Nile Valley University Publications
Nile Journal for Agricultural Sciences (NJAS)
(ISSN: 1585 – 5507)
Volume 04, NO. 02, 2019
http://www.nilevalley.edu.sd

Research paper

Influence of Irrigation Interval and Plant Population Density on Sesame Growth and Yield at High Terrace Soils

Abdel Rahman Ali El Mahdi[1] and Hassan Elhag Hamad H. Alsayim[2]

1 Faculty of Agriculture, Department of Agronomy, Nile Valley University, Sudan
2 Faculty of Agriculture, Department of Agricultural Engineering, Nile Valley University, Sudan
E-mail: alsayim@nilevalley.edu.sd

Corresponding Author: amahdi@nilevalley.edu.sd

ABSTRACT

This experiment was conducted to investigate the effect of irrigation intervals and plant population density on growth and yield attributes of sesame for two successive seasons (2006/07 and 2007/08) in the Farm of the Faculty of Agriculture, Nile Valley University, Darmali, Sudan. The experiment was arranged in split-plot design with four replications. Treatments consisted of three irrigation intervals (7, 14 and 21 days), assigned to the main plots, and four plant populations (100,000, 150,000, 200,000 and 250,000 plants ha^{-1}) to the sub-plots. Parameters recorded included: leaf area index (LAI), number of branches per plant, number capsules per plant, seed yield per plant, seed yield per unit area (kg ha^{-1}), and 1000-seed weight. The results indicated that LAI after 60 days from sowing showed a significant difference among irrigation intervals and plant population density with time. The number of branches and capsules per plant increased significantly ($P \leq 0.05$) under short irrigation intervals and as plant density decreased. The heaviest 1000-seed weight (2.62 g) was obtained under 7 days irrigation interval. There was a significant interaction between irrigation intervals and plant densities on seed weight. A maximum seed yield of 450 to 463 kg ha^{-1} was obtained by plant densities of 150,000 and 200,000 plants ha^{-1}, respectively in both seasons. Therefore, it can be concluded that, irrigation of 7 days interval with density of 200,000 plants ha^{-1} and gave the highest seed yield (955 Kg ha^{-1}), so it recommended for sesame cultivation under tropical high terrace soil conditions.

Keywords: Leaf area index, capsules $plant^{-1}$, 1000- seed weight, seed yield.

تأثير فترات الري والكثافة النباتية على النمو وإنتاج السمسم في التروس العليا

عبد الرحمن علي المهدي[1] وحسن الحاج حمد حسن الصائم[2]

1 قسم المحاصيل، كلية الزراعة، جامعة وادي النيل، السودان
2 قسم الهندسة الزراعية، كلية الزراعة، جامعة وادي النيل، السودان

أجريت هذه التجربة لدراسة تأثير فترات الري والكثافة النباتية على النمو والحاصل ومكوناته من السمسم لموسمين متتاليين (07/2006 و08/2007) في مزرعة كلية الزراعة، جامعة وادي النيل، دار مالي، شمال السودان. وجرى ترتيب معاملات هذه التجربة في تصميم القطع المنشقة بأربعة مكررات. تتألف المعاملات من ثلاث فترات الري (7 و14 و21 يوماً)، في القطع الرئيسة، وأربعة كثافات نباتية (100000، 150000، 200000 و250000 نبات للهكتار) في القطع الفرعية. شملت القياسات: دليل مساحة الورقة وعدد الأفرع والكبسولات في النبات وحاصل البذور للنبات وفي وحدة المساحة (كجم/هكتار)، ووزن الـ 1000 بذرة. أظهرت النتائج فروق معنوية لدليل مساحة الورقة بين فترات الري والكثافة النباتية بعد 60 يوماً من الزراعة. وإلى انخفاض عدد الأفرع والكبسولات في النبات (ف <0.05) في إطالة فترات الري. وزاد عدد الأفرع والكبسولات في النبات معنوياً (0.05) كلما انخفضت الكثافة النباتية. أمكن الحصول على أثقل وزن 1000 بذرة (2.6 جرام) عند الري كل 7 أيام. هناك (ف <0.05) كان التفاعل بين فترات الري والكثافة النباتية معنوياً في وزن البذور. وأعطت الكثافة النباتية 150000 و200000 نبات/هكتار أعلى حاصل من البذور في الموسمين. توصي الدراسة بالري كل 7 أيام وبكثافة نباتية 200000 نبات /هكتار في أراضي التروس العليا.

