Enhancing Sorghum Green Fodder Production Potential through Use of Various Sources and Levels of Osmopriming

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Abstract:
Poor seed performance and unsynchronized germination are the main factors which reduce fodder crops yields in tropics. In this regard a field experiment was conducted to evaluate the response of sorghum green fodder yield to various sources and levels of osmopriming. The experiment was laid down in randomize complete block design with four replications. In this research eight priming sources i.e. NaCl, CaCl₂, KCl, KNO₃, NH₄Cl, Na₂SO₄, PEG and Manitol along with seed soaking in water and control were tested on fodder sorghum performance. Sorghum seed was primed for 24 hour. The data was recorded on various phonological parameters and green fodder yield. Osmopriming sources and levels significantly affected sorghum phenology and green fodder production. PEG 8000, NaCl, CaCl₂ showed best results in term of sorghum phenology and green fodder yield. Similarly NaCl and PEG 800 were also better than other chemical sources. KNO₃ showed very poor performance among all chemicals. The lower levels of most chemicals performed better than

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higher levels. It was concluded that soaking seed with osmopriming agents improve phenology and green fodder production.

Key words: sorghum green fodder production, levels of osmopriming, phenology

1. Introduction

Sorghum (*Sorghum bicolor* L.) is an important food and forage crop of arid and semi arid region of the world. It ranks fifth among cereals after wheat, maize rice and barley. Sorghum contains 6.84 % protein, 1.5 % fats, 6.75 % ash, and 53.1 % nitrogen free extract [1]

Seed priming comprises the soaking of seed in water and drying back to the storage moisture until use. The soaking induces a range of biochemical changes in the seed that are required to start the germination process such as breaking of dormancy, hydrolysis or metabolism of inhibitors, imbibition and enzyme activation. Some or all of these processes that precede the germination are triggered by priming and persist following the re-desiccation of the seeds. Thus upon seeding, primed seed can rapidly imbibe and revive the seed metabolism, resulting in a higher germination rate and a reduction in the inherent physiological heterogeneity in germination. The resulting improved stand established can reportedly increase drought tolerance, reduce pest damage, increase crop yield [2].

Crop production is affected by a low chemical availability of P and Zn. Especially during the early growth stages, a lack of P and Zn retards seedling growth, rendering the young plantlets particularly sensitive to the frequently encountered dry spells [3]. A rapid establishment of healthy seedlings and a sufficient supply with P and Zn are prerogative to reduce the risk of crop failure. Nutrient priming has been
proposed as a novel technique that combines the positive effects of seed priming with an improved nutrient supply [4]. In nutrient priming, seeds are pretreated (primed) in solutions containing the limiting nutrients instead of being soaked simply in water.

Keeping in view the positive effects of this low cost alternative approach, the present experiment was therefore conducted to evaluate the effect of seed priming in nutrient solutions on emergence and yield of maize.

2. Materials and Methods

Site description
The experiment was conducted at New Developmental Farm KPK Agricultural University Peshawar during summer 2007. The experimental farm is located at 34.01° N latitude, 71.35° E longitude at an altitude of 350 m above sea level in Peshawar valley. Peshawar is located about 1600 km north of the Indian Ocean and has continental type of climate. The research farm is irrigated by Warsak canal from river Kabul. Soil is clay, low in organic matter (0.87%), extractable P (5.6 mg P kg⁻¹), exchangeable potassium (121 mg K kg⁻¹), alkaline (pH 8.2) and is calcareous in nature. Mean annual rainfall in the region varies from 300 to 500 mm, of which 70% occurs in summer.

