IJPBCS

International Journal of Plant Breeding and Crop Science
Vol. 5(1), pp. 324-329, February, 2018. © www.premierpublishers.org. ISSN: XXXX-XXXX

Research Article

Effect of Row Spacing on Seed Yield, Oil and Protein Content of Five Sesame (*Sesamum indicum* L.) Varieties in Afar Region, North-Eastern Ethiopia

Deressa Negasa

Department of Plant Science, College of Agriculture, Salale University, Ethiopia
Email address: deressaawata@gmail.com, Mobile phone: +251913619469, Fax number: +251111609320

Due to the absence of an appropriate plant spacing that related to sesame branching habit in the study area; an experiment was conducted to evaluate the effects of row spacing on yield, oil and protein content of sesame varieties in randomized complete block design with three replications. The experiment consisted of five sesame varieties (S, T-85, Argane, Mehado-80, Serkamo) and four rows spacing (30, 40, 50, 60cm). The results showed that the difference between varieties were significant at 5% probability level in all traits except number of capsules plant^{-1} and number of seeds capsule^{-1}. Serkamo variety had the highest 1000- weight seed (3.52 g), seed yield (205.8 kg ha^{-1}), oil yield (94.0 kg ha^{-1}), protein yield (43.9 kg ha^{-1}) and number of seeds capsule^{-1} (61.67). Except 1000- weight seed, all traits were affected at 5% probability level by row spacing. Highest seed yield (205.3 kg ha^{-1}), oil yield (96.4 kg ha^{-1}), protein contents (22.29 %) and protein yield (45.8 kg ha^{-1}) were obtained at 40cm row spacing whereas number of capsules plant^{-1} (99.65) and number of seeds capsule^{-1} (63.34) were at 60cm row spacing. Interaction effect of variety x row spacing was affected number of capsules plant^{-1}, seed yield, oil yield and protein yield. The highest seed yield (242.3 kg ha^{-1}), oil yield (112.3 kg ha^{-1}) and protein yield (53.8 kg ha^{-1}) was obtained from Sekamo variety at 30cm row spacing.

Key words: row spacing; varieties; seed yield; oil and protein content

INTODUCTION

Sesame is one of the most important oil crop "Queen of oil seeds" in the world because its seeds have high contents of oil and protein (Weiss, 2000). Its production is gradually increased in the world as well as Ethiopia due to an increasing demand for sesame oil (Mkamilo and Bedigian, 2007). In Ethiopia, production of sesame was increased from 42,000 tons in the 2003 to 181,376.05 tons in 2013 production year and it covered 24.8% of oil production next to Niger (CSA, 2013). Higher productivity in sesame crop can be achieved through a combination of an ideal variety associated with proper environment and appropriate agronomic practices. There is a great deal of evidence to show that sesame varieties respond differently to agronomic practices because of the availability of many hundreds of varieties and strains of sesame, which differ considerably in size, form, growth, color of flowers, seed size, color and composition (Hedge, 2004).

From different agronomic practices, determination of optimum population density is an essential step in the introduction of sesame crops. Optimum number of plants is required per unit area to utilize efficiently the available production resources such as water, nutrients, light and carbon dioxide. However, response of sesame crop to different levels of spacing varies with varieties because of spacing depends on the growth habit of the variety, the season and the growing conditions such as rain-fed or irrigated. Because of these reasons row spacing of 25–75 cm is recommended for sesame crop in different countries (Hedge, 2004).

Accordingly, different sesame varieties have different branching habit; some of them have more branching and others have less branching. However, in Ethiopia the recommended spacing for all sesame varieties under irrigated and rain fed conditions is the same 40 x 10 cm (EARO, 2004). But, the varieties with different growth habit may respond differentially to different row spacing especially under irrigated environment. Therefore, this research was conducted to evaluate the effects of row spacing on yield, oil and protein content of sesame varieties under irrigation condition.

