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Effect of Seed Invigoration Techniques on Germination and Seedling Growth of Chinese Sweet Sorghum

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ABSTRACT

To assess the comparative efficacy of different priming techniques on the germination and growth of Chinese sweet sorghum, a laboratory trial was conducted at Department of Agronomy, University of Agriculture, Faisalabad, Pakistan, during 2013. The experiment was laid in completely randomized design (CRD) and was replicated thrice. The treatments included control treatment (T_1) with no seed priming, seed priming with 1% KNO_3 for 12 hours (T_2), seed priming with 1% $CaCl_2$ for 12 hours (T_3), seed priming with 5% moringa leaf extract for 12 hours (T_4), 10% moringa leaf extract for 12 hours (T_5) and 15% moringa leaf extract for 12 hours (T_6) and hydro-priming with distilled water for 12 hours (T_7). The results showed that seed priming with 5% moringa leaf extract for 12 hours (T_4) was the best seed priming technique as it gave the maximum final germination percentage and the minimum time for 50% germination as well as mean emergence time. This treatment also gave significantly the highest number of roots and leaves along with root and shoots length. Thus seed priming with 5% moringa leaf extract has the potential to give the highest germination as well as seedling growth and development.

Keyword: Forage and fodders, Hydro-priming, Moringa leaf extract, Salt-priming, Seed priming

INTRODUCTION

Agriculture continues to remain the backbone of Pakistan' economy as it contributes 21% to national gross domestic product. The crop sector contributes 10% to national agricultural GDP, while remaining 11 is shared by livestock sector. Pakistan is endowed with 37 million cattle, 32 million buffaloes, 28 million sheep and 68 million goat populations with 50990 thousand tons of milk production which ranks Pakistan 4th among the largest milk producing countries [1]. The matter of fact is that sustainable milk and meat production is totally dependent upon the economic and sustainable forage supplies throughout the year. The sources of the animal feed include crop residues (44%) grazing (28%) fodder (15%) and concentrates (03%) in Pakistan, while there is a short fall of 24% in total digestible nutrients (TDN) and 33% in digestible protein (DP) [2]. Forages are all those plants that are grown and then fed to animals in green and succulent form and if excessive forages are preserved as hay or silage to feed animals during lean periods, then these are termed as fodders. Sorghum, maize and millet constitute the major forages during summer and sometimes, are grown in association with forage legumes such as cowpea and cluster bean. Berseem, lucern and oat are the major forages that are grown during winter in Pakistan. Forages are deemed to be the most palatable and economic animal feed source. Total area under cultivated forage crops in Pakistan is approximately 2.7 million hectares with a production of 53 M tons of green forage. Average forage yields per hectare are about 19.4 tons [3, 4]. But the area under forage crops is decreasing at the rate of 2% per annum [5]. There is an acute shortage of forage during two periods i.e. June and November-December, which affect the performance of the livestock to the great extent, particularly milch animals [6]. The emerging water shortage has made the situation from bad to worse. Sorghum (Sorghum bicolor L.) is an annual and short day plant with C4 photosynthetic pathway. It is mostly grown in areas which witness extraordinarily higher temperatures with scarce rainfall and severe water deficiency. But green forage yield of sorghum is much less ranging from 14-19 t ha^{-1}, despite the fact that it has the potential to give 50-70 t ha^{-1} of green forage yield [7]. One prominent factor behind poor forage sorghum performance is weak establishment of crop in the field. Various seed invigoration techniques have the potential to increase germination, seedling growth and development and finally the economic yield of the crops. These techniques not only repair the damage caused by age factor [8] as well as alleviate the effects caused by different abiotic stresses, particularly by salinity stress [9]. Seed invigoration techniques such as hydro-priming and salt priming are known to activate the cell cycle and mobilize the storage proteins [10]. Hydro-priming involves soaking of seeds in an osmotica of low water potential to control the amount of water supply to the seed. The increased seed germination has been attributed to the initiation of germination-related processes [11], repair processes [12] and increase in various free radical scavenging enzymes, such as superoxide dismutase, catalase and peroxidase have also been demonstrated [13]. Halo-priming is a pre-sowing soaking of seeds in salt solutions. Moringa is the sole genus of Moringaceae family. Moringa oleifera L. is widely distributed in the Pacific region, sub- tropical regions [14] and in West Africa [15]. The charisma of moringa leaf juice is a substance called zeatin which is natural plant hormone [16, 17]. In addition, moringa leaf is also rich in ascorbates, carotenoids, phenols, potassium and calcium, which have plant growth promoting capabilities and often applied as exogenous plant growth enhancers, but moringa leaf extract can also be used as seed priming agent.

