**Effect of Intra and Inter-Row Spacing on Yield and Yield Component Of Sesame** **(*Sesamum indicum* L**.***)* InWag himira, North Eastern Ethiopia**

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 **Abstract**

*A field experiment was carried out during 2020 to 2022 in Waghimra zone at Ziqulla district North Eastern, Ethiopia, to evaluate the growing performance of sesame under varying inter-row and intra-row spacing. The experiment was arranged in factorial experiment with RCBD design which has three replications. The treatments included four inter row spacing (30 cm, 40 cm, 50 cm and 60 cm) and four intra row spacing were randomized. Data on traits such as plant height at maturity, number of branches per plant, number of capsule per plant, number of seeds per capsule , thousand-seed weight and seed yield were recorded. Analsisie of this results indicated that there is no interaction effect of inter and intra row spacing with consecutive season. However, combined analysis of variance over seasen showed that number of capsule per plant and seed yield were significantly affected by both main effect of inter and intra row spacing. On the other hand thousand seed weight, number of seed per capsule were significantly affected by variability of intra row spacing. A Meangfull result reveal that flowering data, maturity date, plant height, number of branch per plant, and biological yield were statically non-significant for two consecutive years exectionally of plant height ,it was significant for intra row spacing during 2020. Based on combined analsisie of variance maximum yield were obtained from 10 cm intra and 30 cm inter row spacing (****7.39 qt ha-1****) while the lowest yield (****5.93qt ha-1****) were obtained from 5cm intra row spacing 60 cm inter row spacing .Therefore, 10cm intra and 30cm inter row spacing should be applied to attain maximum seed yield at Ziqulla district and similar agroecology.*

**Key words: Agronomic efficiency, parial budget and spacing**

 **Introduction**

Oil crops are one of the principal sources of oils and fats. Growth and improvement of the oilseed sector can substantially contribute to the economic development at national, regional and family levels. Sesame seed has become one of the most important oilseeds for Ethiopia’s export earnings and for increasing the potential of generating income for the local population. Despite the potentials of sesame, the national’s sesame average yield remain lower (7.06 kg ha-1) than Amhara region (7.72 kg ha-1). Ziqulla is one of the districts which is found in Waghimra zones that is suitable for sesame production however, the average productivity is **3.72** per hectare two fold times lower than regional and national average respectively.

The low yield of sesame has been partly attributed to inappropriate plant density, planting time, and pest pressure (weeds, diseases and insect pests) (Gebremichael, 2011). The establishment of an adequate plant density is critical for utilization of available growth factors such as water, light, nutrients and carbon-dioxide and to maximize grain yield. Too wide spacing leads to low plant density per unit area and reduces ground cover, whereas too narrow spacing is related to intense competition between plants for growth factors (Singh et *al*., 2004). It is observed that spacing of crop is important for good yield. Harper (1983) reported that with non-tillering (branching) crop varieties, higher yield per plant will give high total yield per hectare once the optimum population is not exceeded. Adeyemo et *al*., (1992); Olowe and Busari, (1994) reported that decrease in inter row spacing resulted in decreased yield per plant although yield per hectare increase significantly. On the other hand, the variation in plant density has been related to the variation in the number of capsules per plant, seed yield per plant and 1000-seed weight (Rahnama and Bakhshandeh, 2006), and plant height, number of branches per plant and seed yield (Ngala et *al*., 2013).In the distirct the there is no any visible recommendation of both intra and inter row spacing for sesame except the blanket recommendation of 40cm x10 cm there for conducting of this experment was mandatory to the area**.**

* **Objective**: To determine Appropriate and economic feasible of intra and inter row spacing for sesame crop production

**Materials and Methods**

**Description of the study Area**

The study was conducted at Ziqulla District, North Eastern Ethiopia located about at 800 km and 500 km from of North of Addis Ababa and North East of Bahir dar respectively. The experimental site is situated at 120 48’ 72’’ N’ latitude and 38048’ 26′′ E longitude at 1512 meters above sea level. The experiment was conducted under main seasen during 2020/2022 cropping season. The rainy season starts in early july and rains up to end of September. Annual rain fall was 430 mm, and the mean maximum and minimum air temperature of 30oC and 32oC respectively. The net plots were the middle 4 rows; the 2 outer rows of each plot were used as border rows. Thus, the size of the gross and net plot was 7.2m2 (3m x 2.4m) and 4.8m2 (3 x1.6m). The soil of the experimental plot is clay loam. The experiment was laid out in a factorial arrangement with RCBD design maintaining three replications in a plot size of 7.2 m2.