كلمات مفتاحيه: دليل مساحة الورقة، عدد الكبسولات، وزن ال 1000 بذرة وإنتاج البذور.

Introduction

Sesame (*Sesamum indicum* L.) is one of the important oilseed crops in Sudan. However, the seed yield depending upon the amount and distribution of rainfall, cultural practices and cultivars. Therefore, many factors influence plants water requirements namely, duration of growth season, climate and the humidity of soil topography (Boydak *et al.* 2007). Fazeli *et al.* (2006) concluded that leaf water potential and relative water content of the leaves decreased with the increase of water deficit. Moreover, leaf water potential was lower in the high stress. According to Boydak *et al.* (2007) the highest yields were obtained at 6 and 12 day intervals and the lowest yield obtained at 24 day intervals. In India studies of Ayyaswamy and Kulandaivelu (1992) revealed that the height of the first capsule and plant height were greatest in the 15 days interval, whereas irrigation at 20 or 30 days intervals increased the number of branches at harvest compared with 15 days interval. Ucan *et al.* (2007) concluded that, the amount of irrigation water applied significantly affected seed yield. Generally, the yield in sesame can be increased by improving mobilization of assimilations to seeds, and crop losses under deficient water can be minimized by providing irrigation during the reproductive stage (Yadav and Srivastava, 1997). Maintaining an optimum plant density plays a vital role in realizing the yield potential of the crop (Guanamurthy *et al*. 1992; Ghosh and Patra, 1994 and Caliskan *et al*. 2004). Plant density significantly influences growth and yield components. Plant height, branch number, capsule number and seed yield decreased with increasing plant density. Generally, yield parameters obtained with the increase in plant density and stand up to 222000 plants ha^{-1} considered necessary to obtain reasonably good seed yield (Subrahmaniyan and Arulmozhi, 1998 and Adebisi *et al*. 2005). With further increase in density beyond 330000 plans/ha, the number of capsules per plant and seed weight per capsule decreased significantly (Mujaya and Yerokum 2003). Recently, however Imoloame *et al*. (2007) concluded that, seed rate of 6 kg ha^{-1} produced the highest seed yield, However, 1000 – seed weight was not affected by plant density (Sarma, 1994). While, mean seed yield increased with increasing plant density (Tiwari and Namdeo, 1997; Senthilkumar *et al.* 2000). However, the optimum irrigation interval must be related to plant density. The interactive influence of irrigation interval and plant density on sesame performance has not been fully studied. The objective, of this experiment was to examine the effects of irrigation intervals and plant densities on growth, yield and yield components of sesame under irrigation.

Materials and methods

The experiment was carried out during the 2006/07, 2007/08 growing seasons, at the Faculty of Agriculture Farm, Nile Valley University, Darmali, Northern Sudan (latitude 17^{o}48 N, longitude 34^o 00E and altitude 346.5 meter above sea level). The soil of the experimental plots was classified as calcareous matrix strongly alkaline with low permeability to water and low in nitrogen and humus content.

The treatments were arranged in split-plot design with four replications. Three irrigation intervals (7, 14 and 21 days) were assigned to the main plots and four plant populations ($1.0x10^5$, $1.5x10^5$, $2.0x10^5$ and $2.5x10^5$ plants ha^{-1}) to the sub-plots. The Land was prepared by disc ploughed and disc harrowed, leveled and ridged at 70 cm. The plot size was 3.5×7 m^2 consisting of six ridges 7 m in length, with 70 cm spacing between ridges. Sesame cultivar Shuak was sown on the first week of July in both seasons. The crop was irrigated three times for establishment before the start of the differential watering regime. The plants were thinned at two weeks from sowing to achieve the required plant densities.