The present study was designed with dual objective of assessing the comparative efficacy of different seed priming techniques and their effect on the germination and seedling growth and development of Chinese sweet sorghum

MATERIALS AND METHODS

To evaluate the effect of hydro-priming, salt-priming and moringa leaf extract effects on germination and seedling growth and development of Chinese sweet sorghum, a laboratory trial was conducted at Department of Agronomy, University of Agriculture Faisalabad (Latitude 31.26 °N, Longitude 73.06 °E), during 2013. The experiment was laid out in Completely Randomized Design (CRD) and was replicated thrice. Forage sorghum seeds of uniform size with 8.2% initial moisture contents were soaked in water for twelve hours and sown in pots. There was a control treatment (T_1) with no seed priming, seed priming with 1% KNO_3 for 12 hours (T_2), seed priming with 1% $CaCl_2$ for 12 hours (T_3), seed priming with 5% moringa leaf extract for 12 hours (T_4), 10% moringa leaf extract for 12 hours (T_5) and 15% moringa leaf extract for 12 hours (T_6) and hydro-priming with distilled water for 12 hours (T_7). Time taken to 50% emergence of seedlings (E50) was calculated according to the following formulae of Coolbear et al. [18], modified by Farooq et al. [19].

$$E_{50} = t_i + \frac{\left(\frac{N}{2} - n_i\right)(t_j - t_i)}{n_j - n_i}$$

Data was analyzed by using Fisher's analysis of variance technique and the least significant difference test at 5% probability level was used to compare treatment means [20].

Moringa Leaf Extract (MLE) Preparation Bioassay

Moringa leaf extract (MLE) was prepared by collecting young and disease free leaves from moringa tree. Theses leaves were washed and then frozen for two days in refrigerator at 4◦C. Leaves were grinded in a manual juicer to extract the leaf juice. The juice was collected and filtered by passing through a muslin cloth to remove all the green matter. After that the extract was stored at room temperature.

RESULTS AND DISCUSSION

All priming techniques effected the time taken to 50% emergence of forage sorghum, but the maximum time was taken by control treatment. The least time to 50% emergence was recorded by 5% moringa leaf extract (MLE) as shown in Figure 1. The minimum mean emergence time was recorded by 5% moringa leaf extract (MLE) and the maximum mean emergence time was given by control treatment. Among the remaining treatments, $CaCl_2$ was better than other treatments. Similarly, the highest final germination was also given by 5% moringa leaf extract (Figure 2) and this was might be due to the presence of zeatin which is a natural plant growth hormone. These results are in line with Phiri [21], who applied *Moringa oleifera* leaf extracts in the ratio of 1:10 (w/v) on seeds of maize, rice, sorghum and wheat in a growth room at 25°C for 14 days and found that it not only increased the length of radical but also increased hypocotyl length of maize and wheat. It was also supported by Phiri and Mbewe [22], who conducted another series of experiments in which moringa (*Moringa oleifera* L.) leaf extracts were applied on seeds of three legumes including beans, groundnut and cowpea and found that extract obtained from moringa when applied in small concentration reduced time of germination. It was reported in the end that this moringa juica extracts also increased the length of hypocotyle of groundnut.

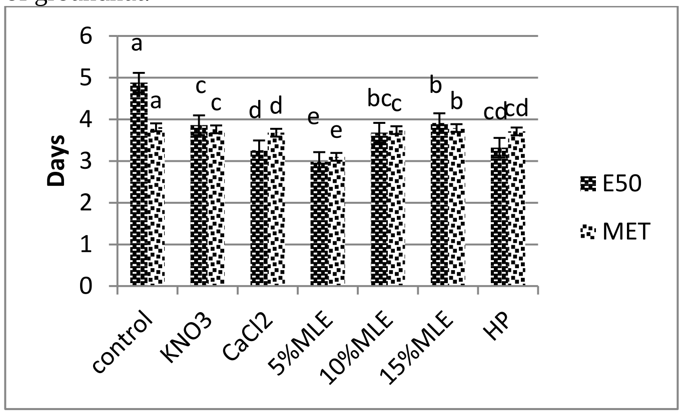

Fig.1: Effect of different priming techniques on time taken to 50% emergence (E50) and mean emergence time (MET) of forage sorghum.

