Full Length Research Paper

Determination of optimum seed rate for the production of sesame (*Sesamum indicum* L.) in the lowlands of North Shewa, Ethiopia

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On-farm study was conducted in the lowland areas of Kewot district in the North Shewa Zone, Ethiopia on two sites during 2011 crop season to determine optimum seed rate of sesame. Four seed rates (2, 4, 6 and 8 kg ha\(^{-1}\)) of sesame cultivar Adi, were arranged in a randomized complete block design (RCBD) with four replications at each experimental site. The results of analysis of variance showed that location and seed rate had no significant effect on grain yield and plant height. Similarly, interaction of seed rate and location had no significant effect on grain yield, plant height and number of branches plant\(^{-1}\). On the other hand, location and seed rate had significant (p≤0.05) effect in the number of branches plant\(^{-1}\). The maximum number of primary branches plant\(^{-1}\) (3.3) was obtained from the seed rate of 2 kg ha\(^{-1}\) and the minimum number of primary branches plant\(^{-1}\) (2.3) was obtained from the seed rate of 8 kg ha\(^{-1}\). Since the statistical analysis revealed non-significant difference among treatment yields, comparison was made by using total costs that vary. Accordingly, 2-4 kg ha\(^{-1}\) seed rate found to be optimum for the production of sesame under rain-fed condition around Kewot district and similar areas.

**Key words:** Adi, broadcast, Kewot, Medina, under rain-fed, Yelen crossing.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is considered one of the most important oil crop in the world because its seeds have high contents of oil (50 - 60%) and protein (Noorka et al., 2011; Islam et al., 2014; Toan et al., 2010; cited in Nadeem et al., 2015). In Ethiopia, sesame is mainly produced for the market and it is wanted for its seed and for the oil in the seed. Seed oil content is the most important parameter for determining its suitability for oil extraction, while sesame coat color determines the quality for the confectionery market and other purposes.

Study reports indicate that Ethiopia is among the top-five producers of sesame seed, linseed and Niger seed (Wijnands et al., 2008; cited in Sorsa, 2009). Sesame has high agronomic importance as it has the ability to adapt to harsh environments in which other crops cannot be cultivated. Hence, in many sesame-growing regions the crop is indispensable not only for its economic importance but also for its suitability in such harsh areas. Therefore, developing improved cultivars and production technology is required to increase sesame yields and...
establish stability in different growing areas (Sorsa, 2009). Islam et al. (2011) stated that plant population or seed rate is influenced by row width, crop species, soil and climatic variables and, crop use. Genetic and environmental factors affect plant density (Shirtliffe, 2007). Loss et al. (1998) indicated that plant density can affect canopy architecture, light conversion efficiency, duration of vegetative growth, dry matter production, seed yield and ultimately, the economic productivity of the crop.

Therefore, optimizing plant density, which may be defined by both the number of plants per unit area and the arrangement of plants on the ground, is a prerequisite for obtaining higher yield (Naser et al., 2013). Several research results indicated that sesame seed rates vary from place to place depending on the specific situation of the localities. El Naim et al. (2012) reported that 1.5 and 2.0 kg ha\(^{-1}\) were optimum for sesame cultivation under rain-fed conditions in sandy dunes of North Kordofan state, Sudan. Islam et al. (2014) indicated that seed yield increased while increasing the seed rate from 6 to 9 kg ha\(^{-1}\). Similarly, Noorka et al., (2011) showed that decreasing planting distance from 20 to 15 and 10 cm increased plant height, height of the first fruiting branch, seed, and oil yields ha\(^{-1}\). On the other hand, Roy et al., (2009) sowed sesame at 15, 30 and 45 cm between plants and observed that seed yield ha\(^{-1}\) and yield components were increased by raising planting space from 15 to 30 cm.

In the lowland areas of Kewot and other similar districts sesame is predominantly grown in mixed cropping with tef as it has good drought and heat tolerance capacity and can access and utilize nutrients and moisture from below the root zone of cereal crops (Langham, 2007). Therefore, to introduce sole cropping and high yielding new cultivars of sesame, determination of the seed rate is essential. According to observation trial made, national recommendation of 7 - 10 kg ha\(^{-1}\) is very high for the rain-fed production of sesame around Kewot district. Hence, this experiment was done with the objective of determining optimum broadcast seed rate under rain-fed condition in the lowlands of North Shewa, Ethiopia.

