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EVALUATING THE POTENTIAL OF SEED PRIMING TECHNIQUES IN IMPROVING GERMINATION AND EARLY SEEDLING GROWTH OF VARIOUS RANGELAND GRASSES

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Abstract

Poor and erratic germination is a sever problem in stand establishment of range grasses. In this study, the potential of seed priming techniques in improving germination and early seedling growth of three rangeland grasses (viz. buffel grass (*Cenchrus ciliaris* (L.), dhaman grass (*C. setigerus* Vahal), and blue panic grass (*Panicum antidotale* Retz.) was evaluated in a laboratory trial. For priming, seeds were soaked in well aerated solution of $CaCl_2$, KNO_3, KCl and $CaSO_4$ (each having 10 and 50 mM solution) for 24 h. Both hydropriming and untreated seeds were considered as control treatments. Maximum germination of buffel grass was recorded from osmopriming (10 m*M* KNO_3) while in dhaman and blue panic grass low concentration of $CaSO_3$ 10 m*M* followed by priming with 50 m*M* KNO_3 proved the best. Maximum plumule length was recorded in $CaSO_4$ and 50 m*M* $CaCl_2$ while less mean germination time (1.91 and 2.06) was recorded in untreated control and 10 m*M* $CaCl_2$ respectively. Osmopriming with 10 m*M* or 50 m*M* KNO_3 can be successfully employed to improve the germination and seedling vigor in bufffel grass and low level of $CaSO_4$ to improved dhaman grass and panic grass performance in rangeland.

Introduction

Among different rangeland grasses, buffel grass (*Cenchrus ciliaris* L), dhaman grass (*Cenchrus setigerus* Vahal) blue panic grass (*Panicum antidotale* Retz.) are considered palatable and nutritious grass for all kinds of grazing animals and are native to tropical, sub-tropical Asia and Africa. In Pakistan, these are found in sub-humid pothowar and salt range along with desert areas like Thal, D.G. Khan, Kohistan and Baluchistan and can easily adopt and withstand to tropical and sub tropical summer rainfall areas with long dry season spell. These grasses are also found in the temperate regions of Pakistan. But performed well in warm climate and is restricted to tropical environment (Mushtaque, 2004). It can grow on wide range of soils varying from sandy to harder heavy textured soils with annual rainfall of 350- 800 mm and up to an altitude of 1000 m. Buffel grass is considered nutritious because it contains high percentage of protein contents (10.0-11.0%). It is preferred due to high nutritional forage for livestock and its ability to recover soon from grazing (Muhammad, 1989) for permanent pastures (Khan & Zarif, 1982) and has more nutritive value than sorghum and millet forages for ruminants (Aganga & Alwetse, 2000). It is also considered an excellent grazing grass for hot, dry areas in tropics and sub-tropics but under heavy grazing and after 4-5 years of its reseeding loses its vigor and ability to compete with other species and the present production from buffel grass is far below than its potential. The reasons for this less production are poor vegetation cover and plant density which results from low seed germination due to temperature extremes prevailing under rangeland (Hardegree & Burgess, 1995).

Seed priming is a controlled hydration treatment in which seeds are allowed to imbibe before radical protrusion (Bradford, 1986) and improves the germination rate, uniformity of germination, and sometimes greater total germination percentage (Basra *et al*., 2002, 2003, 2004, 2005, 2006; Farooq *et al*., 2004, 2005, 2006). This increased in germination rate and uniformity have been attributed to metabolic repair during imbibition (Bray *et al*., 1989), a buildup of germination-enhancing metabolites (Basra *et al*., 2005), osmotic adjustment (Bradford, 1986), and, for seeds that are not re-dried after treatment, a simple reduction in the lag time of imbibition (Bradford, 1986).