 The inter-rows spacing were 30 cm, 40 cm, 50 cm 35 cm and 60 cm and the intra-rows spacing were 5 cm, 10 cm, 15 cm, and 20 cm. The crop was sown manually on a well-prepared seedbed dibbling seeds per hill. Soon after the germination, a single seedling per hill was kept to obtain a uniform stand of the crop. Crop management practices such as weeding, fertilization and plant protection measures were kept normal and uniform in all treatments. Five plants were randomly selected to record plant height, number of branches per plant, number of capsule per plant and number of seeds per capsule in each plot. Seed yield was recorded from each plot. The collected data were compiled and subjected to analysis of variance using Genstat statistical computer package. Least significant difference (LSD) test was employed at 5% probability to compare the difference among treatment means.

**Result and Discussion**

The combined analysis of variance showed that number of days to flowering and maturity, plant height, number of branch per plant and biological yield was not significantly affected by both main effect of intra and inter rows spacing as well as the interaction (Table 3). This result was in contrast with the finding of Bachubhai et *al.* (2016), who stated that days to flowering and maturity were affected by row spacing in sesame crop. Adam et *al.*,(2013) also stated that number of days to flowering was significantly delayed at 75 cm than 25 cm. Langham (2007) reported that at the same moisture and fertility, high populations use up the resources sooner and go through the whole development faster from the mid bloom to the late dry down stage. Probably, application of supplemental irrigation may have dampened the effects of the study factors on the duration that was required to attain flowering phase. The number of days to physiological maturity of the plants in a plot was not significantly affected by the , row spacing and the interaction (Table1).This result disagree with the finding of Bachubhai et *al*.,(2016) who reported that row spacing had significant effects on days to maturity. Accordingly narrow row spaced plants matured faster than wider row spacing because of limitation in resource for development. In this experiment, the inherent high soil N content and supplemental irrigation provided may have reduced the need to shorten developmental phases by plants.

In the present experiment, the absence of interaction of intra- and inter-row spacing for plant height and number of branches per plant has also been reported for canola (Uzun et *al*., 2012). Early flowering and maturity at narrow spacing observed in this study could be because depletion of nutrients at high plant densities hastens processes of flowering and maturity. This agrees with the previous reports for potato (Getachew et *al*., 2012) and pearl millet (Ijoyah et *al*., 2015). However, non-significant effect of plant density on sesame flowering and maturity (El-Naim et *al*., 2010) has been reported indicating that the effect of plant density on crop phenology could vary with planting material used and location. Narrow inter-row and intra-row spacings (10cm x 30cm) increased the capsule length of sesame. This findings agree with the work of Jakusko et *al*., (2013) who reported highest capsule length at narrow spacing (30cm x 10cm).

This finding contradict with Kathiresan (2002) who reported that increase in row spacing decreased intra-specific competition and proper adjustment of plants in the field which facilitated more aeration and penetration of light which eventually caused increase in capsule length as compared to narrow spacing.

The number of seed per capsule was significantly affected by inter and intra-row spacing in both years (Table 3). The highest number of seed was recorded at narrow spacing of 10cm x 30cm ( Kafiriti et *al.* 2001) confirms maximum yield was obtained in close spacing of crops. This result in line with the finding of Ozturk (2012), Bachubhai et al.,(2016) Maximum yield was obtained from 30 cm inter-row spacing(7.38qt ha-1) and the lowest seed yield (5.93 qt ha-1) was recorded from 60 cm inter. The decrease in seed yield at the widest row (60 cm) spacing could be due to low number of population. Higher seed yield at 30 cm was because of plants had more capsules and population per unit area more than compensating for loss on per plant basis. These characters are responsible to contribute major share toward seed yield in sesame.