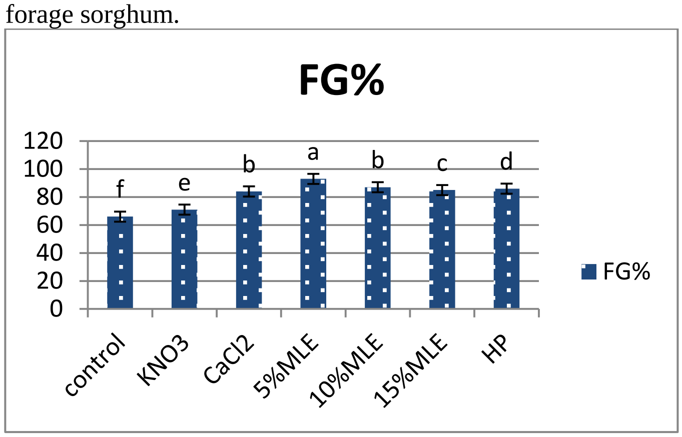

Fig.2: Effect of different priming techniques on final germination percentage (FG%) of forage sorghum.

The maximum root length and shoot length was recorded by 5% moringa leaf extract (MLE) and the minimum values were given by control treatment. This was probably due to the presence of growth promoting hormones as well as other macro and micro nutrient which increased the cell devision and there was more root and shoot length. These results are in line with Akinbode and Ikuton [23], Makkar and Becker [24] and Ella et al. [25], who described more physiological growth and development with the application if moringa leaf extract.

Following the trend, the highest number of leaves and roots were produced by plants that were treated with 5% moringa leaf extract (MLE) and the minimum values were given by control treatment. This was probably due the growth promoting effect of various nutrients present in moringa leaf extract. These findings are in agreement with Ambler et al. [26], who did a novel study by testing the xylem sap from decapitated vegetative and mature plants of nonsenescent and senescent sorghum (Sorghum bicolor L.) and analyzed them in order to check the concentration of cytokinins so as to determine whether the delayed leaf senescence of nonsenescent sorghums was linked to transport of greater quantities of cytokinins towards the roots. For field-grown plants, the amount of zeatin riboside (ZR) in xylem sap per gram shoot dry weight was 1.51 times higher for the non-senescent sorghum as compared to senescent plants. He made conclusion that higher concentration of zeatin was moved to roots that caused senescence.

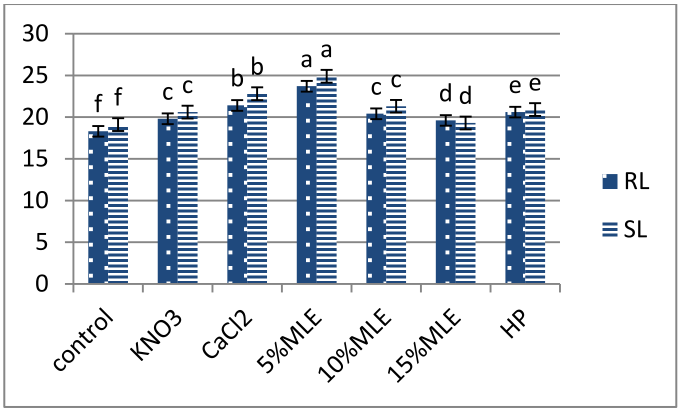

Fig.3: Effect of different priming techniques on root length (RT) and shoot length (SL) of forage sorghum.

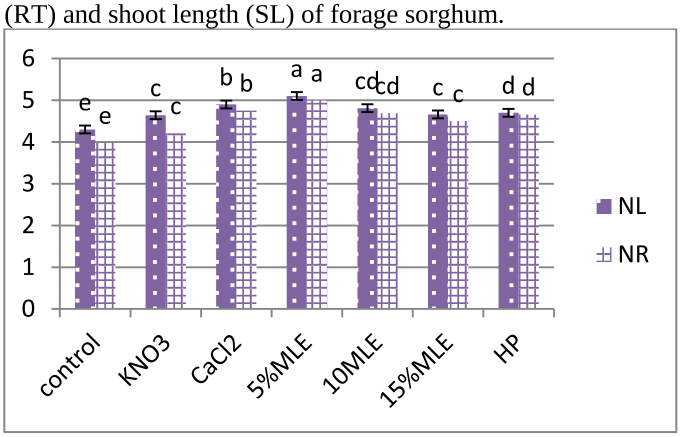

Fig.4: Effect of different priming techniques on number of leaves (NL) and shoot length (NR) of forage sorghum.

CONCLUSION

Thus seed priming with moringa leaf extract has the potential to increase the germination of Chinese sweet sorghum, but also increases the seedling growth and development. The moringa leaf extract is quite economic and environment friendly with no hazardous effect if applied in small concentration, so it can be an important priming tool replacing other priming agents and herein lies the novelty of this trial. However, there is a dire need of more research on moringa leaf extract optimization for Chinese sweet sorghum and future research should be focused on use of even lower concentration of moringa leaf extract as a seed priming agent.

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