (2008) and L.T. Bonome et al. (2006) who reported that PEG 6000 and $KNO_3$ increased the vigor index. G.U. GongPing et al. (2000) suggested that the improvement of the vigor index was associated with the enhancement of activated oxygen metabolism in seedlings. On the other hand, the increased seedling length might cause increasing the vigor index in this species. None of the priming treatment tested showed a beneficial effect on the vigor index in *A. desertorum.* Our results showed that the main effect of priming on the seedling length and fresh weight was positive and significant.

These results are in line with the works done by P. Dissanayake et al. (2008), J.J. Frett and W.G. Pill (1995), W.G. Pill and T.K. Korengel (1997), W.G. Pill and A.D. Necker (2001) who reported that priming treatment increased the seedlings length and fresh weight seedling compared with nonprimed ones. W.G. Pill and T.K. Korengel (1997) knew that the Kentucky bluegrass seedling shoot mass was greater for primed seeds than for non-primed seeds because of an advancement in germination, not because of the stimulation of growth. The beneficial effect of $KNO_3$ was observed in this study, which might be the result of nutrition of $KNO_3$ on seedling after germination. Therefore, priming with a solution of $KNO_3$ for 3 days suggested a method that can be used for increasing the root, shoot, and biomass. In conclusion, priming as physiological treatment causes an increase in the seed performance in laboratory conditions in *F. arundinacea*. Nevertheless, the use of these treatments did not appear to be beneficial for *A. desertorum* seeds.

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