MATERIALS AND METHODS

In order to investigate response of yield and quality parameters of sesame varieties to different row spacing, an experiment was conducted at Gewane District, Afar Regional State, Ethiopia that located at $10^{0}10'$ N and $40^{0}32'$ E (ESRDF, 2003), an average annual rainfall of 400 mm and annual temperature 32 ^{0}C which characterized as semi-arid climatic zone (Yirgalem, 2001). The experiment consisted of five sesame varieties (S, T-85, Argane, Mehado-80 and Serkamo) and four row spacing (30 cm, 40 cm, 50 cm and 60 cm) that was laid out as randomized complete block design (RCBD) with three replications. Sesame seeds were drilled in the row manually by 3.6 m x 2.5 m plot size with 0.8 m spacing between plots and 1.2 m between blocks and thinned to 10 cm distance between plants to maintain recommended spacing between plants. Six, seven, nine and twelve rows were accommodated plot^{-1} for 60cm, 50cm, 40cm and 30cm row spacing, respectively. Irrigation and other agronomic management were given as per recommendation for each plot. At the end of maturity (when leaves and stems tended to change from green to yellow and the leaves began to fall off the plants and when on some varieties the bottom capsule started to open) , seed yield of each net of plot ((2.40 m x 1.90 m (4.56 m^{2}) for 30 cm, 40 cm and 60 cm row spacing and 2.50 m x 1.90 m (4.75 m^{2}) for 50 cm row spacing) was weighed and converted to area basis to determine the yield in Kgha^{-1}. Oil content was tested following the NMR (Nuclear Magnetic Resonance) method whereas seed protein content was analyzed by kjeldhal method and protein % was determined by multiplying % of nitrogen in the seed by 6.25. Oil and protein yield were calculated by multiplying oil and protein content with seed yield Kg ha^{-1} and divided for percentage. All collected data were analyzed by using SAS software and Comparisons of treatment means were done using Least Significant Difference.

RESULTS AND DISCUSSION

Seed yield (kg ha^{-1})

Variance analysis table showed that there was significant difference in seed yield between studied varieties (Table 4). The highest seed yield was obtained from Mehado-80 variety (209.2 kg ha^{-1}) that followed by Serkamo variety (205.8 kg ha^{-1}) whereas the lowest seed yield was obtained from S variety (168.0 kg ha^{-1}). In general, seed yield difference of sesame varieties might be due to their genetic variation. Moreover, Serkamo and Mehado-80 variety yielded highest number of capsules plant^{-1}, 1000-seed weight and number of seeds capsule^{-1}. Low seed yield of S variety was might be due to its 1000 seed weight. In agreement with this, Naseri *et al.* (2012) reported that 401 hyola hybrid cultivar yielded highest seed pod^{-1} and 1000-seed weight than other cultivars and as a result it yielded higher yield.

Significant difference also observed between different row spacing (Table 4). Seed yield was increased up to 40cm row spacing which seems to be appropriate spacing and started declining as row spacing became wider. This increment of seed yield (kg ha^{-1}) at 40cm row spacing might be due to that the greater number of sesame plants per net of plot and the yield reduction at 30cm row spacing might be due the excessive inter competition on resources which contributed for growth and development of capsules plant^{-1} and seeds capsule^{-1}. Result of Singh and Singh (2002) showed that economic yield of sesame increases with increasing plant population up to certain level and then gradually decreases. Roy *et al.* (2009) also reported that higher yield of sesame was obtained when row to row distance was 30 cm and yield was decreased at 45 cm row spacing.

The interaction effect of variety and row spacing was highly significantly ($P<0.01$) affected seed yield (kg ha^{-1}) (Table 4). Among the five sesame varieties, Serkamo gave the highest seed yield (242.3 kg ha^{-1}) at the narrowest (30 cm) row spacing followed by variety Mehado-80 (242.0 kg ha^{-1}) at the widest (60 cm) row spacing and lowest yield was belonged to T-85 variety at 60 cm row spacing. Similar to this result, Dereje (2012) stated that interaction effect of variety and row spacing had significant effect on sesame seed yield.