**Table-1 Mean Seed yield and other agronomic traits of sesame at Ziqulla 2020/2021**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Intra row spacing | FD | MD | Ph | NPB | LC | NCPP | TSW | BY | SY |
| 5 | 46.00b | 81.00b | 112.00a | 2.00b | 6.75b | 46.00bc | 2.76a | 53.07a | 6.20b |
| 10 | 47.00ab | 82.00ab | 114.00a | 3.00ab | 8.00a | 49.00abc | 2.79a | 48.61a | 7.00a  |
| 15 | 47.00ab | 83.00a | 113.00a | 3.00ab | 9.00a | 52.00a | 2.70a | 54.63a | 7.35a |
| 20 | 48.00a | 84.00a | 111.00a | 4.00a | 7.00ab | 44.00c | 2.69a | 53.30a |  6.89ab |
| Duncan(0.05) |  **\*** |  **\*** | **ns** | **\*** | **\*** |  **\*** | **ns** | **ns** | **\*** |
| Inter row spacing |  |  |  |  |  |  |  |  |  |
| 30 | 47.00a | 82.00a | 112.00a | 3.00ab | 8.00a | 48.00a | 2.63a | 74.39a | 7.02a |
| 40 | 47.00a | 82.00a | 113.00a | 3.00ab | 7.00ab | 47.00a | 2.77a | 62.94a | 6.10b |
| 50 | 47.00a | 83.00a | 113.00a | 4.00a | 8.00a | 47.00ab | 2.80a | 69.81a | 7.24a |
| 60 | 48.00a | 84.00a | 111.00a | 4.00a | 6.00b | 45.00ab | 2.74a | 65.47a | 6.83ab |
| Mean | 47.00 | 81.00 | 112.00 | 3.00 | 7.00 | 47.00 | 2.73 | 66.00 | 7.10 |
| CV | 3.57 | 6.26 | 5.65 | 16.94 | 29.64 | 26.94 | 10.09 | 18.10 | 20.75 |
| Duncan(Inter) | **ns** | **ns** | **ns** | **ns** | **\*** | **\*** | **ns** | **ns** | **\*** |
| Inter x intra spacing | **ns** | **ns** | **ns** | **ns** | **ns** | **ns** | **ns** | **ns** | **Ns** |

**ns= non-significant FD =Days to flowering , MD=Days to maturity, Ph=plant height, NPB=number of primary branch, NCPP=number of capsule per plant, TSW=thousand seed weight ,BY=Biomass yield ,SY =seed yield**

**Table -2 Mean yield and yield traits at ziqulla location 2022/2023**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Intra row spacing | FD | MD | PH | NPB | LC | NCPP | TSW | BY | NSPC | SY |
| 5 | 58.00a | 90.00a | 111.00a | 2.00ab | 6.75b | 67.00ab | 3.25a | 23.00a | 34.00a | 6.52ab |
| 10 | 59.00a | 91.00a | 107.00a | 2.00ab | 8.00a | 69.00a | 2.87bc | 25.00a | 35.00a | 6.86a |
| 15 | 59.00a | 91.00a | 108.00a | 2.00ab | 7.00ab | 63.00bc | 2.91ab | 25.53a | 37.00a | 5.94bc |
| 20 | 59.00a | 92.00a | 106.00a | 3.00a | 8.00a | 48.00c | 2.83c | 27.37a | 36.00a | 5.59c |
| Duncan(0.05) | **ns** | **ns** | **ns** | **Ns** | **\*** | **\*** | **\*** | **ns** | **Ns** | **\*** |
| Inter row spacing |  |  |  |  |  |  |  |  |  |  |
| 30 | 58.00a | 90.00a | 107.00a | 2.00ab | 8.00a | 67.00a | 3.04a | 22.76c | 34.00a | 7.44a |
| 40 | 59.00a | 91.00a | 109.00a | 3.00a | 7.00ab | 61.00ab | 2.91a | 26.01ab | 36.00a | 5.77bc |
| 50 | 59.00a | 92.00a | 106.00a | 2.00ab | 8.00a | 60.00bc | 2.83a | 27.00a | 36.00a | 6.02ab |
| 60 | 59.00a | 92.00a | 110.00a | 2.00ab | 6.00b | 58.00c | 3.00a | 25.73bc | 36.00a | 5.69c |
| Mean | 59.00 | 91.00 | 108.00 | 2.00 | 7.00 | 62.00 | 2.73 | 25.38 | 35.00 | 6.23 |
| CV | 3.70 | 1.98 | 5.67 | 8.53 | 29.64 | 17.05 | 10.09 | 18.30 | 11.87 | 17.39 |
| Duncan(Inter) | **ns** | **Ns** | **ns** | **Ns** | **\*** | **\*** | **ns** | **ns** | **Ns** | **\*** |
| Inter x intra spacing | **ns** | **Ns** | **ns** | **Ns** | **ns** | **Ns** | **ns** | **ns** | **Ns** | **ns** |

**ns= non-significant FD =Days to flowering , MD=Days to maturity, Ph=plant height, NPB=number of primary branch, NCPP=number of capsule per plant, TSW=thousand seed weight ,BY=Biomass yield ,SY =seed yield**

