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Research Article

Evaluation of different seed priming methods for improvement of seedling growth of barnyard millet (*Echinochloa frumentacea* L.) cv. MDU1

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Abstract
The present investigation was carried out to study the effect of different priming methods on improvement of seedling growth. Pre-sowing seed priming helps to improve germination and stand establishment. Seeds of barnyard millet were primed with different priming methods *viz.,* hydro priming(H_2O), hormo priming(GA_3 10ppm),organic priming(vermiwash 10%), botanical priming (Calotropis leaf extract 15%), halo priming ($KH_2PO_4$1%) and chemo priming (succinic acid 100ppm). Barnyard millet seeds were soaked in double the volume of priming media for 12hours and evaluated the seed quality parameters. Among these methods, hormo priming ($GA_3$10ppm) recorded higher values in germination (100%), shoot length (10.85 cm) and vigour index (2353) compared to other priming treatment methods. The percentage increase over control was by 5, 12.22, 16.87, 50 and 18.66 for germination percentage, root length, shoot length, dry matter production and vigour index I, respectively.

Keywords
Priming, barnyard millet, seed quality, vigour.

Introduction

Minor millets are claimed to be the future foods for better health and nutrition security. Small millets are also rich in dietary fiber, have low glycemic index and are valued for their preventive and curative health properties (Varma and Patel, 2013; Yenagi and Mannurmath, 2013). They are also known for their water stress tolerance, which makes them suitable for rainfed agricultural systems threatened by climate change.

Barnyard millet (*Echinochloa frumentacaea* L.) also known as sawa millet, is commonly grown in India, Nigeria, Niger, China, Burkina Faso, Mali, Sudan, Uganda, Chad and Ethiopia. It is an important small millet crop well adapted to low and moderate rainfall areas (500-700 mm) due to its early maturity character and it is an excellent source of dietary fiber (13 g/100 g) with good amounts of soluble (4.66 g/100 g) and insoluble (8.18 g/100 g) fractions and fair source of highly digestible (81.13 g/100 g digestibility) protein (Hadimani *et al.*, 1993;Veena *et al*.,2005). The lesser carbohydrate content which is slowly digestible (25.88 g/100 g digestibility) further increases its potential for development of functional foods.

In India, the crop is confined to states like Tamil Nadu, Andhra Pradesh, Karnataka and Uttar Pradesh. In Tamil Nadu, it is cultivated in dry lands and hilly areas of Ramanathapuram, Madurai, Salem, Namakkal, Vilupuram, Dindugal, Coimbatore and Erode districts (Channappagoudar *et al.,* 2008). The area under barnyard millet in India is about 1.95 lakh hectares and production of 1.67 million tonnes with the productivity of 8.57 q/ha. (Rashmi Yadav *et al.,* 2011).The grain is highly nutritious in comparison with other millets and has fair source of protein which is highly digestible and is an excellent source of dietary fibre with good amounts of soluble and insoluble fractions. The carbohydrate content is low and slowly digestible which makes the barnyard millet a nature's gift for the modern mankind who is engaged in sedentary activities. The grains of barnyard millet are low in phytic acid and rich in iron and calcium (Sampath *et al.,* 1990).

Quality seed is the key for successful agriculture, which demands each and every seed should be readily germinable and produce a vigorous seedling ensuring higher yield. To provide higher quality seeds, many researchers have developed new technologies called "Seed Enhancement Techniques". Among these, Seed priming is a pre-sowing strategy for improving seedling establishment by modulating pre-germination metabolic activity prior to emergence of the radicle and generally enhances germination rate and plant performance (Taylor and Harman, 1990). Priming allows seed hydration to initiate the early events of germination, but not permit radicle emergence, followed by drying to initial moisture (Ashraf and Foolad, 2005). Upon subsequent rehydration, seeds show improved seed quality parameters such as reduced time to radicle emergence, synchronization of germination, greater percentage of germination and improved the seed vigour.

Seed priming often results in more rapid and uniform seedling emergence and may be useful under adverse soil conditions. Many researchers have shown the ability of different priming treatments includes chemo priming, hormo priming, halo priming, hydro priming, botanical priming and bio priming. In this context, an attempt was made to evaluate the different priming methods on barnyard millet seeds.

Material and Methods

Genetically pure seeds of barnyard millet MDU-1 obtained from Department of Plant Breeding and Genetics, Agricultural College and Research Institute, TNAU, Madurai served as the basic material for the present experimentation. The experiment was conducted in Completely Randomized Block Design with three replications. The treatment details *viz.*, T_1-Control, T_2-hydropriming, T_3-seed priming with $GA_3$10 ppm,T_4-seed priming with vermiwash 10%, T_5-seed priming with calotropis leaf extract 15%, T_6- seed priming with $KH_2PO_4$1% and T_7-Seed priming with succinic acid 100 ppm and the seeds were primed for about 12h with respective solutions. Then the soaked seeds were air dried to original moisture content under shade for 2 days under ambient condition (28±2°C). The non-primed seeds were used as dry control. The seed quality of the primed seeds *viz.*, germination percentage (ISTA, 2007), root length(cm), shoot length(cm), dry matter production(g seedling^{-10}) and vigour index (Abdul-Baki and Anderson, 1973) were evaluated.

