Response of pearl millet varieties to different dates of sowing at Makoholi and Kadoma Research Stations, Zimbabwe

Accepted 26th February, 2014

ABSTRACT

Pearl millet [Pennisetum glaucum (L.) R. Br.] is a drought-tolerant crop that may serve as an alternative summer crop in the dry region of Zimbabwe. A field experiment was conducted in 2002 at Makoholi Research station and Kadoma research station, to determine the yield response of pearl millet varieties to sowing date. Three improved early maturing varieties namely; PMV 1, PMV 2, PMV 3, and one late maturing popular local varieties namely; Tsholotsho bearded were used. There was significant differences (p<0.05) between the three sowing dates at Kadoma research station while at Makoholi research station sowing dates had no significance at 5% significance level. The crop sown on 6 December 2002 gave highest grain yield of 1754 kg ha⁻¹ at Makoholi and 1031 kg ha⁻¹ at Kadoma.

Key words: Pearl millet, sowing date, grain yield, stover yield, Agro-ecological zones.

INTRODUCTION

Pearl millet is the second most important summer cereal crop after maize in Zimbabwe with about 182 000 ha estimated to be sown annually (statistical yearbooks, 1985-1997). Subsistence communal farmers in the low rainfall (450 to 650 mm) regions III, IV and V account for about 99% of the total area sown to pearl millet (Statistical Yearbooks, 1985-1997). Pearl millet (Pennisetum glaucum (L.) R. Br) is the most draught tolerant of all domesticated cereals and can yield grain under rainfall as low as 200 to 250 mm (Bidinger and Hash, 2003). This therefore makes the cereal a reliable alternative to maize in rain fed regions of the arid and semi-arid tropics.

Even with minimal rainfall, pearl millet will typically still produce high yields. Besides providing food for human, millet stems are used for a wide range of purposes, which include: the construction of hut walls, fences and thatches, and the production of brooms, mats, baskets, sunshades, etc (IFAD, 1999). Yet pearl millet grain yields in the communal areas are very low averaging about 400 kg ha⁻¹. This is inspite of concerted research and extension efforts to develop and disseminate improved varieties and crop management practices.

Crop improvement work by the Sorghum/Millets Research Program in Zimbabwe has seen the release of improved varieties (PMV-1, PMV-2, and PMV-3) which are higher yielding and earlier maturing than the farmers’ traditional varieties like the Tsholotsho bearded. These varieties provide a maturity range from which farmers can select depending on their local rainfall conditions.

A major problem of rain-fed agriculture in semi-arid regions with short rainy seasons is how to determine the optimum sowing date. Previous work has however not evaluated the effect of sowing dates on performance of these improved varieties. Date of sowing directly affects the length of the growing season, varieties of different maturity groups will correspondingly be affected. The current study was therefore undertaken to determine the effect of sowing date on pearl millet varieties of different maturity groups.

MATERIALS AND METHODS

Study site

The study was conducted at Makoholi research station and Kadoma research station which are in natural farming region
Table 1. Effect of sowing date on yield and yield components of pearl millet.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sites</th>
<th>Grain yield (kg/ha)</th>
<th>Thousand grain mass</th>
<th>Stover yield (kg/ha)</th>
<th>Plant height</th>
<th>Days to maturing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Makoholi</td>
<td>Kadoma</td>
<td>Makoholi</td>
<td>Kadoma</td>
<td>Makoholi</td>
<td>Makoholi</td>
</tr>
<tr>
<td>SD 6 Dec</td>
<td>1754</td>
<td>1031^c</td>
<td>9.213^c</td>
<td>10.03</td>
<td>1635</td>
<td>3210</td>
</tr>
<tr>
<td>SD 20 Dec</td>
<td>926</td>
<td>352^ab</td>
<td>7.638^a</td>
<td>9.44</td>
<td>1022</td>
<td>1894</td>
</tr>
<tr>
<td>SD3 Jan</td>
<td>1032</td>
<td>139^a</td>
<td>8.356^b</td>
<td>8.95</td>
<td>1282</td>
<td>2172</td>
</tr>
<tr>
<td>lsd</td>
<td>744.2</td>
<td>217.3</td>
<td>0.5765</td>
<td>1.153</td>
<td>919</td>
<td>1632.5</td>
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<tr>
<td>P value</td>
<td>0.067</td>
<td>0.001</td>
<td>0.002</td>
<td>0.15</td>
<td>0.33</td>
<td>0.196</td>
</tr>
<tr>
<td>Significance</td>
<td>NS</td>
<td>S</td>
<td>S</td>
<td>NS</td>
<td>NS</td>
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</tr>
</tbody>
</table>

*NS-Not significant, S-significant at 5% level *SD: Sowing date.