Number of capsules plant^{-1}

Variance analysis result indicated that there was no statistically significant difference in capsules plant^{-1} between studied sesame varieties (Table 1). It seems that all studied varieties were equally profited from existing condition due to compatibility with region climate and all sesame varieties had relative potential to produce capsules plant^{-1}. However, number of capsules plant^{-1} was highly significantly influenced by row spacing whereas the highest number of capsules plant^{-1} (99.65) was recorded from the widest row spacing (60cm) while the lowest number of capsules (69.39) obtained from the narrowest row spacing (30cm) (Table 1). This indicates that there was positive relationship between number of capsules plant^{-1} and row spacing. Similar to this result, Ahmad *et al*. (2002) reported sesame varieties planted at 60 cm row spacing produced significantly more number of capsules plant^{-1} than 45 and 30 cm row spacing. Rahnama and

Bakhshandeh (2006) also reported that as row spacing increased from 37.5 to 60 cm, number of capsule plant^{-1} was increased significantly. Geremew *et al*. (2012) also reported in high population or close spacing in the row tends to reduce both the number of capsules and number of seeds capsule^{-1}. Roy *et al.* (2009) also reported that in sesame, narrow row spacing (15 cm) gave the lower number of capsules plant^{-1} (39.27) while maximum number of capsules plant^{-1} (76.89) was recorded in the highest spacing (45 cm).

The number of capsules plant^{-1} was significantly (P<0.01) affected by the interaction effect of variety and row spacing (Table 4). The highest mean number of capsules plant^{-1} (122.07) was recorded for Mehado-80 at 60 cm row spacing while the lowest number of capsules plant^{-1} (62.21) was recorded for the same variety at 30 cm row spacing. This might be at wider row spacing less inter competition in the community while narrow row spacing induces competition between the former and later emerged flowers that could lead to flower abortion.

Similar to this result, Ehsanullah *et al*. (2007) reported that interaction effect of cultivars and plant density significantly influenced yield of sesame ha^{-1} wherein variety Punjab-89 produced the highest seed yield (851.00 kg ha^{-1}) at 45 rows spacing while the lowest seed yield (820.00 kg ha^{-1}) for variety TS-3 at 30 cm row spacing. Likewise, Ulsu *et al*. (1998) also reported that interaction effect of cultivar and row spacing on seed yield ha^{-1} of safflower was significant.

Number of seeds capsule^{-1}

Variance analysis result indicated that varieties and the interaction effect of varieties and row spacing had no significant effect on number of seeds capsule^{-1}. But, number of seeds capsule^{-1} was highly significantly influenced by row spacing (Table 1). Number of seeds capsule^{-1} was increased statistically from 30cm (56.02) to 60cm row spacing (63.34) (Table 1). In line with number of capsules plant^{-1} there was positive relationship between number of seeds capsule^{-1} and row spacing. Majumdar and Roy (1992) observed a significant variation in number of seeds capsule^{-1} due to change in plant density. Muhammad *et al.* (2012) reported that sesame crop which was sown at 45 cm row spacing produced significantly maximum number of seeds plant^{-1} (918.5) than 15 and 30 cm row spacing. Moreover, Sivagamy and Rammohan (2013) reported higher number of seeds capsule^{-1} was recorded at wider spacing 11 percent increase over closer spacing.

1000-weight seed

Variance analysis table showed that there was significant difference in 1000-weight seed between studied varieties (Table 4). The heaviest seed weight was obtained from Serkamo variety (3.52 g) that followed by mehado-80 variety (3.44 g) whereas the lightest seed was counted from S variety (2.46 g). This might be due to the genetic variability between sesame varieties. In line with this, Naseri *et al.* (2012) reported that there was significant difference between hyola hybrid cultivars in 1000-seed weight. Ahmed *et al*. (2002) also reported that sesame varieties differed significantly on seed weight capsule^{-1}. Moreover, observations made by researchers Tiwari *et al.* (1994) and Basavaraj *et al.* (2000) revealed that variations in 1000-seed weight were observed among sesame cultivars. However, row spacing and the interaction effects between variety and row spacing had no significant effect on 1000-seed weight (Table 4). But, it showed increment trends starting from 40 cm row spacing to the wider (60 cm) row spacing. In line with this result, Harsha (2006) reported change in plant density and the interaction between cultivar and row spacing did not influence 1000-seed weight significantly. El Naim *et al*. (2012) also reported seed rate had no effect on mean 1000-seed weight.

