Effect of Plant Density and Cattle Manure on Some Agronomic Traits of Sweet Corn Under Different Culture Methods

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Abstract: In order to investigate the effect of different cattle manure levels and plant densities as well as comparing two culture methods on some agronomic traits related to sweet corn, a split-factorial design was conducted as base of randomized complete block design with four replications at the research farm of Takestan, Iran, in 2009 growing season. Cattle manure rates were assigned to main plots at three levels (m1= 0, m2= 25 and m3= 50 t/ha). The combination of two methods of seed sowing (c1= flat culture-on the ridge and c2= furrow culture-on the furrow) with two planting densities (d1= 75000 and d2= 85000 plants/ha) were randomized in sub-plots. The obtained results showed that cattle manure application had highly significant effect on plant height, stalk diameter, ear diameter and green ear yield (p<0.01). So that application of 50 t/ha of cattle manure with mean of 22130 kg/ha, had highest green ear yield. Results also indicated that none of all studied traits were affected by plant densities. Seed sowing on the ridge caused an increase in stalk diameter. Interaction effect of plant density×cattle manure and cattle manure×culture method only affected ear diameter and stalk diameter, respectively. Ear diameter was affected to a highly level via triple interaction of cattle manure ×plant density ×culture method.

Key words: sweet corn; cattle manure; plant density; culture method.

INTRODUCTION

Sweet corn (zea mays) is the same botanical species as a common corn; the main difference is that the endosperm in the grains of fresh sweet corn has greater polysaccharide content at commercial maturity. To ensure a high profitability crop management, large yields have to be obtained in the field with good quality. Sweet corn is cultivated mainly in order to use its fruit (i.e., ear) and classified as vegetables. This plant in term of agronomical value for the conversion industries (conserve making and freezing) has second grade and for fresh consumption has fourth grade (Mokhtarpour, et al., 2008; Normohammadi, et al., 2001). Greatest producers of sweet corn ear are USA, Mexico, Nigeria, France, Hungary, Peru, Indonesia, South Africa and Thailand, respectively (Anon, 2010). Application of organic matters such as animal manure, green manure, plant residue and composted organic matter is accepted as a good soil management practice in sustainable crop production because it enhances soil fertility through the modification of soil physical, chemical and biological properties (Asuegbu and Uzo, 1984). Some researchers have also reported positive response of vegetables grown under both organic and inorganic fertilizer management (Taiwo, et al., 2007; Akinfasoye and Akanbi, 2005). Animal manures have been effectively used as fertilizers for centuries. Poultry manure, for centuries, has been recognized perhaps as the most desirable of these natural fertilizers because of its high nitrogen content. In addition, manures supply other essential plant nutrients and serve as a soil amendment by adding organic matter (Sloan, et al., 2003). Corn grain yield typically exhibits a quadratic response to plant density, with a near-linear increase across a range of low densities, a gradually decreasing rate of yield increase relative to density increase, and finally a yield plateau at some relatively high plant density (Duncan, 1984; Ottman and Welch, 1989; Thomison and Jordan, 1995). Fayzbakhsh, et al., (2007) and Mokhtarpour, et al., (2008) reported that ear yield had not affected by plant density, so that different densities have produced, same statistical yield. However, with increasing plant density, ear weight per plant decrease. Thus, increase of plant density, do not change ear yield, that decrease of ear weight per plant due to shading of adjacent plants (Normohammadi, et al., 2001).

Keeping all this in view, the present investigation was taken up to find out suitable planting densities and optimum culture method with consideration of applied cattle manure levels for sweet corn in the agro-climatic conditions of Takestan (semi-arid area).

MATERIALS AND METHODS

This study was conducted at experimental field of Takestan-Iran (Islamic Azad University), during cropping season of 2009 (as of June 20 until October 12). The site is located at 5 kilometers southwest of...
Takestan (Latitude 36° 04´ N, Longitude 49°39´ E; Mean annual rainfall of 257 mm; Relative humidity: 55 to 65%; Mean annual temperature: 13.8 ºc and 1265 m above sea level). The soil tissue was loamy-clay with pH: 7.6 (Table1). The experimental units were designed as split-factorial on basis of completely randomized block design with four replications. Cattle manure levels were allotted to main plots (m₁: non-application of cattle manure, m₂: application of 25 t/ha of cattle manure and m₃: application of 50 t/ha of cattle manure). Factorial application of plant density (d₁: 75000 plants/ha and d₂: 85000 plants/ha) and culture method (c₁: culture on the ridge and c₂: culture on the furrow) were also allotted to sub plots. Soil tillage was done with a tractor. The sweet corn seeds were selected from hybrid sweet corn namely ’Ksc403su’. The life cycle of this cultivar is about 90 to 100 days and recommended as spring cultivar for many areas in Iran. Cultivation method was based on ridge and furrow system. Weed control was achieved by means of two hoeings, performed at 20 and 40 days after planting (DAP). A thinning operation was performed 26 days after sowing, leaving the more vigorous plants in each plot. The under study traits in this research included: (plant height, stalk diameter, ear diameter and green ear yield). One week before the final harvest, for computing plant height, stalk diameter and ear diameter 5 plant samples collected from the usable area of each experimental plot randomly and their average in terms of said traits were considered. The distance from ground level to the insertion point of the highest leaf blade was considered as plant height. Stalk diameter was measured with a caliper rule below the ear insertion node. After discarding margin plants, the green ear yield was evaluated via total weight of green unhusked ears, and by the weight of both marketable unhusked and husked ears per each plot by a 0.001 g digital precise scale and expressed as kg/ha. Obtained data were subjected to analysis of variance (ANOVA) using the Statistical Analysis System SAS computer software at p<0.05 (SAS, 2001) and significant treatment means were separated by DMRT.