Data were collected on growth attributes leaf area index and at physiological maturity ten plants were randomly selected from harvest area for measurement, number of branches per plant, number of capsules per plant, seed yield per plant, 1000-seed weight and seed yield per unit area (kg ha^{-1}) were obtained from the center rows of each plot leaving 1 m from both ends of the plots as margins. Harvesting was done manually by cutting the crop at the soil surface bound and air dried for twenty days and converted to seed yield per unit area.

Statistical analysis was carried out using compare treatment means using MSTAT-C computer programme.

Results and discussion

Leaf area index (LAI)

Figure 1 shows the influence of irrigation intervals and plant population densities and their interaction on Leaf area index during ontogeny of sesame plants. The results showed that irrigation intervals and plant density significantly affected LAI at flowing stage and declined thereafter due to leaf senescence. Moreover, the maximum Leaf area index was attained at shorter irrigation interval and high planting density at all growth stages. The increase or decrease in LAI directly affects plant growth. It may be due to increasing the capture of radiation within the canopy. This results is in the line with that of Subrahmaniyan and Arulmozhi, (1998) and Abusuwar and Karam Eldin (2013) on alfalfa and Rhodes grass.

Number of branches plant^{-1}

The number of branches per plant was significantly affected by irrigation intervals, plant population density and their interaction (Table. 1 and 2). The maximum number of branches per plant (1.40) was recorded when the crop was irrigated every 7 days interval. However, the number of branches per plant was significantly decreased from 1.35 to 0.67 with increase in plant density from 100,000 to 250,000 plants ha^{-1} (Table 1). Said, *et al.* (2017) reported similar results.

Number of capsules plant^{-1}

Irrigation intervals and plant densities and their interaction had significant effects on number of capsules plant^{-1} (Table 1 and 2). The maximum number of capsules plant^{-1} (27.43) was obtained when the crop was irrigated every 7 days interval and consequently decreased by long irrigation interval. The reduction in number of capsules plant^{-1} may be attributed to the effect of water stress during the reproductive phase. Yadav and Srivastava (1997) reported similar findings. However, the number of capsules per plant increased with decreasing plant population density. These results revealed that, increasing population density to 250,000 plants ha^{-1} resulted in a substantial reduction in number of capsules plant^{-1}. Mujaya and Yerokum (2003) and Adebisi *et al.* (2005) reported similar findings.

1000-seed weight (g)

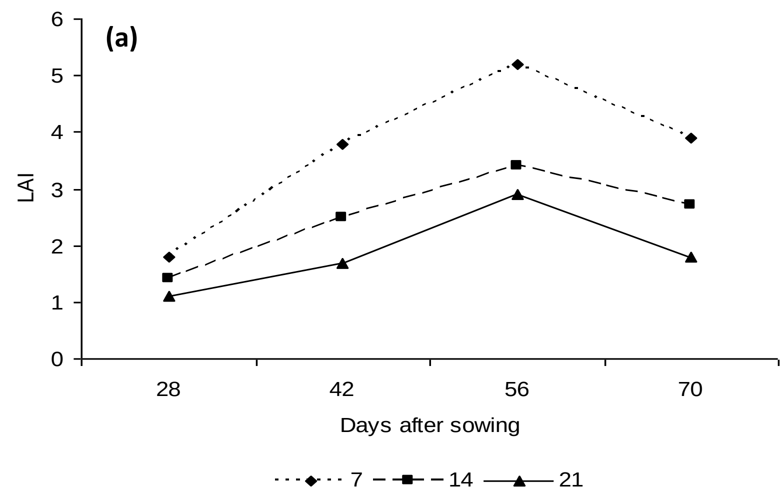
The irrigation intervals had significant effects on 1000-seed weight (Table 1). 1000-seed weights were not significantly affected by plant population density. Change in plant density did not influence 1000-seed weight significantly. However, 1000-seed weight was higher at higher plant density. The interaction effect between irrigation intervals and plant densities on 1000-seed weight was significant (Table 2). Similar results were reported by Sarma (1994) and Mujaya and Yerokum (2003). Generally, increasing the number of plants per ground area increases the competition among plants for soil moisture, nutrients, light and carbon dioxide. This may explain the significant effects of irrigation intervals and the interactions.

