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Effect of Irrigation Methods and Irrigation Intervals on Yield and Some Yield Components of Sesame Growing in Semi-arid Area

[1]Erkan Boydak, [2]Davut Karaaslan, [3]Mehmet Şimşek, [3]Sinan Gerçek,
[3]Halil Kirnak, [4]Yaşar Kasap and [5]Irfan Öztürk
[1]Department of Field Crops, Faculty of Agriculture, University of Harran, 63200 Sanliurfa, Turkey
[2]Southeast Anatolia Agricultural Research Institute, 21110 Diyarbakir, Turkey
[3]Department of Structures and Irrigation, Faculty of Agriculture, University of Harran, 63200 Sanliurfa, Turkey
[4]Department of Soil Science, Faculty of Agriculture, University of Harran, 63200 Sanliurfa, Turkey
[5]Department of Animal Production, Faculty of Agriculture, University of Harran, 63200 Sanliurfa, Turkey

Abstract: The aim of this study, was to determine the effects of irrigation methods and irrigation intervals on yield, plant height, number of branches and number of capsules for 2 years period. The study had two irrigation methods (sprinkle and drip), four irrigation intervals (6, 12, 18 and 24 day intervals) and three replication in Harran Plain conditions, where is semi-arid area in Turkey. Decreasing irrigation interval increased the yield per hectare and capsules number per plant. The highest yields were obtained at 6 and 12 day intervals (173.7 and 175.3 kg ha^{-1}, respectively) from drip irrigation methods and the lowest yields were obtained at 24 day intervals (64.1 kg ha^{-1}) from sprinkle irrigation methods. Generally, the higher yields were obtained from narrow irrigation interval and springle irrigation methods.

Key words: Irrigation methods, irrigation interval, sesame

INTRODUCTION

Development of irrigated agriculture depends not only on sufficient water being available, but also the appropriate use of that water. Salinity and alkalinity may occur if the irrigation programs are not applied properly. It is possible to achieve optimum quality and quantity of crop production if a proper irrigation method is utilized along with other agronomic methods.

Excessive flow quantity caused by the surface irrigation method especially in the regions with insufficient water supply called for appearance of the other irrigation methods particularly sprinkle and drip irrigation methods (Goldhammer and Peterson, 1984). Harran Valley is located in the zone of semi arid climate. The summer is hot and dry and the winter is warm with low precipitation. After the beginning of the valley irrigation meteorological data have sown considerable changes in comparison with the previous years (Şimşek *et al*., 2003). Air temperature, rational moisture quantity and average monthly figures for the several years and places of study are shown in the documents and methods section.

Great many factors influence plants water requirements namely; duration of the growth season, climate (air temperature, precipitation, moisture, evaporation and wind speed), soil moisture, topography and the soil structure.

Evaporation method of the opened water surface calculated directly or by means of different empirical methods for the plants' water use (Class A Pan) is considered to be the most applicable. Such researchers as Penman decided evaporation of the opened water surface by the mathematical method, class A Pan evaporation used for determination of the water consumption has been explained by means of empricial model (Hergrreaves, 1968).

According to Şimşek *et al.* (2003); ET/ET_0 ratio (plant's water consumption/evaporation of the opened water surface) used fort he determination of the water quantity for irrigation based on the opened water surface: depends on the kind of plant, soil structure, soil moisture quantity and capacity type.

In Harran valley conditions the research carried out by irrigation method between two ditches by means of the puddle formation during the secondary product irrigation, soybean depending on the different irrigation areas (are) and different Pan showed that irrigation water quantity for the first year was about 478.2-1055.8 mm for the second year 453.0-805.0 mm and the richest harvest for the both

Corresponding Author: Davut Karaaslan, Southeast Anatolia Agricultural Research Institute, 21110 Diyarbakir, Turkey
Tel: 0412-3261326 Fax: 0412-3261324

years occurred in the areas, which had been irrigated once per 7 days and Pan coefficient applied in the volume of 1.2 the harvest for the first year was 2850 kg ha^{-1}, for the second year 2427 kg ha^{-1} (Yazar *et al*., 1991). The other study established that upon increase of the soybean water stress formed during different periods from 20 to 40% decrease of the day matter volume for about 25-34% and harvest lowering for about 18-30.3% (Vearela, 1998).