Seed oil content

Oil content of five sesame varieties was significantly different. Highest seed oil content was observed from Argane variety (47.36%) whereas the lowest was obtained from Mehado-80 (44.59%). However, there was no statistically significance difference between Mehado-80 and Serkamo and also among T-85, S and Argane varieties. This might be due to the fact that sesame oil content varies based on genetic, environmental factors and color of seeds. Varieties Mehado-80 and Serkamo had grey color while varieties T-85 and S had white color and variety Argane mixed color (white, deep brown and light brown). In addition to this, varieties Mehado-80 and Serkamo had highest weight of 1000 seeds than varieties Argane, T-85 and S. Similarly, Yen *et al*. (1986) reported oil content was related to the color and size of the seeds whereas white or light seed colored varieties usually have more oil than the dark seeds and smaller seeds contain more oil than larger seeds. In line with this, Ahmad *et al*. (2002) stated that seed oil content of sesame was significantly affected by variety. Thakur and Borulkar (1980) also reported significant variations with respect to seed oil content among different sesame varieties.

Significance difference was also observed in oil content between different row spacing. The highest (46.98) and lowest (45.25) percentage of oil content was recorded at 30 cm and 60 cm row spacing, respectively. This might be due to the fact that when row spacing becomes wider as result of ample resources, plants was grown in vegetative rather than effectively transforming sources to sinks. Similar finding was observed by Eilkaee and Emam (2003) that oil content increased as size seeds reduced relatively. However, interaction effect of varieties and row spacing was non-significant with respect to seed oil content.

Oil yield

Sesame varieties showed significant difference in oil yield (Table 4). Agane and Serkamo variety yielded the highest oil yield (94.0 kg ha^{-1}) whereas the lowest oil yield (78.8 kg ha^{-1}) was obtained from S variety. In line with this result, Harsha (2006) obtained significant difference in oil yield (kg ha-1) between sesame cultivars. Different row spacing also showed significant difference in oil yield. As interaction of varieties and row spacing table shown, there was significant difference in oil yield (Table 4). Serkamo variety gave highest oil yield (112.3 kg ha^{-}) at 30 cm row spacing while the lowest oil yield (63.0 kg ha^{-1}) was recorded from T-85 variety at 60 cm row spacing. This might be due to the highest seed yield hectare^{-1} was obtained from the same row spacing and variety. Correlation coefficient also shown that there was positive and significant correlation between oil yield and seed yield (r=0.94) (Table 3). In agreement with this finding, Naseri *et al.* (2012) reported that cultivars, row spacing and its interaction was significantly influenced sesame oil yield.

Protein content

Sesame varieties showed significant difference in protein content (Table 4). Highest protein was obtained from Mehado-80 variety (21.94%) whereas the lowest was obtained from Argane (19.70) (Table 1). In this study, there was negative relationship between seed protein and oil content that is increasing each of them would cause decreasing another. Bahrani and Babaie (2007) reported the same relationship of seed protein and oil content for oily seeds. Significance difference was also observed in protein content between different row spacing. The highest protein content was recorded at 40cm row spacing (22.28%) and the lowest oil content was obtained at 60 cm row spacing (19.86%) This might be due the fact that as row spacing increase from the optimum, resource transformation from source to sinks becomes declined. Correlation coefficient table also shown that seed protein content had negative relationship with seed oil content (r=-0.03). However, the interaction of varieties and row spacing had non-significant effect on seed protein content.

Protein yield

Variance analysis result showed that there was significant difference in protein yield between sesame varieties (Table 4). Accordingly, mehado-80 variety yielded highest protein (45.7 kg ha^{-1}) followed by Serkamo variety (43.7 kg ha^{-1}). Also there was significant difference in protein yield between different row spacing (Table 4). Protein yield increased linearly with increasing row spacing from 30 cm to 40cm. However, increasing row spacing from 40cm to 60 cm caused to reducing protein yield. Highest and lowest protein yield was obtained from 40 cm (45.7) and 60 cm (35.9 kg ha^{-1}) row spacing, respectively. Moreover, the interaction effect of sesame variety and row spacing showed significant difference on protein yield. The highest protein yield (50.1 kg ha^{-1}) was recorded from Serkamo variety at 40 cm row spacing while the lowest was obtained from T-85 variety (27. kg ha^{-1}1) at 60 cm row spacing. Similar to this finding, Naseri *et.al* (2012) reported that cultivars, plant density and the interaction effect of cultivars and plant density were significantly affected seed protein yield.