Incorporating useful seed priming agents may enhance the germination capacity in range species and hydration-dehydration treatment enhanced field establishment have been reported to improve stand establishment in several rangeland grasses (Hardegree, 1994a, b). Hardegree & Emmerich (1992) studied the effect of seed priming on four range grasses and reported increased germination at low water potential. Similarly, seed priming is also considered imperative to overcome the problem of seed dormancy in buffel grass (Butler, 1985; Hacker, 1989; Rajora *et al*., 2002; Bhattarai *et al*., 2008). The present study was therefore planned with the objective to evaluate the response of various summer rangeland grasses to seed priming treatments and find out the most appropriate one which may be employed to increase the germination, vigor of the grass and increase its productivity under rangeland.

Materials and Methods

The present study to observe the response of various rangeland grasses to seed priming treatments were carried out in Seed Physiology laboratory, Department of Crop Physiology, University of Agriculture Faisalabad. Seed of the buffel grass (*Cenchrus ciliaris* L.), dhaman grass (*Cenchrus setigerus* Vahal) blue panic grass (*Panicum antidotal* Retz.) wrer procured from National Range Research Institute, NARC, Islamabad. The experiment was comprised of following seed priming treatments viz. hydropriming, osmopriming with $CaCl_2$, KNO_3, KCl and $CaSO_4$ with two level 10 m*M* and 50 m*M* each for 24 h. Seeds without any seed treatment were taken as control. For priming, healthy seeds of all grasses in sufficient amount were hydrated in aerated solution for each of these priming treatments. For hydropriming, seeds were soaked in distilled water using 1:5 (w/v) ratio.

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Before the radical protrusion, seeds were removed from priming media and given three surface washings with distilled water, and then seeds were redried under shade to their original weight and stored in refrigerator at 5°C until use (Farooq *et al*., 2006).

Seed germination and seedling vigor of each grass were evaluated by placing ten seeds on two moistened layers of Whattman filter paper No. 42 in petri plates. Each treatment was replicated four times in a completely randomized design (CRD) was followed.

Numbers of germinated seed were counted daily following Hand Book of Association of Official Seed Analysts (Anon., 1990). Total number of seeds germinated were expressed in percentage and mean germination times (MGT) was calculated according to the equation of Ellis & Roberts (1981).

$$MGT = \sum(D_n) / \sum n$$

where

n = No of seeds which were germinated on day D,

D= No of days counted from the beginning of germination until all the seeds were germinated.

After fifteen days of germination, five seedlings were randomly selected and tested for vigor evaluation. Radicle and plumule length of germinated seed was measured with the help of transparent ruler. Collected data were statistically analyzed by following Gomez & Gomez (1983).

Results

Seed germination and seedling vigor evaluation: The study pertaining to the response of various grasses i.e. buffel grass, dhaman and blue panic grass to seed priming treatments were observed. The results indicate that priming treatments significantly affect and causes to increase the germination percentage of buffel grass as compared to control while in dhaman and blue panic grass some salt prove toxic and suppressed germination percentage, nonetheless, increase due to hydropriming was less than any other osmoticum employed for osmopriming (Table 1). Maximum (63.33%) and minimum (44.44%) germination were recorded when the seeds were osmoprimed with 10 m*M* KNO_3 and 50 m*M* KCl respectively in buffel grass while in others two grasses low concentration of $CaSO_4$ shows higher germination percentage as compared with contol and as well as other priming treatments (Table 1).

Table 1. Effect of seed priming techniques on the germination time and final germination percentage of range grasses.

