

Effect of Sprinkler and Furrow Irrigation on Sunflower Seed Yield and Quality

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Abstract

Sunflower is grown in Yugoslavia mainly without irrigation and relatively high yields are achieved but the yields vary depending on rainfall variation. High and stable yields can be obtained with irrigation each year regardless rainfall amount and distribution. Only small areas are irrigated. Because of sunflower susceptibility to the occurrence of fungal diseases under the conditions of frequent wetting of the above-ground part in sprinkler irrigation and varying of micro climate, particularly increase of relative air moisture, sprinkler and furrow irrigation was comparatively studied as well as the irrigation effect on seed yield, oil percentage and water use. The studied hybrids were NS-H-116 of short vegetative growth and NS-H-43 of long vegetative growth. Irrigation time was determined analyzing soil moisture and was performed at 65% of field water capacity. Considering sprinkler irrigation, we performed 2 to 3 irrigations annually with 100 to 150 mm water, while 1 to 3 furrow irrigations were performed with irrigation norm from 60 to 180 mm.

Water use for evapotranspiration with irrigation is 470 mm on average, which can be considered as potential evapotranspiration and 430 mm without irrigation which is a real evapotranspiration. With irrigation, sunflower seed yields were higher for about 1 t ha^{-1} , i.e., for 37%. Furrow irrigation brings to the yield for about 10% higher than sprinkler irrigation. Oil percentage is similar for both irrigation systems and was slightly higher (1%) than with no irrigation.

Under variable climatic conditions in Yugoslavia, irrigation is supplementary. Sprinkler irrigation is used most often. Sunflower gives high yields with irrigation, but furrow irrigation is recommended which gives yields higher for 10% or even more.

Key words: sunflower, furrow irrigation, sprinkler irrigation, yield, evapotranspiration.

INTRODUCTION

Sunflower (*Helianthus annus* L.) is grown on a large acreage in FR Yugoslavia, particularly in the north part, in the Vojvodina Province. Under variable semi humid to semi arid climate conditions with unstable and unfavourable rainfall distribution is grown with no irrigation on the largest part of the acreage. Average

yields of 2 t ha⁻¹ are achieved varying from 1.5 to 3.0 t ha⁻¹, which depends on weather conditions and the hybrid grown.

With irrigation and other favourable conditions, the sunflower gives high yields particularly in dry years when the yields are even doubled. High yields are achieved also in moderately dry years with no irrigation and consequently, the sunflower is not considered to be the culture that demands irrigation in Yugoslavia. Sunflower has root system well developed and with a capacity to use water from deep layers that is accumulated as soil reservoirs. According to Bošnjak (1993), sunflower uses over 200 mm of water from the 2-m soil depth, which is about 50% of total water demands. Unger (1983), Jones (1984) and others also claimed that sunflower has a capacity to extract soil water to a 1.8-m depth. Sunflower can extract water from the soil that has matric potential lower than maize and other field crops (Stegman and Lemert, 1980).

As there is a low number of studies considering the sunflower irrigation, we decided to establish a field trial with aim to determine the effect of sprinkler and furrow irrigation on plant development, yield and total amount of consumed water which is of general importance and particularly valuable for irrigation practice.

MATERIALS AND METHODS

The study was conducted from 1992 through 1994 at the Experiment fields of the Institute of Field and Vegetable Crops in Novi Sad, the Vojvodina Province, north part of Yugoslavia. The soil of the experiment plot is fertile, of fine structure and favourable chemical and water - physical properties.

Two factors were included in the study:

A - Irrigation method

- a₁ - sprinkler irrigation
- a₂ - furrow irrigation
- a₃ - non-irrigated control

B - Hybrids

- b₁ - NS-H-116 hybrid (early)
- b₂ - NS-H-43 hybrid (late)

The trial was plown and fertilized with 300 kg ha⁻¹ of N₁₅P₁₅K₁₅ in autumn while sowing was performed about April 20. Other management practices were performed like for intensive sunflower production. The harvest of early and late hybrids was performed at the beginning and middle of September, respectively.

Irrigation was performed at the moment when soil moisture in the rhizosphere was at 65% of field water capacity which was determined analyzing soil moisture gravimetrically and with neutron probe.

Seed moisture at harvest was approximately 10%, while the yield per ha was calculated for 13% moisture. Oil content was analyzed in the Institute's laboratory. The obtained data were analyzed by analysis of variance.

RESULTS, DISCUSSION AND CONCLUSION

Effect of irrigation on seed yield depends on weather conditions, first of all on rainfall amount and distribution in the vegetative period. In 1992, 1993 and 1994, annual precipitation averages 451, 595 and 630 mm, respectively. The respective amount in the growing period was 212, 249 and 346 mm.

Rainfall deficit with respect to sunflower water demands varied according to years, so that the number of irrigations and the amount of water differed according to years and irrigation methods (Table 1).

Evapotranspiration of the irrigated sunflower was determined according to soil moisture reservoirs to 2-m depth, rainfall and irrigation but the non-irrigated sunflower used the water from soil reserves and rainfall.

Sunflower evapotranspiration with irrigation is 473 mm on average (from 438 to 500 mm) and without irrigation it is 433 mm (from 398 to 464 mm) (Table 2).

Sunflower seed yields are usually highest when sunflower is adequately irrigated to avoid water stress. That was realized in all years of the study, particularly in dry 1993 when the hybrid NS-H-16 gave double yields with furrow irrigation with respect to the non-irrigated control (5.17 : 2.5 t ha⁻¹). However, the differences in seed yield with irrigation and non-irrigation were lower with the hybrid (NS-H-43) of long vegetative period (Table 3).

