Original Research Article

PERFORMANCE OF *RABI* SUNFLOWER TO DIFFERENT LEVELS OF DRIP IRRIGATION REGIMES AND FERTIGATION

Abstract

A field trial was conducted at Water Technology Center, College farm, College of Agriculture, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar, during *rabi* season (2018-19) to study the effect of different levels of drip irrigation regimes and fertigation on *rabi* sunflower. The experiment was carried out under split plot design with three main plot treatments (Irrigation regimes) and four sub-plot treatments (Fertigation levels) and replicated thrice. In irrigation levels sunflower performed better under 1.2 and 1.0 Epan in growth parameters followed by 0.8 Epan. The growth parameters, *viz.*, plant height (214.4 & 214.6 cm), Number of leaves per plant (24.7 & 24.6), LAI (5.63 & 5.27), dry matter accumulation (6041 kg ha^{-1} & 5683 kg ha^{-1}), Root depth (17.2 cm & 17.4 cm) and Root volume (91.5 cm^3 & 101.0 cm^3) were found significantly higher at 1.2 Epan and 1.0 Epan. Among fertigation levels, fertigation with 120% RD N & K_2O reported higer plant height (216.8 cm), Number of leaves per plant (25.5), LAI (5.96), dry matter accumulation (5950 kg ha^{-1}), Root depth (18.6 cm) and Root volume (103.2 cm^3) followed by 80% RD N & K_2O and 60% RD N & K_2O. The economic yield reported higher at 1.0 Epan (2082 kg ha^{-1}) and 100% RD N & K_2O (2162 kg ha^{-1}) in main and sub plot treatments than other treatments. The benefit-cost ratio was reported highest for Drip irrigation scheduled at 1.0 Epan (2.52) and fertigation with 100% RD N & K_2O (2.59) among the Irrigation and fertigation levels respectively.

Key words: Drip, Fetigation, Irrigation, Sunflower and B:C ratio

Introduction

In India, sunflower was introduced in 1965 but commercial cultivation was started in 1972 with the introduction of Russian cultivars. It is an important oilseed crop contributes 1.4 per cent of the total oilseed production from nine major oil seed crops. It was cultivated over an area of about 2.8 lakh hectares with a production of 2.2 lakh tones and productivity of 643 kg ha^{-1} (IIOR, 2018). The projected population of India was expected to be around 1.39 billion by 2025 AD and the required oil seeds production and oil requirement will be around 102.3 million tonnes and 34.10 million tonnes by 2030 AD (DRMR, 2011). Sunflower holds great promise as oilseed crop because of its versatility, photo insensitiveness, short duration, day neutral crop (cultivated in *kharif, rabi* and *summer* seasons), and best for contingent crop, high degree of adaptability to different soils and climatic conditions, easy for

cultivation, low seed rate, high seed multiplication ratio (1:80), higher market price, drought tolerant, good scope of diversified cropping pattern, high quality of oil (poly unsaturated fatty acids) content and deep root system. The oil demand was increasing day to day so we need to increase area and production of sunflower by using optimum irrigation and fertigation methods. Drip irrigation is a very efficient method, which reduces water requirement of crop (Kaur and Brar, 2016). It minimizes conventional losses of water by deep percolation, evaporation and run off. Fertigation of nutrients significantly increased saving of fertilizer nutrients up to 40 per cent without affecting the yield of crops compared to the conventional method of nutrient application (Sathya *et al*., 2008).