Treatment	Final germination (%)			Mean germination time (days)		
	Buffel grass	Dhaman grass	Blue panic grass	Buffel grass	Dhaman grass	Blue panic grass
Control	41.13j	55.47e	55.21d	1.91e	1.66e	2.06d
Hydropriming	42.11i	55.40e	54.00e	3.94a	3.93a	3.47a
10 m*M* $CaCl_2$	48.11h	56.11d	56.85c	2.06e	3.45b	1.97d
50 m*M* $CaCl_2$	48.44d	56.89c	54.01e	3.32b	2.10d	1.88d
10 m*M* KNO_3	63.33a	54.70f	54.00e	2.99c	1.98d	2.82bc
50 m*M* KNO_3	58.78b	54.67f	55.01d	3.35b	2.06d	3.33 a
10 m*M* KCl	45.67e	44.67g	44.95f	3.31b	2.00d	3.21ab
50 m*M* KCl	44.44f	36.6h	45.10f	2.49d	2.64c	2.58 c
10 m*M* $CaSO_4$	45.33g	75.60a	77.67a	2.52d	2.08d	2.71c
50 m*M* $CaSO_4$	45.78e	72.67b	72.00b	2.49d	1.32f	2.55c
LSD value at p 0.05	**0.07**	**0.24**	**0.35**	**0.16**	**0.25**	**0.39**

Means sharing common letter in a column do not differ significantly at 5% probability level

The effect of seed priming treatment on mean germination time (MGT) was found variable (Table 1). All the priming treatments behaved similar and increase mean germination time (MGT), nonetheless, untreated seeds reduced MGT (1.91days) that was statistically similar with osmopriming with 10 m*M* $CaCl_2$ with MGT (2.06 days) in case of buffel grass (Table 1). In dhaman grass, seed priming with 50 m*M* $CaSO_4$ reduced MGT followed by untreated seed while in blue panic grass MGT time was reduced in both in $CaCl_2$ primed (1.97 days) and in control (2.06 days) (Table 1).

Seed priming treatments also affected the plumule and radicle length of all three grasses. Hydropriming resulted in decrease of the plumule length but increased radicle length (Table 2). In buffel grass no significant difference were observed in priming treatments to improved plumule length as compared to control and also some priming treatments become toxic and depressed plumule length (Table 2). Whereas osmopriming with 10 and 50 m*M* $CaCl_2$, 50 m*M* KCl and $CaSO_4$ including control increased plumule length (Table 2). However, osmopriming with 50 m*M* KNO_3 and $CaSO_4$ increased the radicle length of the grass seeds followed by hydropriming and osmopriming with 10 m*M* KCl and 50 m*M* $CaSO_4$ as compared to unprimed seeds (Table 2). Maximum plumule length (1.75cm) in case of buffel grass and radicle length (4.21cm) was recorded under the treatment of 50 m*M* $CaCl_2$ and $CaSO_4$ respectively (Table 2). While minimum plumule length (1.14 cm) and radicle length (3.77cm) was recorded when the seeds were primed with 10 m*M* KCl (Table 2).

Table 2. Effect of seed priming techniques on the plumule and radicle length of range grasses.

Treatment	Plumule length (cm)			Radicle length (cm)		
	Buffel grass	Dhaman grass	Blue panic grass	Buffel grass	Dhaman grass	Blue panic grass
Control	1.61a	1.37c	1.85ab	3.83cde	3.82c	3.81a
Hydropriming	1.40bc	1.36c	1.18d	3.96b	3.6d	4.08a
10 m*M* $CaCl_2$	1.70a	0.75f	2.07b	3.93bc	3.08e	3.91a
50 m*M* $CaCl_2$	1.75a	1.29cd	2.08a	3.88bcd	3.75c	3.92a
10 m*M* KNO_3	1.2cd	0.77f	1.38cd	3.80de	3.07e	3.83a
50 m*M* KNO_3	1.25cd	1.54b	1.18d	4.15a	3.74c	3.95a
10 m*M* KCl	1.14d	1.28cd	1.24d	3.77e	3.80c	3.95a
50 m*M* KCl	1.63a	1.18de	1.58bc	3.94 b	4.02a	3.90a
10 m*M* $CaSO_4$	1.58ab	1.14e	1.48bcd	3.98b	3.77c	3.98a
50 m*M* $CaSO_4$	1.69a	1.63a	1.62bc	4.21a	3.95b	4.14a
LSD value at p 0.05	**0.18**	**0.23**	**0.35**	**0.11**	**0.09**	**1.07**