Due to the fact that these two hybrids differ according to the length of vegetative period, the plant development stages differed, particularly in the second part of vegetative growth. Consequently, drought affected the yield differently. The available results show that seed yield depends most of all on soil water content when the sunflower is at the late budding growth stage and flowering (Robinson, 1973; Stegman and Lemert, 1980). However, according to Mikov (1975), Dimitriev (1975) and others, the most critical period with respect to sunflower yield is the growth stage from early flowering to seed formation.

The yield of the sunflower with irrigation can be 4 or more tons per ha. One or two irrigations in due time can give the yields that are not significantly lower than the yields achieved with adequate irrigation. Good plant development provide high yield of sunflower seed, and consequently besides the supplying available water in soil in various development stages, other optimum conditions are also necessary such as the application of management practices.

The irrigation of sunflower increased seed yield significantly; more than 1 t ha⁻¹ on average which is 37%. Considering irrigation method, significant differences were also achieved. Furrow irrigation gave on average 0.41 t ha⁻¹ higher yield than sprinkler irrigation, which is 10.6%. Considering these two methods of irrigation, different seed yields were achieved in different years. In 1992 there were no differences while in 1994 the yield was higher for 0.86 t ha⁻¹, which is 27% with furrow irrigation.

Sunflower is susceptible to diseases, particularly in the years with low temperatures and frequent rainfalls. Sprinkler irrigation brings about the changes in microclimate in the crop, and the wetting of the sunflower heads and the whole plants, which can last long, can cause the development of fungal diseases. It can unfavourably affect the seed yield although the NS - hybrids are resistant to diseases. However, mass application of automatic wide-ranging sprinkler irrigation linears includes the sunflower as well. Although the differences in yield with respect to sprinkler and furrow irrigation are significant, high yield of the seed was achieved with sprinkler irrigation (3.88 t ha⁻¹) which means that this is a good method for sunflower irrigation. In such a case, early hybrids resistant to fungal diseases should be cultivated.

According to some average values, the differences between the hybrids are low although significant differences occur in some years. The effect of weather conditions is also significantly expressive. The highest yield was achieved in 1993, which had favourable rainfall amount and meteorologic conditions.

Oil percent was high and unified for both irrigation methods, 50.3% on average. With no irrigation, oil percentage was 1% lower than with irrigation (Table 4).

Positive effect of irrigation on oil content was found in some previous studies as well, due to the fact that under favourable soil moisture, sunflower has favourable conditions for better photosynthetic activity and better oil synthesis (Dragović, 1988; Stanojević, et al., 1988).

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Tab. 1. Dates of irrigation and irrigation rate of sunflower

Irrigation	1992.		1993.		1994.	
	Time	Rate,mm	Time	Rate,mm	Time	Rate,mm
Sprinkler irrigation	15.07.	50	22.06.	50	02.07.	50
	29.07.	50	21.07.	50	05.08.	50
			10.08.	50	19.08.	50
Total		100		150		150
Furrow irrigation	10.07.	60	23.06.	60	05.07.	60
			19.07.	60	05.08.	60
			09.08.	60		
Total		60		180		120

Tab. 2. Evapotranspiration of sunflower in sprinkler irrigation and non-irrigation (mm)

Treatment	Source of water	Year			Average
		1992.	1993.	1994.	
Sprinkler irrigation	Soil water reserve	170	157	37	121
	Rainfall	168	193	295	219
	Irrigation	100	150	150	133
	Total	438	500	482	473
Non-irrigation	Soil water reserve	230	246	169	215
	Rainfall	168	193	295	218
	Irrigation	0	0	0	0
	Total	398	439	464	433

Tab. 3. Yield of sunflower seeds depending of method of irrigation, hybrids, and weather conditions (t/ha)

Irrigation (A)	Hybrid (B)	Year (C)			Average
		1992.	1993.	1994.	
Sprinkler irrigation	NS-H-116	3.87	4.40	3.10	3.79
	NS-H-43	4.09	4.57	3.24	3.97
	Average	3.98	4.49	3.17	3.88
Furrow irrigation	NS-H-116	4.65	5.17	3.94	4.59
	NS-H-43	3.34	4.51	4.13	4.00
	Average	4.00	4.84	4.03	4.29
Non-irrigated	NS-H-116	2.95	2.50	3.16	2.87
	NS-H-43	2.60	3.74	2.98	3.11
	Average	2.77	3.12	3.07	2.99
Average	NS-H-116	3.82	4.02	3.40	3.75
	NS-H-43	3.34	4.28	3.45	3.69
Average		3.58	4.15	3.43	3.72

		A	B	C	AB	BC	AC	ABC
LSD:	5%	0.27	0.22	0.27	0.38	0.38	0.47	0.66
	1%	0.36	0.29	0.36	0.51	0.51	0.62	0.88

Tab. 4. Percentage of oil in sunflower seeds

Irrigation	Hybrid	Year			Average
		1992.	1993.	1994.	
Sprinkler irrigation	NS-H-116	49.4	50.0	53.4	50.9
	NS-H-43	47.7	49.8	51.4	49.6
	Average	48.5	49.9	52.4	50.3
Furrow irrigation	NS-H-116	48.6	50.9	53.9	51.1
	NS-H-43	48.9	48.8	50.8	49.5
	Average	48.7	49.9	52.3	50.3
Non-irrigated	NS-H-116	49.8	50.0	51.5	50.4
	NS-H-43	46.0	47.1	50.6	47.9
	Average	47.9	48.6	51.1	49.2