Experimental description
Eight osmopriming sources each with two levels were used in experiment along with water soaked and control were tested in a field experiment in Randomize Complete Block Design with four replications. The treatment used were T1=Control, T2=Hydro priming, T3= NaCl 150 mM, T4= NaCl 300 mM, T5=CaCl₂ 150 mM T6=CaCl₂ 300 mM, T7=KCl 150 mM, T8=KCl 300 mM, T9=Na₂SO₄ 150 mM T10=Na₂SO₄ 300 mM, T11=NH₄Cl 150 mM, T12=NH₄Cl 300 mM, T13=KNO₃ 150 mM T14=KNO₃ 300 mM.
The seeds were primed for 24 hours before sowing. Dry seeds of sorghum were used as a control treatment. Basal dose of NP at the rate of 100-50 kg ha\(^{-1}\) was applied to each plot. Urea and Single Super Phosphate was used as sources of N and P, respectively. Plot size was 3x4 m with seed rate of 25 kg ha\(^{-1}\). Approximately 30 g of primed and untreated seed was sown in each plot of 12 m having 6 rows of 4 m length and 50 cm apart. All other agronomic practices including hoeing, weeding and irrigation were uniformly applied to each plot treatment during the experiment.

The data on number of stalk m\(^{-2}\) was recorded by counting number of plants in one-meter row length at three different places in each plot plants was counted and average was obtained. Numbers of leaves were counted on five representative tillers randomly selected in two central rows in each treatment and average was calculated. Five plants were harvested from two central rows of each treatment at bloom stage and were weighted with electronic balance in the laboratory. The plants harvested for shoot fresh weight was dried in the sun and was again weight after complete drying. For biological yield two central rows was harvested air-dried, weighed and was converted in to ton ha\(^{-1}\).

**Statistical analysis**

Data collected during the course of the experiment was analyzed according to Randomize Complete Block Design and upon obtaining significant F. value; least significant difference (LSD) test was employed [5].

**3. Results and discussions**

**Stalk m\(^{-2}\)**
Stalk m\(^{-2}\) was significantly affected by osmopriming sources and levels of osmopriming concentration while insignificantly by chemical sources (CS) Vs levels (Table 1). The interaction between CS x C, and HP Vs CS was not significant. Mean values showed that maximum stalk m\(^{-2}\) (46.6) was recorded for CaCl\(_2\) 150mM followed by Na\(_2\)SO\(_4\) 150mM (42.1) stalk m\(^{-2}\) while minimum stalk m\(^{-2}\) (28.9) was recorded for KNO\(_3\).

Control produced more stalk m\(^{-2}\) (39.8) compared with hydropriming (36.4). Hydropriiming produced more stalk m\(^{-2}\) (38.5) than chemical sources (36.1).Lower concentration of all chemical sources produced stalk m\(^{-2}\) than higher concentration except KCL, PEG 8000 and Manitol. Same results are obtained by Hubungi [6] who reported that more stalks\(^{-2}\) in lower levels of osmopriming agents was recorded due to of high germination and good crop establishment.

Number of leaves stalk\(^{-1}\)

Statistical analysis of the data revealed that number of leaves stalk\(^{-1}\) was significantly affected by osmopriming sources (OS) while none significantly affected by levels of osmopriming concentration (table 1). The interaction between control (C) Vs chemical sources (CS) was not significant while significant for Hydropriiming (HP) Vs CS. Mean values showed that maximum number of leaves stalk\(^{-1}\) (19) was recorded for CaCl\(_2\) 150mM followed by hydropriiming (18.9 leaves Stock-1) while minimum number of leaves stalk\(^{-1}\) (14.5) was recorded for KNO\(_3\) 150 mM. Control produced more number of leaves stalk\(^{-1}\) (17.4) compared with hydropriiming (17.1). Hydropriiming produced more number of leaves per stocks (18.9) than chemical sources (16.9). Lower concentration of KCL CaCl\(_2\) and NaCl\(_2\) and NH\(_4\)Cl produced more number of leaves stalk\(^{-1}\) than higher concentration while high concentration of Manitol, PEG 8000, Na\(_2\)SO\(_4\) and KNO\(_3\) produced more number of leaves per stock.
than lower concentration. These results are in agreement with the work of Ruiz and his colleagues [7].