Materials and methods

The field experiment was conducted during *rabi* 2019-2020 at Water Technology Center, College farm, College of Agriculture, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar, Hyderabad sandy clay loam soil which was alkaline in reaction and non-saline, low in available nitrogen, high in available phosphorous and available potassium, medium in organic carbon content, having total available soil moisture 60.91 mm in 45 cm depth of soil. Irrigation water was neutral (7.22 pH) and was classified as C3 class suggesting that it is suitable for irrigation by following good management practices. The experiment was laid out in a split plot design consisting of three main irrigation regimes *viz.*, drip irrigation scheduled at 0.8, 1.0 and 1.2 Epan and four fertigation levels of 60% RD N& K_2O, 80% RD N& K_2O,100% RD N& K_2O and 120% RD N& K_2O and replicated thrice. The recommended dose of (RD) nutrients were 75:90:30 kg NPK $ha^{-1}$and entire dose of P_2O_5 was applied as basal, N and K_2O was applied as fertigation in 18 splits in the form of urea and sulphate of potash (SoP) based on crop requirement at each stage with 4 days interval from 10 days after sowing onwards. The data of Epan was collected from agro meteorological observatory away from 500 m at Agricultural Research Institute, Rajendranagar and accordingly application rate and drip system operation time was calculated. The crop was irrigated once in 2 days. Need based plant protection measures were taken up and kept weeds low to avoid crop weed competition by weeding at 30 days after sowing. When crop reach harvested maturity stage net plot yield was taken and computed to kg per hectare. The data collected was statistically analyzed as suggested by Gomez and Gomez (1984).

Results and discussion:

Growth parameters

Data on different levels of drip irrigation regimes and fertigation on growth parameters are prescribed in Table.1. Among irrigation levels significantly higher plant height of *rabi* sunflower was

observed with drip scheduled at 1.0 Epan (214.6 cm) compared with drip irrigation scheduled at 0.8 Epan (199.7 cm), and was on par with 1.2 Epan (214.4 cm). In fertigation levels, 100% RD of N & K_2O recorded significantly higher plant height (217.5 cm) than 80% RD of N & K_2O (207.7 cm) and 60% RD of N & K_2O (196.1 cm) and was on par with 120% RD of N & K_2O (216.8 cm). The increased plant height with increase in drip irrigation level could be traced to favorable soil water maintained in the effective crop root zone depth with higher frequency of irrigation. An optimal soil and plant water balance under drip irrigation scheduled at 1.2 Epan and 1.0 Epan treatments might have stimulated increased activity of meristematic cells and cell elongation of internodes resulting in higher growth rate of stem in turn promoting higher plant height of sunflower (Gardner *et al*., 1985 and Jaleel *et al*., 2009).

Higher number of leaves plant^{-1} recorded with drip irrigation scheduled at 1.2 Epan (24.7) and it was significantly different from leaf number realized with 0.8 Epan (20.7) and was on par with 1.0 Epan (24.6). Data presented in Table.1 showed that the number of leaves plant^{-1} with fertigation levels of 120% RD N & K_2O (25.5) and 100% RD N & K_2O recorded were on par with each other and were significantly higher than 80% RD N & K_2O (22.5) and 60% RD N & K_2O (19.8). The number of leaves plant^{-1} were increased with increase in fertigation dose due to better availability and uptake of nutrients in tune with the growth rate resulting in better growth and development in terms of plant height resulting in more number of leaves.

Significantly greater LAI was achieved with irrigation scheduled at 1.2 Epan (5.63) compared to 0.8 Epan (4.37) and was on par with 1.0 Epan (5.27). Drip irrigation scheduled at 0.8 Epan observed significantly lower LAI than other two irrigation levels. Improved LAI under drip irrigation scheduled at 1.2 Epan and 1.0% Epan treatments could be attributed to maintenance of higher soil water potential contributing favourable plant water balance as compared to the crop in deficit irrigation treatment (0.8 Epan). Among varied fertigation levels, 120% RD N & K_2O recorded significantly higher LAI (5.96) than 80% RD N & K_2O (4.81) and 60% RD N & K_2O (4.20) and was not significantly different with 100% RD N & K_2O (5.38). The LAI increased with enhancement in fertigation of RD N & K_2O level from 60% to 120% and this was due to higher availability of NPK.

Drip irrigation scheduled at 1.2 Epan produced significantly higher dry matter (6041 kg ha^{-1}) compared with 1.0 Epan (5683 kg ha^{-1}) and 0.8 Epan (4864 kg ha^{-1}). However, significantly lower dry matter was recorded with drip irrigation scheduled at 0.8 Epan over 1.0 Epan and 1.2 Epan. Fertigation with 120% RD N & K_2O (5950 kg ha^{-1}) recorded significantly superior dry matter than 80% RD N & K_2O (5422 kg ha^{-1}) and 60% RD N & K_2O (4918 kg ha^{-1}) and was not significant with 100% RD N & K_2O (5829 kg ha^{-1}). Application of water and nutrients through drip system which enabled continuous

availability of optimum soil moisture and nutrients in the root zone facilitating effective absorption of water and nutrients by plants at higher irrigation levels which lead to increases nutrient uptake results higher plant height, number of leaves, and LAI increases the photo synthesis, ultimately it increased dry matter.