MATERIALS AND METHODS

Description of experimental site and materials

The experiment was conducted on farmers’ field in Kewot district on two localities viz., Medina and Yelen crossing, on fertile black soil types as determined by farmers’ experience for one year (2011) in the central lowland of Ethiopia. Medina is located at an altitude of 1480 m above sea level and Yelen crossing is located at an altitude of 1340 meters above sea level (Adamu and Kemelew, 2010). One improved sesame cultivar (Adi) which is early and white in color was used.

Treatments and experimental design

The treatment included four broadcast seed rates (2, 4, 6 and 8 kg ha\(^{-1}\)) of sesame cultivar Adi. Randomized complete block design (RCBD) with four replications was employed at each location. The gross plot size of 5 m x 5 m (25 m\(^2\)) with alley space of 1 m between plots and replications was employed.

Experimental procedures

The experiment was conducted under rain-fed condition during main cropping season of 2011. Seeds were sown by manual broadcast seeding method on each plot by mixing the seeds with sand. No fertilizer was applied. Weeding and other cultural practices were done based on the agronomic recommendations and/or farmers’ practices. Planting was done on July 25 – July 28, 2011.

Crop data collection and measurement

Plant height was measured in cm from the ground to the tip of the main stem as average of ten plants randomly taken at 90% physiological maturity in each plot (from the central part) by using measuring tape. Number of branches was recorded by counting the number of branches produced on the main stem as average of ten plants randomly taken from each plot from the central part. Grain yield was measured from plants harvested from the whole plot after sun drying and threshing manually. It was measured in grams and converted to kilograms per hectare basis.

Statistical data analysis

Data collected were subjected to the analysis of variance (ANOVA) following the statistical procedure stated by Gomez and Gomez (1984) by using General Analysis of Variance procedure of GenStat for Windows Version 16 (VSN International, 2013). Mean comparison was performed by using Least Significant Difference (LSD) at 5% level of significance upon obtaining significant F-values of the factor and interaction.

RESULTS AND DISCUSSION

The results of the combined analysis of variance (ANOVA) showed that location and seed rate had no significant influence on grain yield and plant height. On the other hand, there was significant (p≤0.05) difference among treatments for number of primary branches plant\(^{-1}\). Interaction of seed rate and location had no significant effect on grain yield, plant height and number of primary branches plant\(^{-1}\) (Table 1).

Grain yield

Although the seed rate, location and the interaction of seed rate and location had no significant effect on grain yield, the highest grain yield was obtained from the lowest seed rates (Table 2). It was probably related to the increased number of branches while decreasing the seed rate which may compensated for higher seed rates. In other words, the decrease in branch number by increasing plant density could be attributed to high competition between plants in the same unit area. This
indicates that lowering the seed rates may have advantage over higher seed rates. Therefore, a seed rate of 2 – 4 kg ha\(^{-1}\) seemed optimum for the study area. El Naim et al. (2012) also reported that 1.5 and 2.0 kg ha\(^{-1}\) were optimum for sesame cultivation under rain-fed conditions in sandy dunes of North Kordofan state, Sudan. In contrast, this result was in disagreement with the results obtained by Islam et al. (2014) in which seed yield increased while increasing the seed rate from 6 to 9 kg ha\(^{-1}\). However, according to Baloch et al. (2002), under increased plant density, intra-specific competition for light and nutrient leads to a reduction in grain yield. Bond et al. (2005) revealed that intra-specific competition due to different seeding densities may vary in their intensity and compensatory growth of individual plants, when grown at lower densities, results in similar grain yield over a broad range of densities. Based on the fact that marginal response in yield is very small at high population and when the marginal cost of an increase in plant density approaches the marginal return from the increase in yield, further increases in seed rate are not warranted (Graf and Rowland, 1987, cited in Naser et al., 2013). Hence, the optimum population is highly dependent up on seed cost.

**Effect of seed rate on plant height**

Increasing seed rate from 2 to 8 kg ha\(^{-1}\) had no significant effect on plant height probably due to vigorous and taller growth of lower seed rates. Similar results were reported by El Naim et al. (2012), which showed that plant density had no significant effect on plant height of sesame. On the other hand, contrasting results were obtained by Islam et al., 2014 who reported that significantly tallest plants were obtained from 10 kg ha\(^{-1}\) and the shortest plants were obtained from 6 kg ha\(^{-1}\). Similarly, Noorka et al., (2011) stated that increasing plant population density from 200000 to 266666 and 400000 plants ha\(^{-1}\) by decreasing planting distance between hills from 20 to 15 and 10 cm significantly increased plant height. According to the authors, this result might be due to the higher competition effect among plants for light in dense plant population, which may results elongation of internodes and in turn gave taller plants. Nadeem et al. (2015) obtained similar results indicating that when the number of plants m\(^{-2}\) increases, the competition for light also increases and plant grows taller to intercept maximum light.