**Shoot fresh weight (g)**

Shoot fresh weight was significantly affected by (OS) and osmopriming levels (OL) (Table 1). The interaction between control (C) Vs hydropriming (HP) was not significant and chemical sources (CS) Vs HP was significant. Mean values showed that maximum shoot fresh weight (178.75 g) was recorded for CaCl$_2$ 150mM followed by NaCl 150mM (177 g) while minimum shoot fresh weight (147 g) was recorded for KNO$_3$ 150 mM. Control produced less shoot fresh weight (159 g) than hydropriming (163.6 g). Hydropriming produced less shoot fresh weight (156.3 g) than chemical sources (164.5 g). Lower concentration of KNO$_3$ CaCl$_2$, NaCl and NH$_4$Cl produced more shoot fresh weight than higher concentration while lower levels of PEG 8000, Manitol and Na$_2$SO$_4$ produced less shoot fresh weight than higher concentration. This decrease in shoot fresh weight is due to decrease in leaf area and thus less photosynthesis [3].

**Shoot dry weight (g)**

Data regarding shoot dry weight is presented in table 1. Statistical analysis of the data revealed that shoot dry weight was significantly affected by osmopriming sources (OS) and osmopriming levels (OL). The interaction between control (C) Vs hydropriming (HP), and chemical sources (CS) Vs HP was none significant. Mean values showed that maximum shoot dry weight (33.40 g) was recorded for CaCl$_2$ 150mM followed by NaCl 150mM (31.85 g) while minimum shoot dry weight (21.90 g) was recorded for KNO$_3$ 300 mM. Control produced and hydropriming produced same shoot dry weight (27.7 g). Hydropriming produced less shoot dry weight (27.1 g) than chemical sources (27.7 g). Lower concentration of KNO$_3$ CaCl$_2$, NaCl and NH$_4$Cl produced more shoot dry weight than higher concentration while lower levels of PEG 8000, Manitol and Na$_2$SO$_4$ produced less shoot dry weight than higher concentration.
NaCl and NH$_4$Cl produced more shoot dry weight than higher concentration while lower levels of PEG 8000 Manitol and Na$_2$SO$_4$ produced less shoot dry weight than higher concentration. The decrease in shoot dry weight might be due the fact of poor leaf area and thus low photosynthesis [3].

**Fodder yield (kg ha$^{-1}$)**
Fodder yield is one of the most important parameter. The ultimate aim of a fodder is Fodder yield. Statistical analysis of the data revealed that Fodder yield was significantly affected by osmopriming sources (OS), osmopriming levels (OL), control (C) Vs hydropriming (HP), chemical sources (CS) and interaction between CS x L, and HP Vs CS (Table 18). Mean values showed that maximum Fodder yield (14.7 ton ha$^{-1}$) was recorded for NaCl followed by CaCl$_2$ (11.2 ton ha$^{-1}$) while minimum Fodder yield (2.8 ton ha$^{-1}$) was recorded for KNO$_3$. Hydropriming produced more Fodder yield (9.2 ton ha$^{-1}$) compared with chemical sources (7.9 ton ha$^{-1}$). Control produced higher Fodder yield (9 ton ha$^{-1}$) than hydropriming (8.1 ton ha$^{-1}$).

Lower concentration of NaCl, CaCl$_2$, Na$_2$SO$_4$ and Manitol Produced more Fodder yield than higher concentration while higher concentration of NH$_4$Cl, KNO$_3$ and PEG 8000 resulted in higher yield than lower concentration. The difference in Fodder yield is due to the fact that primed seed germinates more rapidly and uniformly than unprimed seeds [4]. NaCl produced higher Fodder yield the changes in growth and physiological responses induced by NaCl pretreatment are maintained throughout life cycle [7].

**Conclusion**

It is concluded from our experiment that under the semi arid condition of Peshawar valley seed priming should be carried out
for higher green fodder yield in sorghum. As green fodder is one of the most importance factor in animal feed so we recommend seed priming with osmopriming chemicals in low concentration (<150 mMol lit⁻¹).

Table: 01. Stalk m⁻² leaves stalk, shoot fresh weight, shoot dry weight and Fodder yield sorghum as affected by different sources and levels of osmopriming.