Significantly higher root depth and root volume of *rabi* sunflower were recorded when drip irrigation was scheduled at 1.2 Epan (17.4 cm & 101.0 cm^3) over 0.8 Epan (14.8 cm & 72.6 cm^3) and was on par with drip irrigation at 1.0 Epan (17.2 cm & 91.5 cm^3). Drip fertigation of 120% RD N & K_2O (18.6 cm & 103.2cm^3) and 100% RD N & K_2O (17.7 cm & 98.1cm^3) were on par each other and recorded significantly superior root depth and volume at harvest compared with 80% RD N & K_2O (16.0 cm & 85.2cm^3) and 60% RD N & K_2O (13.7 cm & 67.0cm^3).

Yield parameters:

Maximum head diameter of sunflower was recorded in drip irrigation scheduled at 1.0 Epan (16.0 cm) compared with 0.8 Epan (14.1 cm) and was on par with drip irrigation scheduled at 1.2 Epan (15.6 cm). Irrigation at 0.8 Epan produced significantly lower head diameter than rest of the irrigation levels. Fertigation with 100% RD N & K_2O recorded significantly higher head diameter of *rabi* sunflower (16.2 cm) than 80% RD N & K_2O (14.9 cm) and 60% RD N & K_2O (13.7 cm) and was not significantly differ with 120% RD N & K_2O (16.0 cm). Fertigation with 120% RD N & K_2O was next to 100% RD N & K_2O and was on par with 80% RD N & K_2O. This might be due to higher availability of nutrients in 100% and 120% RD N & K_2O compared to other treatment, there by higher plant height, number of leaves and LAI and more head diameter. These results are in supporting with the findings of Himaja, (2017) and Preethika, (2018).

Number of seeds $head^{-1}$ presented in Table. 2 indicated that significantly maximum number of seeds were observed with irrigation scheduled at 1.0 Epan (687.6) than 0.8 Epan (578.5) and was on par with 1.2 Epan (677.4). Among the fertigation levels, 100% RD N & K_2O (737.2) and 120% RD N & K_2O (727.6) recorded significantly greater number of seeds $head^{-1}$ than 80% RD N & K_2O (586.5) and 60% RD N & K_2O (540.1).

The shelling per cent was not significantly influenced by irrigation regimes and fertigation of RD N & K_2O levels and by their interactions. However higher shelling per cent was recorded with drip irrigation scheduled at 1.0 Epan (70.2 %) and fertigation with 60% RD N & K_2O (73.7 %) than rest of the treatments.

Significantly higher seed yield of *rabi* sunflower was recorded with drip irrigation scheduled at 1.0 Epan (2082 kg ha^{-1}) than irrigation at 0.8 Epan (1781 kg ha^{-1}) and was on par with 1.2 Epan (2028 kg

ha^{-1}). Among fertigation levels, significantly higher seed yield (2162 kg ha^{-1}) was observed with fertigation of 100% RD N & K_2O over fertigation of 80% RD N & K_2O (1872 kg ha^{-1}) and 60% RD N & K_2O (1688 kg ha^{-1}) and was on par with fertigation of 120% RD N & K_2O (2133 kg ha^{-1}). The results were in similar trend with the results reported by Akanksha, (2015) and Kumar *et al.* (2014).

The oil yield followed the trend as that of seed yield presented in Table 2. indicated that significantly higher oil yield was recorded with drip irrigation scheduled at 1.0 Epan (814 kg ha^{-1}) than 0.8 Epan (707 kg ha^{-1}) and was on par with irrigation at 1.2 Epan (794 kg ha^{-1}). Fertigation with 100% RD N & K_2O recorded significantly higher oil yield (844 kg ha^{-1}) than 80% RD N & K_2O (739 kg ha^{-1}) and 60% RD N & K_2O (671 kg ha^{-1}) and was statistically on par with fertigation with 120 % RD N & K_2O (834 kg ha^{-1}).