Table 1: Effect of row spacing and variety on number of capsules per plant, number of seeds per capsule, weight of thousand seeds, seed yield per hectare, seed oil contents, oil yield, protein contents and protein yield

Treatment	Number of Capsules Plant^{-1}	Number of Seeds Capsule^{-1}	1000-Weight Seed (g)	Seed Yield (kg ha^{-1})	Oil Content (%)	Oil Yield (kg ha^{-1})	Protein Contents (%)	Protein Yield (kg ha^{-1})
Variety								
S	85.56$_{a}$	59.56$_{a}$	2.46$_{c}$	168.0$_{c}$	46.86$_{a}$	78.8$_{c}$	21.21$_{b}$	35.7$_{c}$
T-85	80.28$_{a}$	60.33$_{a}$	3.09$_{b}$	181.3$_{b}$	47.15$_{a}$	85.7$_{b}$	20.74$_{b}$	37.7$_{bc}$
Argane	83.94$_{a}$	59.70$_{a}$	3.07$_{b}$	198.5$_{a}$	47.36$_{a}$	94.0$_{a}$	19.70$_{c}$	39.1$_{b}$
Mehado-80	84.98$_{a}$	61.11$_{a}$	3.44$_{a}$	209.2$_{a}$	44.59$_{c}$	93.1$_{a}$	21.94$_{a}$	45.7$_{a}$
Serkamo	80.08$_{a}$	61.67$_{a}$	3.52$_{a}$	205.8$_{a}$	45.60$_{b}$	94.0$_{a}$	21.30$_{b}$	43.7$_{a}$
Row spacing (cm)								
30	69.39$_{d}$	56.02$_{c}$	3.08$_{a}$	199.2$_{a}$	46.98$_{a}$	93.5$_{a}$	20.62$_{c}$	40.8$_{b}$
40	76.17$_{c}$	60.62$_{b}$	3.09$_{a}$	205.3$_{a}$	46.89$_{a}$	96.4$_{a}$	22.28$_{a}$	45.7$_{a}$
50	86.67$_{b}$	61.91$_{ba}$	3.10$_{a}$	185.2$_{b}$	46.12$_{b}$	85.3$_{b}$	21.16$_{b}$	39.1$_{b}$
60	99.65$_{a}$	63.34$_{a}$	3.16$_{a}$	180.4$_{b}$	45.25$_{c}$	81.4$_{b}$	19.86$_{d}$	35.9$_{c}$
CV (%)	10.11	6.06	3.57	7.70	2.14	7.87	3.44	8.09

Mean values within column followed the same letters are not significantly different at LSD 5%; CV (%) = coefficient of variation

Table 2: Interaction effect of variety and row spacing on number of capsules per plant, number of seeds per capsule, weight of thousand seeds, seed yield per hectare, seed oil contents, oil yield, protein contents and protein yield