Means sharing common letter in a column do not differ significantly at 5% probability level

Discussion

Seed priming treatments affect seed germination and seedling vigor in all the grasses which were under investigation. Among the different priming treatments various species of grasses respond differently (Tables 1, 2). Osmopriming of buffel grass with 10 m*M* KNO_3 resulted in increased seed germination while in dhaman and blue panic grass low level of $CaSO_4$ (10 m*M*) proved best as compared to untreated seed (Tables 1, 2). Our findings are similar with Chowdhary & Baset (1994) who found decreased seed germination percentage of common Kentucky blue grass and wheat seed by hydropriming. Water potential and priming duration are important factors affecting seed germination. Hardegree & Emmerich (1992) also reported that optimum seed germination occurred at higher water potential for the shortest period whereas low water potential for long period exhibited a negative response in hydropriming treatment of certain grass like Boute loua curtipendula (Michx) Torr, *Cenchrus ciliais L*, *Erogrostris lehmanniana* Nees and *Panicum coloratum* L. Contrary to our findings, other workers observed rapid earlier germination of hydropriming seeds (Farooq *et al*., 2005; Basra *et al*., 2002; Afzal *et al*., 2005, 2006; Nagar *et al.*, 1998; Bush *et al*., 2000; Hardegree, 1996; Dezfuli *et al.,* 2008).

Osmopriming was the most effective in alleviation the most adverse effect of salinity by improving seed germination percentage of wheat (Irfan *et al.,* 2006) and is also well established practice used to enhance germination of field crops but it was relatively less used in turf grasses (Siebert & Richardson, 2002). Some researcher also demonstrated that use of KNO_3 as priming agent enhanced the germination percentage of cool and warm season grasses (Mauromicale & Cavallaro, 1996; Bush *et al.,* 2000; Young *et al*., 1977; Qian *et al*., 2006) whereas observed the effect of KCl on germination percentage of sorghum seed positive to some extent which is in confirmation with our findings. The main reason of difference in reported work may be due to water potential level and temperature degree maintained during hydropriming.

However, the reduced time for mean germination time was taken by 10 m*M* $CaCl_2$ and 10 m*M* KNO_3 (Table 1). These results are similar with the findings of Farooq *et al.* (2006) and Ruan *et al.* (2002) in which they reported reduced MGT by $CaCl_2$ primed seeds. The reasons for this reduced mean germination time may be the vigorous and earlier start taken by the $CaCl_2$ primed seeds.

The effect of priming on plumule length in buffel and blue panic grass have no significant difference because control treatment in both the grasses showed better results as compared to seed priming with various osmotica. In panic grass there was no statistical difference in radicle length but in buffel grass 50 m*M* $CaCl_2$ and in dhaman grass seed priming with 50 m*M* $CaSO_4$ proved best (Table 2). Similar results were reported by Farooq *et al*., (2005) in rice, Basra *et al*., (2002) and Afzal *et al*., (2005, 2006) in wheat and Nagar *et al*., (1998) in maize. Water potential affects the length of plumule and radicle length of grass seeds like blue bunch, wheat grass, sand berg blue grass and bottle bush squirrel tail grass (Hardegree, 1998). In an experiment, Farooq *et al*., (2007) found fewer roots and shoot length due to hydropriming as compared to control treatment in rice. During osmopriming the effect of different osmotica agents on different grasses was different. The results support the findings of other workers (Siebert & Richardson, 2002; Mauromicale & Cavallero, 1996; Bush *et al.,* 2000; Young *et al*., 1977; Kader & Jutzi, 2003; Afzal *et al.,* 2006; Perveen *et al.,* 2008 and Farooq *et al.*, 2007, 2008).

In conclusion osmopriming with KNO_3 and $CaCl_2$ may effectively improve the germination and early seedling growth of range grasses.

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