<table>
<thead>
<tr>
<th>T</th>
<th>Priming Source</th>
<th>Conc.</th>
<th>Stalk m⁻²</th>
<th>Leaves plant⁻¹</th>
<th>Fresh Weight (g)</th>
<th>Dry Weight (g)</th>
<th>Fodder yield (ton ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td></td>
<td>39.8 abcde</td>
<td>17.4 cdefg</td>
<td>159.0efg</td>
<td>27.70efg</td>
<td>9.0 d</td>
</tr>
<tr>
<td>2</td>
<td>HP</td>
<td>38.5g</td>
<td>18.9ab</td>
<td></td>
<td>156.2fgh</td>
<td>27.13fgh</td>
<td>9.2d</td>
</tr>
<tr>
<td>3</td>
<td>NaCl 150mM</td>
<td>39.1abcd</td>
<td>17.7abcd</td>
<td></td>
<td>177.00ab</td>
<td>31.85ab</td>
<td>19.3a</td>
</tr>
<tr>
<td>4</td>
<td>NaCl 300M</td>
<td>34.6abc</td>
<td>17.2cdefg</td>
<td></td>
<td>163.75de</td>
<td>27.25efg</td>
<td>10.1cd</td>
</tr>
<tr>
<td>5</td>
<td>CaCl₂ 150M</td>
<td>46.6bcdef</td>
<td>19.0a</td>
<td></td>
<td>178.76a</td>
<td>33.40a</td>
<td>16.5b</td>
</tr>
<tr>
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<td>CaCl₂ 300M</td>
<td>35.2a</td>
<td>16.4defgh</td>
<td></td>
<td>158.7efg</td>
<td>27.75ef</td>
<td>5.9c</td>
</tr>
<tr>
<td>7</td>
<td>KCl 150M</td>
<td>32.1bcde</td>
<td>18.6abc</td>
<td></td>
<td>175.5ab</td>
<td>30.95bc</td>
<td>10.5c</td>
</tr>
<tr>
<td>8</td>
<td>KCl 300M</td>
<td>32.2cdef</td>
<td>17.7abcde</td>
<td></td>
<td>171.25bc</td>
<td>30.35bcd</td>
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</tr>
<tr>
<td>9</td>
<td>Na₂SO₄ 150M</td>
<td>42.1ab</td>
<td>16.2fgh</td>
<td></td>
<td>158.75ef</td>
<td>25.85hi</td>
<td>9.3d</td>
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<td>26.8f</td>
<td>17.5bcde</td>
<td></td>
<td>169.00bc</td>
<td>29.35cde</td>
<td>5.6e</td>
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<tr>
<td>11</td>
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<td>16.0fgh</td>
<td></td>
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<td>25.80hi</td>
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<td>12</td>
<td>NH₄Cl 300M</td>
<td>34.6bcdef</td>
<td>15.9ghi</td>
<td></td>
<td>151.75gh</td>
<td>24.68ij</td>
<td>9.0d</td>
</tr>
<tr>
<td>13</td>
<td>KNO₃ 150M</td>
<td>30.3def</td>
<td>14.5i</td>
<td></td>
<td>147.00i</td>
<td>22.85jk</td>
<td>2.6g</td>
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<tr>
<td>14</td>
<td>KNO₃ 300M</td>
<td>28.9ef</td>
<td>15.3hi</td>
<td></td>
<td>149.75hi</td>
<td>21.90k</td>
<td>3.0g</td>
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<tr>
<td>15</td>
<td>Manitol 2%</td>
<td>37.9abcd</td>
<td>16.8defg</td>
<td></td>
<td>156.25fg</td>
<td>25.88ghi</td>
<td>9.1d</td>
</tr>
<tr>
<td>16</td>
<td>Manitol 4%</td>
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<td>17.3cdefg</td>
<td></td>
<td>166.75cd</td>
<td>28.15def</td>
<td>4.1f</td>
</tr>
<tr>
<td>17</td>
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<td>40.2abc</td>
<td>16.9defg</td>
<td></td>
<td>174.25ab</td>
<td>28.65def</td>
<td>5.6c</td>
</tr>
<tr>
<td>18</td>
<td>PEG 200g L⁻¹</td>
<td>40.9ab</td>
<td>17.1defg</td>
<td></td>
<td>175.50ab</td>
<td>28.93def</td>
<td>5.7e</td>
</tr>
</tbody>
</table>

Mean followed by same letter(s) with in the same category are not different statistically using least significant difference (LSD) test at 5% level of probability.

REFERENCES

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