II and IV, respectively. Kadoma is 1157 m above mean sea level and Makoholi has an altitude of 1208 m.

Experimental procedure

An open environment field experiment was set up to evaluate potential of pearl millet varieties production at Makoholi Research station and Kadoma research station in 2002 under rain fed conditions.

The trial was conducted in a split-plot design with sowing date and pearl millet varieties as factors. Sowing date was the main plot and the varieties being sub plots, sowing was done on 6 December 2002, 20 December 2002 and 3 January 2003 using PMV-1, PMV-2, PMV-3 and Tsolostho varieties of pearl millet. A seed rate of 10 kg ha⁻¹ was used in 0.75 m rows in gross plots of 6 rows: 0.75 × 5 m and net plot of 4 rows: 0.75 × 4 m. Fertilizer application was at the rate of 400 kg ha⁻¹ for compound D (8:14:7) and 100 kg ha⁻¹ of Ammonium nitrate (34.5%). Thinning was done at three weeks after sowing.

Data collection

Dates of all operations were noted; data collected included Days to 50% seedling emergence, 50% flowering, and 50% physiological maturity. Physiological maturity was determined by the presence of the black layer at the attaching part of the grain to the heard.

Number of plants per net plot before and after thinning, and at harvest were recorded. Numbers of leaves per plant at 50% flowering were also recorded. Weight of grain per net plot after harvest was collected.

For the height of main shoot, six representative plants from each net plot were selected randomly, their height measured from ground level to the tip of panicle or plant, and the mean recorded.

Fresh weight of stover subsample was recorded by harvesting all the six plants from each net plot which were weighed (leaves + stem) in the laboratory, recording total fresh weight.

Dry weight of stover subsample was collected by drying the six plants (leaves + stem) as in fresh weight data collection above at 60-80°C for 48 h.

Dry weight of stover for the sub sample was measured by drying the six plants (leaves and stem) as in fresh weight data collection above and drying was done in an oven at 70°C for 48 h.

Statistical analysis

Analysis of variance (ANOVA) was used to determine significant differences. Correlation coefficients were calculated for the relationship between crop yield and several crop parameters. All data was statistically analyzed using the Genstat Discovery 4. Confidence level was at 5%.

RESULTS

There were significant differences (P<0.05) between the three sowing dates which were used in the experiment at Kadoma research station, with first sowing giving a yield of 1031 kg/ha as shown in Table 1. There was no significant difference in yield due to sowing dates at Makoholi research station.

The first sowing took 112 days for the pearl millet to mature on average at Makoholi site while at Kadoma under the same date of sowing 126 days were required for the crop to be physiologically mature. The second sowing which was done on 20 December 2002 at Makoholi took 105 days on average for the crop to mature physiologically and the third sowing date of 03 January 2003 resulted in the pearl millet taking few days of 97 to mature, however more days were required at Kadoma for the crop to mature than at Makoholi as a result of different sowing dates.

Also there was significant difference of thousand grain mass at Makoholi where early sowing gave the heaviest
seeds than subsequent sowing; the mass of thousand seeds was not significantly different at kadoma. Plant height significantly differed at kadoma where tall plants averaging 1.72 m were measured in the first sowing date. However the stover yield was not influenced by sowing date at both sites.

Table 2 shows the effect of the varieties chosen in the trial for the two sites. The varieties used included three released varieties (PMV1, PMV2, and PMV3) from Sorghum and Millets Improvement Programme (SMIP) and a popular local variety, Tsholotsho bearded.

Generally high yields for the varieties were obtained at Makoholi where PMV3 gave a higher yield of 1320 kg/ha however there was no significant different in yields on the varieties used. Significance difference in yield among the varieties was noticed at kadoma where PMV3 gave a higher yield of 784 kg/ha while Tsholotsho bearded produced 395 kg/ha with PMV1and PMV2 giving similar yield just above the local variety.

Stover yield differed significantly at Makoholi where Tsholotsho variety gave the highest yield of 1902 kg ha⁻¹ and PMV3 giving the least yield of 958 kg ha⁻¹, also at all sites Tsholotsho was the tallest variety and PMV1 being the shortest variety at both sites.