Sesamum (*Sesamum indicum* L.), also known as sesame, till and gingerly, is an important and ancient oil-yielding crop. The sesame seed is a rich source of edible oil. Its oil content generally varies from 46 to 52%. Sesame oil is used for anointing the body, for manufacturing perfumed oils and for medicinal purposes.

It is a good source of vitamins (pantotenic acid and vitamin E) and minerals such as calcium (1450 mg/100 g) and phosphorous (570 mg/100 g) and the seed cake is also an important nutritious livestock feed. Planting pattern/method is considered an important aspect of advanced production technology which not only ensures better crop establishment but also result in water saving when the crop is sown on ridges or beds. Sowing of sesame crop of ridges with 10 cm distance between hills and ridges 70 cm apart gave highest values for number of capsules $plant^{-1}$, seed weight $plant^{-1}$ and 1000 seed weight (Malik *et al*., 2003).

MATERIALS AND METHODS

In this study, a local dark sesame was grown in June of 1998 and 1999 in the Faculty of Agriculture Department of Field Crops, Harran University, Turkey. The experimental design for irrigation methods (sprinkle irrigation and drip irrigation) and irrigation interval trials (6, 12, 18 and 24 days) was a split-plot with three replications. The altitude of the research field is approximately 464-467 m. The field is located at 37°-08 N and 38°-46 E.

All treatments were fertilized with 100 kg ha^{-1} nitrogen (50% after planting) and 60 kg ha^{-1} phosphorus in each year. Seeds were planted between seeds with 20 cm in 4 m rows. Germination percentage was 100%. The row spacing were 700 mm in 4 row-plots.

Twenty plants were randomly sampled at harvest to determine capsules number per plot, branches number and plant height. The capsules number and branches number values were obtained counting on the 20 plants. Plant height was observed with measurement between soil surface and top of plants. For seed yield, plants were harvested from middle two rows of 4 rows per plot treatment. Harvest was done by hand.

Trials were conducted on a silted-clay soil (Bouyoucus, 1952) at pH 7.5 (Grewelling and Peech, 1960) and lime content of 99000 ppm (Caglar, 1984) without salinity problem (620 ppm) (Peech, 1965) which was deficient in organic matter (11200 ppm) (Hizalan, 1963). Modify potassium was 780 kg ha^{-1} (Jackson, 1962).

Field capacity between (32.71-33.19%), permenant wilting point (21.18-22.55%) and bulk density of experiment soils were changed. Irrigation water was determinated in C_2S_1 soil classification. Soil moisture changing in 0-30 cm layers was determinated by gravimetric method. Twelve sprinkles were laid down in 6×6 m interval as square for per sprinkle irrigation plot. In drip irrigation a lateral pipe was laid down to per 700 mm row spacing.

The meteorological data were recorded from planting date to the harvest of each treatment in Table 1.

The following equation, was used to determine changes in soil water content at 0-30 cm soil depths using gravimetric method (Garrity *et al*., 1982). Water was applied to bring the soil at 0-90 cm to the field capacity in the first irrigation. The amount of required irrigation water was calculated by Class A evaporation pan every day (Kanber, 1984). Total water level, measured by using a manual limnimeter with 0.1 mm accuracy, was multiplied by area to calculate volume of water evaporated. These measurements were checked with the readings obtained from flow meters mounted in each plot.

$$ET = P + I - R - D_p \pm \Delta S$$

Where; ET is crop water consumption, P is rainfall, I is irrigation water, R surface flow, Dp is deep percolation, ΔS soil water content variation in crop root depth.