Treatment		Number of Capsules Plant^{-1}	Number of Seeds Capsule^{-1}	1000-Weight Seed (g)	Seed Yield (kg ha^{-1})	Oil Content (%)	Oil Yield (kg ha^{-1})	Protein Contents (%)	Protein Yield (kg ha^{-1})
	30	73.40_{efg}	53.78_{e}	2.46_{d}	164.0_{gh}	47.97_{ab}	78.6_{fg}	22.20_{bc}	36.4_{ef}
S	40	77.53_{def}	60.33_{abcd}	2.40_{d}	181.1_{defg}	46.40_{bcdef}	84.3_{ef}	21.86_{cd}	39.5_{def}
	50	88.50_{cd}	61.67_{abc}	2.46_{d}	172.3_{fgh}	47.41_{abcd}	81.7_{fg}	21.40_{cde}	36.8_{ef}
	60	102.80_{b}	62.45_{ab}	2.5_{d}	154.8_{hi}	45.66_{ef}	70.6_{gh}	19.40_{hij}	30.0_{g}
	30	69.13_{fg}	55.89_{cde}	3.14_{bc}	197.3_{bcde}	47.49_{abcd}	93.7_{de}	20.18_{fghi}	39.6_{def}
T-85	40	78.20_{def}	61.45_{abc}	3.08_{bc}	207.4_{bc}	48.69_{a}	100.8_{abcd}	22.00_{bcd}	45.6_{abc}
	50	87.93_{cd}	61.44_{abc}	2.98_{c}	183.3_{cdefg}	46.52_{bcde}	85.3_{ef}	21.03_{cdef}	38.4_{ef}
	60	85.87_{cde}	62.56_{ab}	3.14_{bc}	137.3_{i}	45.91_{def}	63.0_{h}	19.76_{ghij}	27.1_{g}
	30	70.63_{fg}	$55.00d_{e}$	2.98_{c}	201.1_{bcde}	47.43_{abcd}	95.4_{cde}	19.16_{ij}	38.5_{ef}
Argane	40	$76.43d_{ef}$	60.00_{bcd}	3.04_{bc}	221.7_{ab}	48.36_{a}	107.2_{ab}	21.06_{cdef}	46.6_{ab}
	50	$90.20b_{cd}$	61.00_{abcd}	3.19_{b}	180.4_{defg}	47.71_{abc}	86.0_{ef}	19.76_{ghij}	35.5_{f}
	60	98.50_{bc}	62.78_{ab}	3.08_{bc}	190.8_{cdef}	45.96_{def}	87.5_{ef}	18.83_{j}	35.8_{ef}
	30	62.13_{g}	55.00_{de}	3.45_{a}	191.5_{cdef}	45.68_{ef}	87.3_{ef}	21.5_{cde}	41.2_{cde}
Mehado-80	40	69.00_{fg}	60.33_{abcd}	3.41_{a}	199.2_{bcde}	44.92_{efg}	89.5_{def}	23.4_{a}	46.5_{abc}
	50	86.73_{cde}	62.89_{ab}	3.38_{a}	204.2_{bcd}	43.78_{g}	89.3_{def}	21.96_{bcd}	44.8_{bcd}
	60	122.07_{a}	66.22_{a}	3.51_{a}	242.0_{a}	43.98_{g}	106.2_{abc}	20.90_{defg}	50.5_{a}
	30	71.67_{fg}	60.44_{abcd}	3.52_{a}	242.3_{a}	46.32_{cdef}	112.3_{a}	20.06_{fghi}	48.6_{ab}
Serkamo	40	79.67_{def}	61.00_{abcd}	3.51_{a}	217.2_{b}	46.10_{cdef}	100.1_{bcd}	23.10_{ab}	50.1_{ab}
	50	80.00_{def}	62.56_{ab}	3.49_{a}	186.3_{cdefg}	45.21_{efg}	84.2_{ef}	21.63_{cd}	40.1_{def}
	60	89.00_{bcd}	62.67_{ab}	3.55_{a}	177.3_{efgh}	44.77_{fg}	79.4_{fg}	20.41_{efgh}	36.1_{ef}
CV (%)		10.11	6.06	3.57	7.70	2.14	7.87	3.44	8.09

Mean values within column followed the same letters are not significantly different at LSD 5%; CV (%) = coefficient of variation

Table 3: Correlation coefficients among traits under study

	Treatment	1	2	3	4	5	6	7	8
1	Seed yield (kg ha^{-1})	1							
2	Number of capsules plant^{-1}	0.35^{ns}	1						
3	Number seeds capsule^{-1}	0.97^{**}	0.43^{*}	1					
4	1000-Weight Seed	0.28^{ns}	-0.28^{ns}	0.03^{ns}	1				
5	Seed Oil Contents	0.32^{ns}	-0.13^{ns}	0.16^{ns}	0.65^{**}	1			
6	Oil yield	0.94^{**}	0.31^{ns}	0.90^{**}	0.32^{ns}	0.57^{*}	1		
7	Seed protein contents	0.07^{ns}	-0.09^{ns}	0.11^{ns}	-0.14^{ns}	-0.03^{ns}	0.08^{ns}	1	
8	Protein yield	0.18^{ns}	0.13^{ns}	0.26^{ns}	-0.27^{ns}	-0.02^{ns}	0.21^{ns}	0.55^{*}	1

ns, * and ** showed statistically non-significant, significant and highly significant, respectively