Table 1: Physical and chemical properties of experimental soil before planting.

<table>
<thead>
<tr>
<th>Soil depth(cm)</th>
<th>O.C(%)</th>
<th>N(%)</th>
<th>P(p.p.m)</th>
<th>K(p.p.m)</th>
<th>Soil texture</th>
<th>pH</th>
<th>EC(ds/m)</th>
<th>S.P(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-30</td>
<td>0.81</td>
<td>0.07</td>
<td>5</td>
<td>180</td>
<td>Clay-loam</td>
<td>7.68</td>
<td>0.75</td>
<td>41</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

Plant height:
A highly significant (p<0.01) effect of cattle manure on sweet corn plant height at maturity was observed in this study, while the individual effect of culture method and plant density was not significant. Interaction effects of cattle manure × plant density, cattle manure ×culture method and plant density × culture method as well as cattle manure × plant density× culture method, were not significant (Table 2). Significantly, taller plants (148.9 cm) were observed in manure application of 50 t/ha; which was statistically at par with the 25 t/ha of cattle manure (Table 3). The increase in plant height could be due to the improved soil fertility and soil water holding capacity. The results are in conformity with Obi and Ebo (1995) and Fallah et al., (2007).

Stalk diameter:
Data revealed that, stalk diameter was highly significantly affected by the cattle manure levels applied (p<0.01), and culture methods had significant effect on this trait (p<0.05). Plant density showed non-significant effect (Table 2). Since individual effect of cattle manure and culture method were significant, mean values for each treatment are presented in Table 3. Results indicated that cattle manure×culture method interaction had significant effect on stalk diameter (p<0.05) (Table 2), whereas the rest of interactions were not affected by this trait. According to Figure 1, in case of not applying cattle manure both culture methods (on the furrow and on the ridge) were equal statistically; while with increasing in cattle manure application, culture on the furrow was more superior than culture on the ridge and recorded higher stalk diameter (21.63 mm).

Fig.1: Effect of cattle manure and culture method interaction on stalk diameter.
Ear diameter:
The results in Tables 2, indicated that ear diameter of sweet corn was highly significantly affected ($p<0.01$) by the cattle manure levels, while the individual effects of plant density and cultured method in terms of this trait were not significant. Maximum ear diameter (41.86 mm) was obtained in plots that received 50 t/ha of cattle manure (Table 3). The interaction effects of cattle manure × plant density × culture method had a highly significant effect on ear diameter of sweet corn (Table 2). Means comparison results of data related to ear diameter (Figure 2) revealed that, among all combination treatments, 50 t/ha of cattle manure coupled with 85000 plant/ha in both culture methods (i.e., $m_3d_2c_1$ and $m_3d_2c_2$) produced the highest ear diameter (42.97 and 43.14, respectively in Figure 2-(c)). In this regard, it should be noted that, in case of cattle manure application of 25 t/ha with increase in plant density ear diameter enhanced only on the furrows. Furthermore, a decline is noticed in this trait while increasing the density at each culture method coupled with no manure application (i.e., $m_1d_2c_1$ and $m_1d_2c_2$). Inversely, in lower densities, due to lesser competition between the plants and also the existence of sufficient light as a potent source for increasing biomass, the ear diameter was increased. Totally, it should be reminded that, in a rich and fertile soil, higher densities in both culture methods, despite its partial negative effect on ear diameter, could be compensated with cattle manure application.