**Effect of seed rate on number of primary branches plant\(^{-1}\)**

Decreasing seed rate from 8 to 2 kg ha\(^{-1}\) had significant effect on number of primary branches plant\(^{-1}\). The highest number of primary branches plant\(^{-1}\) (3.3) was obtained from the seed rate of 2 kg ha\(^{-1}\) and the lowest number of

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>df</th>
<th>GY (kg ha(^{-1}))</th>
<th>PH (cm)</th>
<th>NPBPP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>1</td>
<td>903.1(^{ns})</td>
<td>178.13(^{ns})</td>
<td>4.21**</td>
</tr>
<tr>
<td>Seed rate</td>
<td>3</td>
<td>844.8(^{ns})</td>
<td>6.13(^{ns})</td>
<td>1.52**</td>
</tr>
<tr>
<td>Location x seed rate</td>
<td>3</td>
<td>5561.5(^{ns})</td>
<td>33.79(^{ns})</td>
<td>0.18(^{ns})</td>
</tr>
<tr>
<td>Residual</td>
<td>18</td>
<td>8208.68</td>
<td>27.16</td>
<td>0.17</td>
</tr>
</tbody>
</table>

\(^{*}, \^{**}, \^{***}\) Significant at 5, 1 and 0.1%, respectively. df= degree of freedom, GY = Grain yield, PH = Plant height, NPBPP = Number of primary branches plant\(^{-1}\).
primary branches plant$^{-1}$ (2.3) was obtained from the seed rate of 8 kg ha$^{-1}$. As expected lower seed rate produced significantly highest number of primary branches plant$^{-1}$. These results are in agreement with Islam et al. (2014) who reported that the number of primary branches plant$^{-1}$ decreased with the increase of seed rate from 6 kg ha$^{-1}$ to 10 kg ha$^{-1}$. He also indicated that the production of higher number of primary branches per plant$^{-1}$ at a lower seed rate was probably due to numerous factors such as availability of more space and water available to the plants. Other similar evidences were also reported by Noorka et al. (2011), El Naim et al. (2012) and Nadeem et al. (2015).

### Economic analysis

Because there was no significant difference among treatment yields, developing partial budget and/or performing economic analysis was found irrelevant (CIMMYT, 1988). Hence, the treatments were compared by using total costs that vary. The lowest seed rate of 2 kg ha$^{-1}$ was out yielded only by the seed rate of 4 kg ha$^{-1}$ with yield advantage of 1.9% and with extra cost of 100%. The other two seed rates (6 and 8 kg ha$^{-1}$) produced lower yields of -2.9 and -0.2% respectively than the lowest seed rate of 2 kg ha$^{-1}$ yet with extra cost of 200 and 300% respectively. As can be seen from this result, increasing seed rate above the optimum incurred extra seed cost without any significant yield increment. Hence, the optimum seed rate of sesame for the above locations seems 2 – 4 kg ha$^{-1}$ under rain-fed condition (Table 3).

### Conclusion

This result revealed that nationally recommended seed rate of sesame could be changed depending on the situations of specific localities. Accordingly, 2- 4 kg ha$^{-1}$ seed rate found to be optimum for the production of sesame under rain-fed condition around Kewot district and similar areas. This result could be used for sole cropping of sesame and/or could be used for determination of optimum proportions for tef-sesame intercropping.

### CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

### REFERENCES


Sorsa DG (2009). Sesame trade arrangements, costs and risks in

### Table 3. Comparison of seed rates in Kewot district, Ethiopia, 2011.

<table>
<thead>
<tr>
<th>Seed rate (kg ha$^{-1}$)</th>
<th>Mean grain yield (kg ha$^{-1}$)</th>
<th>Yield advantage over 2 kg ha$^{-1}$ in %</th>
<th>Seed cost (Birr ha$^{-1}$)</th>
<th>Seed cost difference with 2 kg ha$^{-1}$ in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>516.2</td>
<td>0.2</td>
<td>40</td>
<td>100</td>
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<td>4</td>
<td>526.2</td>
<td>1.9</td>
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<td>200</td>
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<td>8</td>
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<tr>
<td>Mean</td>
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VSN International, Hemel Hempstead, UK.