**DISCUSSION**

Early flowering and grain filling stages are the most sensitive stages to water deficits (Mahalakshmi and Bidinger, 1985; Mahalakshmi et al., 1988). Both timing of stress in relation to flowering and intensity of stress determine the reduction in grain yield (Mahalakshmi et al., 1988). Most of the variation among sowing dates especially at Kadoma where there was significance could be due to the availability of water during early grain filling, the second and third sown crop had limited moisture during the grain filling stage as compared to the first sowing. As pearl millet is largely a quantitative short day plant flowering early under 12 h photoperiod, and may be delayed by 14-16 h photoperiods these changes in yield relative to day length would be expected (Mangat et al., 1999).

The first sowing date had more days taken for the crop to reach physiological maturity and the number of days dropped as sowing was delayed. Early planting allowed the crop to enjoy the full length of the growing season, utilizing all the available soil moisture and warm temperatures of summer. As sowing was delayed the number of days available for the crop to develop were reduced resulting in the crop maturing in a short period of time and yielding poorly as compared to the early sown crop. The existence of relationships between start, end and length of growing season, and number of wet days per growing season is critical for planning farming activities before the start and during the season (Mugalavai et al., 2008).

Kouressy et al. (1998) found that the number of leaves and the total biomass are higher with early sowing because of the extended development period. Bacci et al. (1998) indicates however that this greater biomass yield is mainly due to stalks and not to grain yield. In other words, higher biomass does not necessarily mean higher grain yields in fact Tsholotsho bearded had the highest stover yield of 1902 kg/ha but had the least yield of grain at Makoholi and PMV3 had the highest yield among the varieties at Kadoma site but had the poor stover yield among the varieties which were used at Kadoma.

Farmers in the rural areas use stalk of pearl millets as thatching material for their huts so the taller varieties like Tsholotsho bearded will be mostly be preferred than the PMV1 variety despite the fact that Tsholotsho is low yielding, presenting a challenge to persuade farmers to adopt improved varieties which are high yielding. Farmers especially in Binga district prefer the variety with a wide range of use e.g. thatching and fencing etc.

Manipulation of sowing dates in pearl millet offers flexibility owing to the narrowness of the optimum time of sowing as conditioned by erratic onset of the rains and shorter raining season. Differences in grain yield can be

### Table 2. Effect of Pearl Millet variety on yield and yield components.

<table>
<thead>
<tr>
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<td>Site</td>
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<tr>
<td>PMV 1</td>
<td>1206</td>
<td>423&lt;sup&gt;abcd&lt;/sup&gt;</td>
<td>7.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.68</td>
<td>1016&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>PMV 2</td>
<td>1278</td>
<td>428&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>8.81&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9.62</td>
<td>1375&lt;sup&gt;abc&lt;/sup&gt;</td>
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<td>PMV 3</td>
<td>1320</td>
<td>784&lt;sup&gt;d&lt;/sup&gt;</td>
<td>9.46&lt;sup&gt;d&lt;/sup&gt;</td>
<td>10.08</td>
<td>958&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Tsholotsho</td>
<td>1145</td>
<td>395&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.73&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>9.5</td>
<td>1902&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>Isd</td>
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<td>NS</td>
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</table>

*NS-Not significant, S- significant at 5% level.
caused by differences in either biomass accumulation or in partitioning to the grain and could be associated with genotype differences in tillering habit. In the absence of stress, biomass accumulation is a function of the amount of radiation intercepted by the leaves and the efficiency with which this is converted into biomass (Van Oosterm et al., 2002).

This annual variability makes the selection of crop types and varieties, and planning of planting dates critical, yet also difficult, for successful cropping in rainfed systems (Hussein, 1987; Kinsey et al., 1998; Raes et al., 2004). Crop yields are often reduced significantly due to the late start and early cessation of the growing season. This is further complicated by the occurrence of long dry spells during the January to February period when most crops are in their vegetative and reproductive growth stages.

PMV3 performed well in all sites in terms of its yield making it suitable for adoption in Makoholi a natural farming region IV and Kadoma which is in natural farming region II though it has better mean annual rainfall than Makoholi.

Conclusions

Based on current data and plant growth habits planting date of early December will result in significantly higher yields of grain and stover. Management recommendations change with the release of improved varieties, and additional information is needed to optimize management of small grains by the small scale farmers in the dry regions of Zimbabwe.

ACKNOWLEDGEMENT

The authors would like to acknowledge all the effort which was done by Dr. LT Gono in the implementation of the trial.

REFERENCES


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