![Fig. 2: Influence of plant density and culture method interaction on ear diameter under application of 0 t/ha (a), 25 t/ha (b) and 50 t/ha(c) cattle manure.](image)

Green ear yield:
The production of green ears is interesting for several reasons. The ears can be harvested in a very short time (70 to 75 days), and up to four annual crops can be obtained in tropical zone (Silva, et al., 2007). If the farmer does not intend to sell green ear sweet corn, the dry grain can still be profitable. Totally, green ear yield enhancement is very important in this crop due to being an economic yield and harvested crop mainly is in the form of green ear with milky grains, having moisture content between 70 and 80% (Silva, et al., 2007). Therefore, one of the important management strategies in agricultural soil’s enrichment, in order to increase green ear yield, could be the use of cattle manure. As regards green ear yield in Table 2, Recorded data indicated non-statistical significant difference in this trait on the plant densities of 75000 and 85000 plants/ha ($p>0.05$). On the other hand, plant density had no effect on this trait. In this regard, contradictory results obtained by earlier researchers, have demonstrated the beneficial influence of higher planting densities on dry corn grain yield (Sangoi, et al., 2002; Widdicombe and Thelen, 2002), common corn (Silva, et al., 2002) and sweet corn (Silva, et al., 2003). Whereas, similar results in this term achieved by Mokhtarpour, et al., (2008) and Normohammadi, et al., (2001).

Results indicated that there was a significant difference between different values of cattle manure application on green ear yield at 1% probability level (Table 2). Means comparison showed that, with increase in cattle manure application, green ear yield increased significantly. Considering the Table 3, application of 50 t/ha produced maximum green ear yield (22130 kg/ha), while non-application of cattle manure produced
minimum green ear yield (10240 kg/ha). Cattle manure enriches the soil and increases the ability of plants to produce the ear; clearly, enhanced-use of this manure, which caused more soil fertility that, resulted in produce larger ear. Nevertheless, in case of not consuming cattle manure, the soil will get poor and a nutrient-deficient soil has low productivity that will produce smaller ear and in this case, the green ear yield decreases. Concerning our findings, both culture methods as well as all of the interactions did not influenced green ear yield.

Table 2: The mean squares of ANOVA for Plant height, Stalk diameter, Ear diameter and Green ear yield.

<table>
<thead>
<tr>
<th>S.O.V</th>
<th>df</th>
<th>Plant height</th>
<th>Stalk diameter</th>
<th>Ear diameter</th>
<th>Green ear yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replication</td>
<td>3</td>
<td>1584.461**</td>
<td>3.305**</td>
<td>48.5**</td>
<td>0.306 ns</td>
</tr>
<tr>
<td>Cattle manure</td>
<td>2</td>
<td>3824.04**</td>
<td>85.195**</td>
<td>318.237**</td>
<td>5.654**</td>
</tr>
<tr>
<td>Plant density</td>
<td>6</td>
<td>157.66</td>
<td>1.257</td>
<td>11.981</td>
<td>0.142</td>
</tr>
<tr>
<td>Cattle manure × Plant density</td>
<td>2</td>
<td>4.195 m</td>
<td>3.713 m</td>
<td>0.018 m</td>
<td>0.105 m</td>
</tr>
<tr>
<td>Culture Method</td>
<td>1</td>
<td>37.118**</td>
<td>7.545*</td>
<td>5.769 m</td>
<td>0.407 m</td>
</tr>
<tr>
<td>Cattle manure × Culture method</td>
<td>2</td>
<td>69.84**</td>
<td>6.028*</td>
<td>11.22 m</td>
<td>0.138 m</td>
</tr>
<tr>
<td>Plant density × Culture Method</td>
<td>2</td>
<td>37.471 m</td>
<td>1.632 m</td>
<td>0.034 m</td>
<td>0.051 m</td>
</tr>
<tr>
<td>Cattle manure × Plant density × Culture method</td>
<td>2</td>
<td>190.009 m</td>
<td>2.053 m</td>
<td>50.95**</td>
<td>0.077 m</td>
</tr>
<tr>
<td>Error</td>
<td>27</td>
<td>82.832</td>
<td>1.349</td>
<td>8.261</td>
<td>0.143</td>
</tr>
</tbody>
</table>

*; ** = Significant at 5 and 1% probability, respectively. ns= non-significant

Table 3: Effect of cattle manure levels and culture methods on Plant height, Stalk diameter, Ear diameter and Green ear yield of sweet corn in estimated means.

<table>
<thead>
<tr>
<th>Cattle manure (kg/ha)</th>
<th>Culture method</th>
<th>Plant height (cm)</th>
<th>Stalk diameter (mm)</th>
<th>Ear diameter (mm)</th>
<th>Green ear yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>118.9 b</td>
<td>16.08 c</td>
<td>33.1 b</td>
<td>10240 c</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>140.5 a</td>
<td>18.31 b</td>
<td>38.97 b</td>
<td>16020 b</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>148.9 a</td>
<td>20.69 a</td>
<td>41.86 a</td>
<td>22130 a</td>
</tr>
<tr>
<td>on ridge</td>
<td></td>
<td>136.94 a</td>
<td>18.76 a</td>
<td>37.63 a</td>
<td>17100 a</td>
</tr>
<tr>
<td>on furrow</td>
<td></td>
<td>135.18 a</td>
<td>17.96 b</td>
<td>38.32 a</td>
<td>15200 a</td>
</tr>
</tbody>
</table>

Means not sharing a common letter in a column differ significantly at 0.05 level of probability

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REFERENCES