Seed yield plant^{-1} (g)

Irrigation interval and the interactions significantly affected seed yield per plant at 0.05 statistical level (Table 1 and 2), but this trait was not significantly affected by population density (Table 1). The highest seed yield per plant (1.52) was produced by 7 days irrigation interval and increase in irrigation interval from 14 to 21 days decreased it by 67%, it is likely that water deficit stress at seed setting stage resulted in the abortion in some capsules, their shedding and the decrease in seed weight per plant. Seed yield plant^{-1} reduced to 33% with increase in plant density from 100,000 to 250,000 plants ha^{-1}. Results from the present findings are in conformity with results obtained by Tomar (1992) and Jooyban and Moosavi (2011) who observed the seed yield plant^{-1} decreased with increasing plant density pressures whereas seed yield per unit area was higher at higher plant densities. This clearly indicates that the seed yield plant^{-1} at lower densities could not compensate for the loss of seed yield due less number of plants per unit area. Seed yield plant^{-1} was reduced at longer irrigation intervals. The results revealed that seed yield per plant was significantly increased with decreasing plant density. Higher seed yields per plant were recorded in the range of 100,000 – 200,000 plants ha^{-1} relative to 250,000 plants ha^{-1} is apparently as of possible lower interplant competition. Further increase in the density may affect the agronomic traits of sesame.

Seed yield (kg ha^{-1})

Seed yield of sesame was significantly affected by irrigation intervals, plant population and their interaction (Table 1 and 2). The highest seed yield (822 kg ha^{-1}) was obtained from 7 days irrigation interval which was 69 and 74% higher than that obtained from 14 and 21 days irrigation intervals, respectively (Table 1). This was related to the decreased competition between plants and the increased number of capsules per plant. This could be due to the amount of soil moisture available by irrigation which influence nutrients uptake. In addition, long irrigation intervals caused water loss by evapotranspiration. The obtained results are in agreement with Duraisamy *et al.* (1999) who mentioned that the crop suffered from moisture stress as a result of longer irrigation intervals, the stress adversely affected the growth and yield attributes and ultimately decreased the seed yield. The plant populations of 150,000 and 200,000 plants ha^{-1}produced the highest seed yield than 100,000 plants/ha. A maximum seed yield of 450 to 463 kg ha^{-1} was obtained by plant populations of 150,000 and 200,000 plants ha^{-1}, respectively. These results clearly indicated that for irrigated sesame a density of 100,000 plants ha^{-1} were sparse and hence affecting adversely the seed yield. These findings are in accordance with those of Guanamurthy *et al.* (1992). The interaction effect between irrigation intervals and plant populations was significant. These results are in agreement with those findings of Mujaya and Yerokum (2003), seed yield is directly related to the number of capsules. The results of the current study it can concluded that irrigation sesame treatment of 7 days interval grown with densities of 200,000 plants ha^{-1} is recommended for the sesame cultivation under tropical high terrace soil conditions.