Table 1: Monthly mean temperatures and rainfall during the growing season for sesame (June-October) in 1998 and 1999 in Şanliurfa of Turkey

	Mean temperature (°C)		Minimum temperature (°C)		Maximum temperature (°C)		Total rainfall (mm)	
Month	1998	1999	1998	1999	1998	1999	1998	1999
June	29.4	28.8	17.8	18.8	41.2	40.0	0.6	1.6
July	33.0	32.5	19.8	21.5	45.4	43.2	NR	NR
August	33.4	31.2	22.6	20.5	43.0	43.0	NR	26.0
September	27.0	26.2	15.1	17.0	39.6	36.6	0.0	NR
October	21.5	21.0	10.2	11.3	34.1	35.6	0.1	8.4

*NR: No Rainfall

Four irrigation intervals (6, 12, 18 and 24 day intervals) were used to determine most suitable irrigation intervals for sesame in the Harran conditions.

Amount of water given to plots were calculated, based on class-A-pan evaporation. Since high sprinkle irrigation rate causes soil and water losses, a 80% of accumulated evaporation was applied based on soil infiltration rate. Water was supplied from a well located in the experimental area. The space between the in-line type of drippers was 33 cm and flow rate of it was 2.5 L h^{-1} for 1 atmosphere. The lateral with a 16 mm diameter was placed in the centre of two rows.

Statistical analysis was carried out using Statistical Analysis System (TARIST, version 1) (Açikgöz *et al*., 1993) with general linear model (GLM). Significant differences were determined using LSD (Least Significant Difference) multiple range test at $p<0.05$.

RESULTS AND DISCUSSION

Water use: Total applied water was 971 mm and evapotranspration rate of the sesame was 995 mm (sprinkle), 1102 mm (drip) in 1998, respectively. Total applied water was 1037 mm and evapotranspration rate was 1111 mm (sprinkle), 1135 mm (drip) in 1999, respectively growing period. There was a similar trend for applied water and water use of sesame in both years. Since precipitation was higher in 1998 compared to 1999, soil moisture storage was higher in 1998 according to soil moisture in 1999. These results are in agreement with the findings of Sepaskhah and Andam (2001).

Analysis of variance: Irrigation methods, irrigation intervals, irrigation methods×irrigation intervals and year×irrigatin mothods×irrigation intervals were highly significant ($p<0.001$) for most of the tested charecteristics. Variation of branch number was not significant for the irrigation intervals and irrigation methods×irrigation intervals interaction effect. But variation of branch number was significant for the irrigation intervals ($p<0.01$). Variation of plant height was not significant for irrigation methods in contrast variation of plant height was highly significant for irrigation intervals and irrigation methods×irrigation intervals interaction effects. Variation of capsule number and seed yield was significant for irrigation methods and irrigation intervals. Variation of capsules number was not significant for the irrigation methods×irrigation intervals interaction effect. But variation of seed yield was highly significant for the irrigation methods×irrigation intervals interaction effect (Table 2).

Agronomic traits: According to the results obtained it was noted that the highest plant height (125.6 cm), branch number (4.93 per plant), capsule number (121.7 per plant) and seed yield (173.7 kg ha^{-1}) were obtained from drip irrigation method at 6 day irrigation interval. The lowest plant height (88.5 cm), branch number (3.40 per plant), capsule number (56.6 per plant) and seed yield (64.1 kg ha^{-1}) were obtained from springle irrigation method at 24 day irrigation interval. The possible cause of this difference may be that since the period of irrigation was longer in the drip irrigation method, because the plants are able to uptake more plant nutrients and water regularly. Furthermore, weed density in sprinkle irrigation was higher compared to drip irrigation. This might be due to fully irrigation of the field, stimulating weed density and development of the weeds in sprinkle irrigation. In our experiment, weed density, in particular johnson grass (*Sorghum halepense* L.), was more in sprinkle irrigation than in drip irrigation and this, in turn, caused a competition for light between weeds and sesame plants resulting in increased plant height to utilize the light. On the other hand, in drip irrigation, weed development and density has been less intensive due to irrigation of plant canopy region only. As a result of this, number of branches and number of capsules per plant increased and yield increased as well.