Germination test was carried out with 3 sub replicates of 25 seeds, were carried out in roll paper towel method (ISTA, 1999), in a germination room maintained at 25 ± 1°C and RH 96 ± 2 % with diffused light during the day. On seventh day of germination test, number of normal seedlings were counted and the average was expressed as percent.

Root length of all the normal seedlings from the germination test was measured from collar region to the root tip and the mean was expressed in cm. Shoot length of all normal seedlings from the germination test was measured from collar region to the shoot apex and the mean was expressed in cm. The normal seedlings used for growth measurements were placed in paper cover and dried under shade for 24 h and then in a hot air oven maintained at 80°C for 16 h and the weight was recorded using and electronic balance. The mean weight was expressed in g. 10 seedlings^{-1}.

Seedling vigour index was computed by adopting the following formula and was expressed in whole number. (Abdul-Baki and Anderson, 1973).

Vigour index = Germination percentage x Total seedling length (cm)

The data collected from various experiments were analysed statistically adopting the procedure described by (Panse and Sukatme, 1985). AGRES software package was used for finding critical differences (CD) values. The critical differences (CD) were calculated at 5 per cent probability level. The data were analyzed after (Snedecor and Cochran, 1967). Wherever necessary, percentage values were transformed to arc sin values before carrying out the statistical analysis.

Results and Discussion

Significant differences were observed in all the treatments. Among the different methods of priming treatments, hormo and halo priming recorded higher seed quality parameters *viz.*, germination, root length, shoot length, dry matter production and vigour index. The cent percent germination was observed in hormo and halo priming compared to non-primed seeds (dry) (95%) (Fig.1). An increase of 5% was noticed in hormo and halo priming over non primed seeds. Germination is an important stage of seedling establishment and therefore it plays a key role in crop production. Priming is one of the most important physiological methods which improves the seed performance and provides faster and synchronized germination. The primed seeds gives earlier, more uniform and sometime greater germination and seedling establishment and growth (Bardford *et al.*, 1986). The improvements in seed germination and seedling emergence were due to enhanced supply of soluble carbohydrates to the growing embryo, which was caused by an increase in alpha amylase activity. Re-drying of seeds followed by priming treatment will maintain the activity of other enzymes at the levels required for occurrence of germination.

GA_3 was found most important growth regulator to increase the germination. It releases the seed dormancy, promotes the germination and reduces the time taken for germination. The results are in agreement with findings of Mavi *et al.* (2004), Demir *et al.* (1994), Yogananda *et al.* (2004) and Afzal *et al.* (2008).The longest root length was recorded in chemo priming (13.15cm) and it was at par with halo priming (13.12cm) and hormo priming (12.68 cm) compared to non-primed seeds (11.13 cm) (Plate 1). The highest shoot length was recorded in hormo priming (10.85cm) followed by chemo priming (9.47cm) (Plate 1). The non-primed seeds recorded (9.02cm) (Fig. 2). During hormo priming, seed's imbibition occurs in the presence of GA_3, which can have direct impact on the seed metabolism and also improved the photosynthetic properties and seedling emergence. The dry matter production also higher in hormo and chemo priming (0.10g/10 seedlings) compared to non-primed seeds (0.05g/10 seedlings) (Fig. 2). Also other researchers reported that priming increased weight of utilized (mobilized) seed reserve and seedling dry weight as compared to non primed seeds. These results agree with those of (Maasoumeh *et al.,* 2014). The vigour index values were significantly improved by priming with hormones. The improvement of seed vigour was highest with hormo priming (2353) followed by halo priming (2250) (Fig. 1). The non-primed seeds recorded vigour index (1914). Similar findings were reported by Kumar and singh.(2013), Saeedipour (2013), Das *et al.* (2014), Khan *et al.* (2011), Sakhabutdinova *et al.* (2003), Afzal *et al.* (2006) and Heydecker *et al.* (1977). The vigour enhancement by using hormones as priming agent might be due to increase cell division within the apical meristem of seedling root, which caused an increase in seedling growth. Moreover, hormonal treatment maintains the IAA and cytokinin levels in the plant tissues, which enhances cell division. Enzymes such as amylases, proteases and in some cases lipases play vital roles in the early growth and development of embryo. Any increase in activity of these enzymes may result in early vigorous growth and good crop establishment.