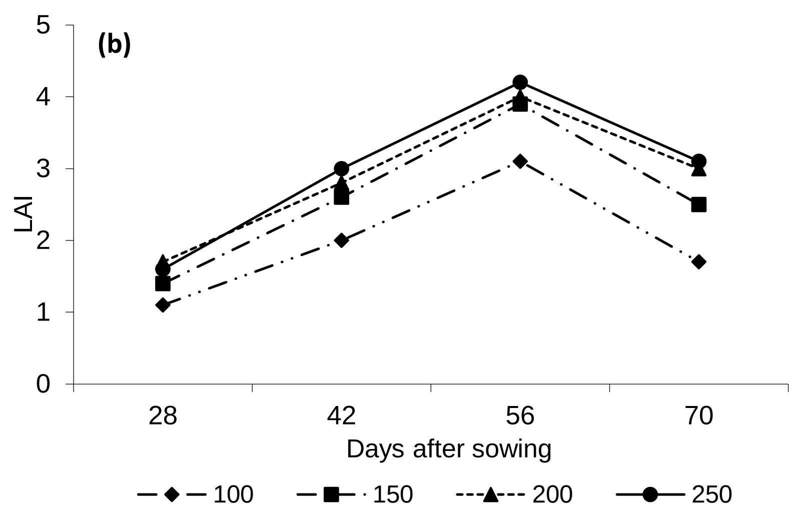


Fig.1 Leaf area index as influenced by (a) irrigation intervals (…♦…7, —■— —14 and ——21 days) and (b) plant population density (100000, 150000, 200000 and 250000 plants ha^{-1}) during 2006/07 season

Table 1. Effects of irrigation interval and plant population density on the yield and yield components of sesame (data combined for 2006 - 2007 seasons).

Treatments	No. of branches plant^{-1}	No. of capsule plant^{-1}	1000-seed weight (g)	Seed yield (plant^{-1})	Seed yield (kg ha^{-1})
Irrigation interval (days)					
7	1.40a	27.43a	2.62a	1.52a	822a
14	0.63b	13.42b	2.48a	0.69b	257b
21	0.84b	14.12b	2.08b	0.50c	214c
LSD (0.05)	0.32	2.882	0.223	0.133	23.9
Plant density (000) ha^{-1}					
100	1.35a	18.11c	2.36a	1.02a	382c
150	1.12a	20.52a	2.37a	0.95a	450a
200	0.68b	19.73b	2.41a	0.96a	463a
250	0.67b	14.90d	2.42a	0.68a	427b
LSD (0.05)	0.24	0.762	NS	NS	23.08

Means followed by the same letters in each column are not significantly different according to least significant difference (P≤0.05).

Table 2. Interactive effects of irrigation level and plant population density on the yield and yield components of sesame (data combined for 2006 - 2007 seasons).

Irrigation intervals (days)	Plant density (000) ha^{-1}	No. of branches plant^{-1}	No. of capsule plant^{-1}	1000-seed weight (g)	Seed yield (plant^{-1})	Seed yield (kg ha^{-1})
	100	2.1a	28.49ab	2.60b	1.66a	693c
	150	2.2a	31.29a	2.56b	1.58a	830b
	200	1.3c	26.64b	2.65b	1.57a	955a
	250	1.0c	23.31c	2.86a	1.28b	809b
14	100	1.8ab	11.66ef	2.43c	0.83c	237e
	150	1.6bc	14.70de	2.48b	0.64d	308d
	200	0.9c	16.83d	2.46b	0.93c	264e
	250	0.7d	10.50f	2.56b	0.37e	218f
21	100	1.3c	14.19d	2.01d	061d	216f
	150	1.2a	15.55d	2.11d	0.63d	211f
	200	0.8c	15.88d	2.08d	0.39e	171g
	250	0.6d	10.87f	2.12d	0.40e	256e
LSD (0.05)		0.37	3.099	0156	0.143	32.3

Means followed by the same letters in each column are not significantly different according to least significant difference (P≤0.05).

References

Abusuwar, A. O. and Karam Eldin, A. (2013). Effect of seed pelleting and water regime on the performance of some forage spiecies under arid conditions. American-Eurasian Journal Agric. and Environ.Sci.,13 (5): 728-734.

Adebisi, M. A.; Ajala, M. O.; Ojo, D. K. and Salau, A.W. (2005). Influence of population density and season on seed yield and its components in Nigerian sesame genotypes. Journal of Tropical Agriculture. 43: 13-18

Ayyaswamy, M. and Kulandaivelu, R. (1992). Effect of methods and interval of irrigation on growth of sesame (*Sesamum indicum* L.). Madras Agricultural, 79, 481-44.