Table 4: Mean of squares of traits as affected by varieties and row spacing and interactions

		Mean squares							
Source	df	Number of Capsules Plant^{-1}	Number of Seeds Capsule^{-1}	1000-Weight Seed (g)	Seed Yield (kg ha^{-1})	Oil Content (%)	Oil Yield (kg ha^{-1})	Protein Contents (%)	Protein Yield (kg ha^{-1})
Replication	2	50.43^{ns}	6.25^{ns}	0.001^{ns}	4.71^{ns}	0.81^{ns}	0.93^{ns}	0.59^{ns}	0.11^{ns}
Variety (A)	4	81.74^{ns}	9.90^{ns}	2.11^{**}	36.50^{**}	16.75^{**}	5.45^{**}	8.28^{**}	2.13^{**}
Row spacing (B)	3	2612.19^{**}	150.49^{**}	0.012^{ns}	20.37^{**}	9.70^{**}	7.32^{**}	15.57^{**}	2.49^{**}
A x B	12	228.82^{*}	6.96^{ns}	0.011^{ns}	15.82^{**}	1.24^{ns}	3.44^{**}	1.01^{ns}	0.85^{**}
Error	38	70.39	13.42	0.012	2.20	0.98	0.49	0.52	0.60

* = indicates significance at P=0.05, ** = significance at P=0.01, df= degree of freedom.

CONCLUSION

The study results indicated that there was significance difference between sesame varieties in all attributes except number of capsules plant^{-1} and number of seeds capsule^{-1}. Row spacing also showed significance difference in all traits except 1000-seed weight (g). Seed yield, oil and protein yield had significantly influenced by the interaction of varieties x row spacing. Sesame varieties respond differentially to different row spacing. Accordingly, varieties T-85, S and Argane produced the highest seed yield (t ha^{-1}), oil yield (kg ha^{-1}) and protein yield (kg ha^{-1}) at 40 cm row spacing with 10 cm distance between plants whereas varieties Mehado-80 and Serkamo yielded these traits at 60 cm and 30 cm row spacing, respectively.

REFERENCES

Ahmad, R., Mahmood T., Farrukh M.S. and Ahmad S. (2002). Comparative performance of two sesame (*Sesamum indicum* L.) varieties under different row spacing. *Asian Journal of Plant Science*, 1(5): 546 - 547.

Basavaraj, B., Shetty R.A. and Hunshal C.S. (2000). Response of sesame varieties to fertilizer and population levels in paddy lands of Tunga Bhadra project area during summer. *Karnataka Journal of Agricultural Sciences*, 13(1): 138-140.

Bahrani and Babaei (2007). Effect of different levels of plant density and nitrogen fertilizer on seed yield and its components and some quality traits two sesame (*Sesame indicum* L.) cultivars. *Iranian Journal of crop sciences*

CSA (Central Statistical Agency) (2013). Agricultural Sample Survey, Area and Production of Major Crops, Statistical Bulletin, No. 532, May 2013, Addis Ababa.

Dereje Agizie (2012). Effect of plant density on yield and yield related traits of sesame *(Sesamum indicum* L.*)* varieties at Woyto river basin in south western Ethiopia. (Unpublished MSc. thesis), Haramaya, Ethiopa.

EARO (Ethiopian Agricultural Research Organization) (2004). Directory of released crop varieties & their recommended cultural practices, Addis Ababa, Ethiopia.

Ehsanullah, Akbar N., Iqabal A and Mohsin R.M. (2007). Effects of different planting patterns on the growth and yield of two varieties of sesame. *Pakistan Journal of Agriculture Science*, 44(4): 584 - 586.

El Naim, A.M., El Dey E.M., Jabereldar A.A., Ahmed S.E. and Ahmed A.A. (2012). Determination of suitable variety and seed rate of sesame (*Sesamum indicum* L.) in sandy dunes of Kordofan Sudan. *International Journal of Agriculture and Forestry,* 2(4): 175-179.