The present findings clearly indicate that seeds primed with GA_3 are effective in improving the germination, shoot length, root length, dry matter production and vigour index of barnyard millet seeds. Seed priming is a popular and commercially used technique developed mainly to accelerate seedling emergence, uniformity and to overcome germination related problems during adverse conditions. Therefore, it is concluded that barnyard millet seeds primed with GA_3 (10ppm) for 12h could be recommended as a pre-sowing seed treatment.

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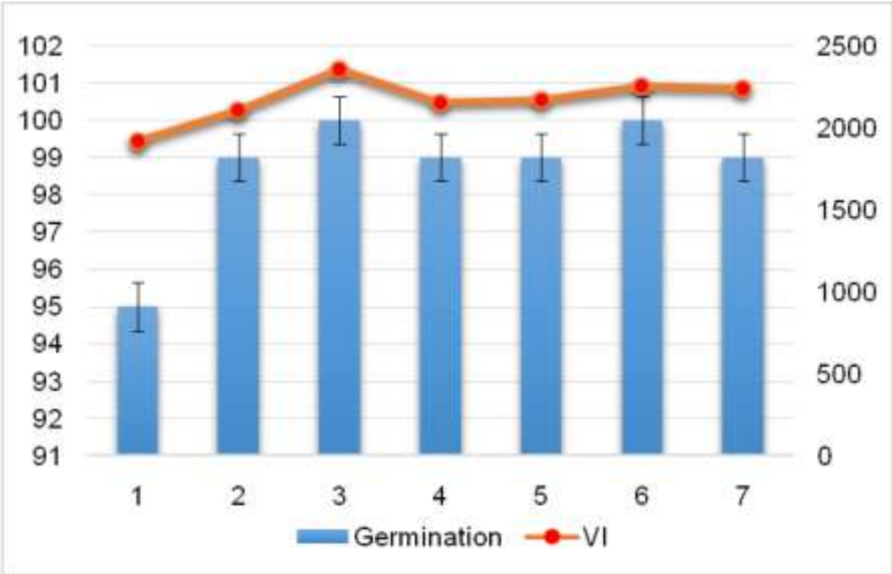

Fig. 1. Germination% and vigour index of barnyard millet MDU1

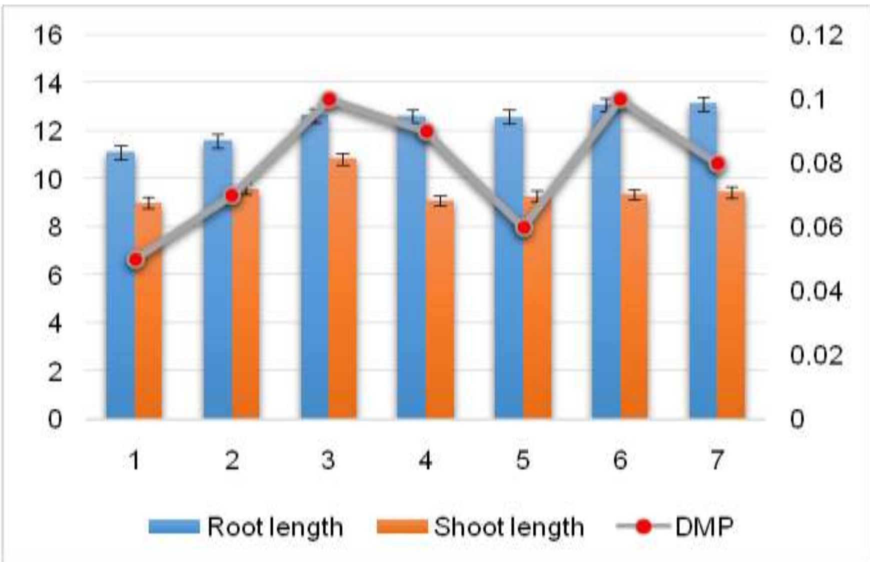

Fig. 2. Root length, shoot length and dry matter production of barnyard millet MDU1

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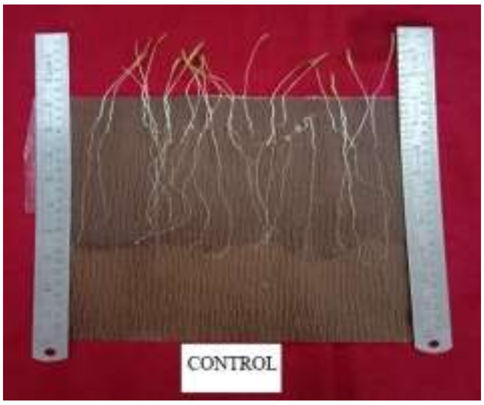

Plate 1. Seedling vigour at 7th day of germination in the barnyard millet seed primed using GA_3(10ppm) and control.

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