Boydak, E.; Karaaslan, D.; Simsek, M. and Gercek, S. (2007). Effect of irrigation methods and irrigation intervals on yield and some yield components of sesame growing in Semi-arid area. Journal of Agronomy. 6: 439-443.

Caliskan, S.; Arslan, M.; Arioglu, H. and Isler, N. (2004). Effect of planting methods and plant population on growth and yield of sesame (*Sesamum indicum* L.) in a Mediterranean type of environment. Asian Journal of Plant Sciences. 3:610-613.

Duraisamy, K.; G. Kathiresam and Balasubraanian, A. (1999). Effect of irrigation frequency and coinpith application in sesame (*Sesamum indicum* L.) Indian J. of Agronomy 44, 416-418.

Fazeli, F.; M. Ghorbanli and Niknam, V. (2006). Effect of drought on water relations, growth and solute accumulation in two sesame cultivars. Pakistan Journal of Biological Sciences. 9: 1829-1835.

Ghosh D. C. and Patra, A. K. (1994). Effect of plant density and fertility levels on productivity and economics of summer sesame (*Sesamum indicum* L.) Indian Journal of Agronomy 39, 71-75. 1974.

Guanamurthy, P.; X. Hendry and Balasubramaniyan, P. (1992). Spacing and nitrogen requirement of sesame (*Sesamum indicum* L.). Indian Journal of Agronomy 37, 280- 282.

Imoloame, E. O.; Gworgwor, N. A. and Joshua, S.D. (2007). Sesame (*Sesamum indicum* L.) weed infestation, yield and yield components as influenced by sowing method and seed rate in a Sudan Savanna agro-ecology of Nigeria. African J. of Agricultural Research. 2:528-533.

Jouyban, Z.; M. S. Gholamreza and S. M. Javad (2011). Seed yield and nitrogen use and agronomic efficiency of sesame as affected by irrigation levels, nitrogen and superabsorbent. Australian J. Basic and Appl. Sci., 5(12):697-702.

Mujaya I. M. and Yerokum, O.A. (2003). Response of sesame (*Sesamum indicum L.*) to plant population and nitrogen fertilizer in North- Central Zimbabwe. Sesame and Safflower Newsletter 18: 64 – 69.

Said. B.; Khalil, S.K.; Jalal, F.; Basser, A.; Suleman, M.; Khan, H.; Khan, S. and Zaheer, S. (2017). Influence of nitrogen and row spacing on sesame (*sesamum indicum* L.) growth and yield attributes, Pure and Applied Biology,Vol.6, (1):116-124.

Sarma, N. N. (1994). Response of sesame (*Sesamum indicum* L.) varieties to levels of nitrogen and spacing. Annals of Agricultural Research 15: 107- 109.

Senthilkumar, R.; Imayavaramban, V.; Thanunathan, K. and Manickam, G. (2000). Effect of intra-row spacing and different levels of nitrogen in combination with Azospirillum inculation on growth and yield of sesame. Research on Crops l: 35- 354.

Subrahmaniyan, K. and Arulmozhi, N. (1998). Response of sesame (*Sesamum indicum* L.) to plant population and nitrogen under irrigation condition. Indian Journal of Agronomy. 44: 413-415.

Tiwari, K.P. and Namdeo, K.N. (1997). Response of sesame (*Sesamum indicum* L.) to planting geometry and nitrogen, Indian Journal of Agronomy 42: 365- 369.

Tomar, D.P.S.; Bhargava, S.C. and Dhaka, R.P.S. (1992). Productivity of sesame cultivars under varying plant population. Indian Journal of Plant Physiology 35: 238- 244.

Ucan, K.; Killi, F.; Gencoglan, C. and Merdum, H. (2007). Effect of irrigation frequency and amount of water use efficiency and yield of sesame (*Sesamum indicum* L.) under field conditions. Field Crop Research. 101: 249-258.

Yadav, D.S. and Srivastava, J.P. (1997). Analyses of growth pattern and effect of soil moisture stress in (*Sesamum indicum* L.). genotypes. Plant physiology and Biochemistry, New-Delhi. 24. pp 58-63.