ESRDF (Ethiopian Social Rehabilitation Development Fund) (2003). Integrated Gewane Woreda development plan for 10 years (2003-2013), Afar Regional Office.

Eilkaee, M.N and Emam Y. (2003). Effect of planting density on yield and yield components in two winter oilseed rape (*Brassica napus* L.) caltivars. Iranian Journal of Agricultural Science 34(3): 509-515.

Geremew Terefe, Adugna Wakjira, Muez Berhe and Hagos Tadesse (2012). Sesame production manual. Ethiopian institute of agricultural research, Addis Ababa.

Harsha, K.N. (2006). Effect of plant on growth and yield of sesame cultivars during summer. (Unpublished MSc. thesis), University of Agricultural Sciences, Dharwad.

Hedge, D.M. (2004). Directorate of Oilseeds Research. In K.V. Peter (Ed.) *Handbook of Herbs and Spices*, pp. 268-301. Wood head Publishing Ltd, India.

Majumdar, D.K. and Roy S.K. (1992). Response of summer sesame (*Sesamum indicum* L.) to irrigation, row spacing and plant population. *Indian Journal of Agronomy*, 37(4): 758-762.

Muhammad, T., Saeed U., Ali A., Hassan I., Naeem M., Ibrahim M., Rehman H. and Javeed H.M.R. (2012). Optimizing Sowing Date and Row Spacing for Newly Evolved Sesame. *Pakistan Journal of Life and Social Sciences,* 10:15-27.

Naser, N., Kazemi E., Mahmoodian L., Mirzael A. and Soleymanifard A. (2012). Study on effects of different plant density on seed yield, oil and protein content of four canola cultivars in western Iran. *International Journal of Agriculture and Crop Science*, available online at *www.ijacs.com*. 2012/2-4/70-78. January 4, 2012.

Rahnama, A. and Bakhshanden (2006). Determination of optimum row spacing and plant density for un-branched sesame in khuzestan province. *Journal Agriculture Science Technology*, 8: 25-33.

Roy, N., Abdullah S.M. and Jahan M.S. (2009). Yield performance of sesame (*Sesamum indicum*L.) varieties at varying levels of row spacing. *Research Journal of Agriculture and Biological Sciences*, 5(5): 823-827.

Singh, N.P. and Singh R. A. (2002). *Scientific crop production. 1st ed*. X-press Graphics, Delhi-28, India.

Sivagamy, K. and Rammohan J. (2013). Effect of sowing date and crop spacing on growth, yield attributes and quality of sesame. *IOSR Journal of Agriculture and Veterinary Science 5(2):38-40*

Thakur, B.D. and Borulkar D.N. (1980). Effect of spacing and nitrogen levels on growth, yield and quality of different varieties of Sesamum (*Sesamum indicum* L.). *Oilseeds Journal*, pp. 85-87.

Tiwari, K.P., Jain R.K. and Raghuwanshi R.S. (1994). Effect of sowing dates and plant densities on seed yield of sesame cultivars. *Crop Research*, 8(2): 404- 406.

Ulsu, N., Alin A., Halitligil M.B. (1998). Cultivar, weed and row spacing effects on some agronomic characters of safflower (*Carthamus tinctorius* L.) in spring planting. *Tropical Journal of Agriculture and Forestry*, 22: 533-536.

Weiss, E.A. (2000). Oil seed Crops2nd edition. Black well Science, Inc., Malden.

Yen, G.C., Shyu S.L.and Lin J.S. (1986). Studies on protein and oil composition of sesame seeds. *Journal of Agriculture Forestry*, 35: 177–81.

Yirgalem Assegid (2001). Challenges, opportunities and prospects of common property resource management in the Afar Pastoral areas. FARM-Africa report, Addis Ababa.

Accepted 5 January 2018

Citation: Negasa D. (2018). Effect of Row Spacing on Seed Yield, Oil and Protein Content of Five Sesame (*Sesamum indicum L.*) Varieties in Afar Region, North-Eastern Ethiopia. International Journal of Plant Breeding and Crop Science, 5(1): 324-329.