Average results of yield and yield components at irrigation intervals according to irrigation methods showed in Table 3.

Seed yield: The methods of irrigation and irrigation intervals had a significant effect on the seed yield.

Table 2: Analysis of variance (mean square values) for sesame seed composition and agronomic factors

Source of variation	df	Plant height	Branch No.	Capsule No.	Seed yield
Year	1	153.30	16.450	3887.2	81.3
Irrigation method	1	2.70	5.670**	4555.2**	12828.2***
Year×irrigatin method	1	684.00**	0.005	51.7	144.5*
Irrigation interval	3	2530.04***	0.910	4097.1***	12773.6***
Year×irrigation interval	3	216.43**	0.320	1563.2***	29.1
Irrigation method×Irrigation interval	3	237.67**	0.560	115.5	1417.5***
Year×irrigation method×irrigation interval	3	193.00**	0.400	1256.6***	33.8
Error	47	242.33	0.870	673.8	1200.1

*Significant at $p<0.05$, **Significant at $p<0.01$, ***Significant at $p<0.001$

Table 3: Average results of yield and yield components at irrigation intervals according to irrigation methods

Irrigation intervals/years	Irrigation methods	
	Sprinkle	Drip
Mean of plant height (cm)		
6 day	120.2a	125.6a
12 day	113.9a	102.4b
18 day	93.6b	102.3b
24 day	89.5b	88.7c
LSD (5%)	0.72	
Mean of branch number (per plant)		
6 day	4.33a	4.93a
12 day	4.40a	4.90a
18 day	4.25a	4.58a
24 day	3.40b	4.72a
LSD (5%)	0.72	
Mean of capsule number (per plant)		
6 day	105.3a	121.7a
12 day	92.8b	113.5a
18 day	84.8b	98.1b
24 day	56.6c	84.2c
LSD (5%)	9.0	
Mean of seed yield (kg ha^{-1})		
6 day	128.3a	173.7a
12 day	126.6a	175.3a
18 day	128.7a	129.9b
24 day	64.1b	99.5b
LSD (5%)	5.1	

Mean values with same letter are not statistically significant at 5% level

The drip irrigation and 6 day irrigation interval gave better results (1737 kg ha^{-1}) than the sprinkle irrigation method and 6 day irrigation interval (1283 kg ha^{-1}) (Table 3). This resulted from that since the period of irrigation was longer in drip irrigation method, the plants were able to uptake more plant nutrients and water regularly. Also, the insufficient irrigation due to surface flow in sprinkle irrigation and lodging of the plants may be other possible reasons of lower seed yield in the latter case. Furthermore, application of irrigation in rhizosphere or canopy region, effective use of water in drip irrigation and easy transpiration and photosynthesis of the plants are other likely seasons for higher yields in drip irrigation method. Similar results for the characters being studied in this experiment, were reported in other studies (Yazar *et al*., 1991; Glenn *et al*., 1992; Paltineanu *et al*., 1994; Graterol *et al*., 1996; Vearela, 1998) on soybean and on sesame Vpraveen and Raikhelkar (1994).

Results showed that the highest seed yield was obtained from 6 and 12 day irrigation intervals and the lowest seed yield obtained from 24 day irrigation interval. Overall, the yield of seed in both irrigation methods springle and drip decreased relatively with the increase in irrigation interval.

This probably resulted from the fact that the increase of evaporation in a defined area caused decrease in the seed yield. In addition, long irrigation intervals caused water loss by evaporation.

As a results of this study indicated that obtaining the highest yield in sesame occurred when the crop was irrigated interval as narrow as possible up to 6 days interval and irrigated with a drip irrigation.