**Table -3 combine seed yield and other agronomic traits of sesame at Ziqulla 2020/-2022 cropping season**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Intra row spacing | FD | MD | Ph | NPB | LC | NCPP | TSW | BY | NSPC | SY |
| 5 | 52.00a | 86.00a | 111a | 2.00a | 3.00a | 56.00b | 3.00a | 27.00a | 26.00bc | 5.89b |
| 10 | 53.00a | 87.00a | 110a | 3.00a | 3.00a | 58.00a | 2.85ab | 29.72a | 28.00a | 6.94a |
| 15 | 54.00a | 88.00a | 110a | 3.00a | 2.00a | 54.00bc | 2.79ab | 27.00a | 27.00b | 5.89d |
| 20 | 54.00a | 88.00a | 108a | 3.00a | 3.00a | 50.00c | 2.76b | 29.27a | 25.00c | 6.37c |
| Duncan(0.05) | ns | ns | ns | Ns | ns | **\*** | **\*** | ns | **\*** | **\*** |
| Inter row spacing |  |  |  |  |  |  |  |  |  |  |
| 30 | 52.00a | 87.00a | 109.54a | 3.00a | 4.00a | 57.00a | 2.83a | 30.38a | 27.60a | 7.39a |
| 40 | 53.00a | 86.00a | 111.00a | 2.00a | 3.00a | 55.00b | 2.84a | 27.00a | 29.70a | 6.38ab |
| 50 | 54.00a | 87.00a | 109.55a | 3.00a | 3.00a | 54.00bc | 2.81a | 28.37a | 27.00a | 6.28b |
| 60 | 54.00a | 85.00a | 110.00a | 2.00a | 3.50a | 53.00ab | 2.91a | 28.92a | 27.00a | 5.93c |
| Mean | 53.00 | 86.00 | 110.02 | 2.76 | 3.06 | 54.11 | 2.83 | 28.56 | 27.00 | 6.50 |
| CV | 12.69 | 7.39 | 6.200 | 7.39 | 7.08 | 18.57 | 13.50 | 24.56 | 15.78 | 20.73 |
| Duncan(Inter) | ns | Ns | ns | Ns | ns | \* | ns | ns | ns | \* |
| Inter x intra spacing | ns | Ns | ns | Ns | ns | ns | ns | ns | ns | ns |

**ns= non-significant FD =Days to flowering , MD=Days to maturity, Ph=plant height, NPB=number of primary branch, NCPP=number of capsule per plant, TSW=thousand seed weight ,BY=Biomass yield ,SY =seed yield**

 **Table -4 Comparison of dominance analsisie**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Intra row spacing | Adjusted (90%) seed yield Qt ha-1 | Total variable cost(ETB birr) | Gross Benefit (ETB birr) | Net benefit (ETB birr) | DA |
| 20 | 5.73 | 10000 | 34398 | 24398 |  |
| 15 | 5.30 | 12000 | 31806 | 19806 | DA |
| 10 | 6.24 | 12000 | 37476 | 25476 |  |
| 5 | 5.30 | 12400 | 31806 | 19406 | DA |
| Inter row spacing |  |  |  |  |  |
| 60 | 5.33 | 9900 | 32022 | 22122 |  |
| 50 | 5.65 | 10300 | 33912 | 23612 |  |
| 40 | 5.74 | 10500 | 34452 | 23952 |  |
| 30 | 6.65 | 12500 | 39906 | 27406 |  |

 **Table -5 comparison of marginal rate of return**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Intra row spacing | Adjusted (90%) seed yield Qt ha-1 | Total variable cost(ETB birr) | Net benefit (ETB birr) | MRR (%) |
| 20 | 5.73 | 10000 | 24398 | - |
| 10 | 6.24 | 12000 | 25476 | 53.9 |
| Inter row spacing |  |  |  |  |
| 60 | 5.33 | 9900 | 22122 | - |
| 50 | 5.65 | 10300 | 23612 | 372.5 |
| 40 | 5.74 | 10500 | 23952 | 170 |
| 30 | 6.65 | 12500 | 27406 | 172.7 |

**Figure -1 combine Seed yield verse row spacing at Ziqulla 2020/2022 cropping season**

**Conclusion**

From the results obtained, this study indicated that growth and yield components **,number of capsule per plant, number of seed per capsule** and **seed yield** were significantly influenced by row spacing. Significantly higher seed yield was recorded with row spacing of 30 x 10cm based on the combined data, and hence it is recommended that for optimum seed yield, farmers should adopt the spacing of 30 x 10cm in Ziqualla distirct and similar agroecology.

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