REFERENCES

Açikgöz, N., M.E. Akkaş, A. Maghaddam and K. Özcan, 1993. Tarist a pacquet of statistical and quantitative genetic for PC. International PC Application Symposium, Konya, 133: 10-19.

Bouyoucus, G.J., 1952. A recalibration of the hydrometer for making mechanical analysis of soils. Agron. J., 43: 434-438.

Caglar, R., 1984. Soil Science, Pablication of Ankara University, No. 10, Ankara.

Garrity, P.D., D.G. Watts, C.Y. Sullivan and J.R. Gilley, 1982. Moisture deficits and grain sorghum performance. Evapotranspirasion yield relationships. Agron. J., 74: 815-820.

Glenn, R.B., L.R. James, O.A. Lanny and B.S. Judith, 1992. Row spacing in the early soybean production systems. Agron. J., 84: 524-531.

Goldhamer, D. and C.M. Peterson, 1984. A Comparison of linear Move Sprinkler and Furrow Irrigation on Cotton. Case Study. Department of Land and Water Research University of California. Final Technical Report No. B54162. Davis. California, pp: 135.

Graterol, Y.E., R.W. Elmore and D.E. Eisenhauer, 1996. Narrow-row planting systems for furrow-irrigated soybeans. J. Prod. Agric., 9: 546-553.

Grewelling, T. and M. Peech, 1960. Chemical Soil Test. Cornell University Agric. Exp. Sta. Bull., 960. NY.

Hergrreaves, G.H., 1968. Consumptive use derived from evaporation pan date. J. Irr. Drain. Asce., 94: 97-105.

Hizalan, E., 1963. The Main Soil Material and Torn Events. Publication of Ankara University, Ankara.

Jackson, M.L., 1962. Soil Chemical Analysis. Prentice Hall. Inc. Englewood Cliffs. N.J. USA.

Kanber, R., 1984. Using Class a Pan Evaporation for Developing First and Second Groundnut Crop Irrigation. Pablication of Soil and Water Investigation Institute, General Publication No. 114, Tarsus.

Malik, M.A., M.F. Salem, M.A. Cheema and S. Ahmed, 2003. Influence of different of nitrogen levels on productivity of sesame under varying planting patterns. Int. J. Agric. Biol., 4: 490-492.

Paltineanu, I., C. Negrila, M. Craciun and I. Craciun, 1994. Long term trials on irrigated field crops in semiarid area of romania. Romania Agricultural Research No. 1, pp: 85-92.

Peech, M., 1965. Hydrogen Ion Activity in Soil chemical Analysis. Am. Soc. Agron. Madison. Wisc. USA., pp: 914.

Sepaskhah, A.R. and M. Andam, 2001. Crop Coefficient of sesame in a semi-arid region of I.R. Iran. Agric. Water Manage., 49: 51-63.

Simşek, M., E. Boydak, H. Kirnak, S. Gerçek and Y. Kasap, 2003. The effect of sprinkle irrigation on water and yield product interaction in sesame as affected by different irrigation intervals and row spacing, University of Ankara, Faculty of Agricultre. J. Agric. Sci., 9: 136-142, Ankara.

Vearela, B.D., 1998 Deficit Irrigation During the Reproductive Stages of Soybean (*Glycine max* L.) Merrill Philippines Uni. Los Banos, College Laguna 1998, Vol. 97.

Vpraveen, R. and S.V. Raikhelkar, 1994. Evapotranspiration of sesame (*Sesamum indicum*) in relation to pan evaporation. Indian J. Agric. Sci., 64: 771-774.

Yazar, A., V. Oğuzer, K. Tülücü, H. Arioğlu, C. Gençoğlan and K. Diker, 1991. Using class a pan evaporation for developing second crop soybean irrigation programmes in harran plain conditions. Outcome of Southeast Anatolia Project Report No. 5.3.3., Sanliurfa.