Among varied fertigation levels significantly higher (2.59) and lower (2.08) B:C ratios were found with fertigation of 100% RD N & K_2O and 60% RD N & K_2O treatments which were on par with 120% RD N & K_2O (2.52) and 80% RD N & K_2O (2.27), respectively. B:C ratio with fertigation of 60% RD N & K_2O was significantly lower than the fertigation of 100% and 120% RD N & K_2O. This may be due to relative increase in fertility level did not increase the yield proportional to increased cost of inputs. Results obtained by Preethika *et al*. (2018) and Tahir e*t al.* (2011) corroborate with the findings of present investigation B:C ratio.

Table.1 Growth parameters of *rabi* sunflower as influenced by different levels of drip irrigation regimes and fertigation.

Treatments	Plant height (cm)	No. of leaves (g)	LAI	Dry matter (kg ha^{-1})	Root depth (cm)	Root volume (cm^3)
Main plot – (Irrigation regimes) :						
I_1: Drip irrigation at 0.8 Epan	199.7	20.7	4.37	4864	14.8	72.6
I_2: Drip irrigation at 1.0 Epan	214.6	24.6	5.27	5683	17.2	91.5
I_3: Drip irrigation at 1.2 Epan	214.4	24.7	5.63	6041	17.4	101.0
SEm ±	2.2	0.3	0.12	54	0.2	2.5
C.D (P=0.05)	8.8	1.2	0.49	212	1.0	9.8
Sub plot – (Fertigation levels) :						
F_1 – 60 % RD N & K_2O	196.1	19.8	4.20	4918	13.7	67.0
F_2 – 80 % RD N & K_2O	207.7	22.5	4.81	5422	16.0	85.2
F_3 – 100 % RD N & K_2O	217.5	25.4	5.38	5829	17.7	98.1
F_4 – 120 % RD N & K_2O	216.8	25.5	5.96	5950	18.6	103.2
SEm ±	3.1	0.5	0.23	94	0.5	2.1
C.D (P=0.05)	9.2	1.6	0.70	280	1.4	6.2
Interaction :						

Fertigation levels at same level of irrigation regimes :						
SEm ±	5.4	0.9	0.41	164	0.8	3.7
C.D (P=0.05)	NS	NS	NS	NS	NS	NS
Irrigation regimes at same or different levels of fertigation :						
SEm ±	5.2	0.9	0.37	151	0.7	4.0
C.D (P=0.05)	NS	NS	NS	NS	NS	NS

Table.2 Yield parameters, yield and B:C ratio of *rabi* sunflower as influenced by different levels of drip irrigation regimes and fertigation.

Treatments	Head diameter (cm)	No. of seeds head^{-1}	Threshing (%)	Economic yield (kg ha^{-1})	Oil yield (kg ha^{-1})	B:C ratio
Main plot – (Irrigation regimes) :						
I_1: Drip irrigation at 0.8 Epan	14.1	578.5	29.4	1781	707	2.20
I_2: Drip irrigation at 1.0 Epan	16.0	687.6	40.4	2082	814	2.52
I_3: Drip irrigation at 1.2 Epan	15.6	677.4	37.8	2028	794	2.38
SEm ±	0.3	17.8	0.7	51	20	0.06
C.D (P=0.05)	1.4	70.0	3.0	200	78	0.23
Sub plot – (Fertigation levels) :						
F_1 – 60 % RD N & K_2O	13.7	540.1	29.0	1688	671	2.08
F_2 – 80 % RD N & K_2O	14.9	586.5	34.5	1872	739	2.27
F_3 – 100 % RD N & K_2O	16.2	737.2	40.3	2162	844	2.59
F_4 – 120 % RD N & K_2O	16.0	727.6	39.7	2133	834	2.52
SEm ±	0.3	25.7	1.0	73	32	0.09
C.D (P=0.05)	1.1	76.5	3.0	219	95	0.26
Interaction :						
Fertigation levels at same level of irrigation regimes :						
SEm ±	0.6	44.6	1.7	127	55	0.15
C.D (P=0.05)	NS	NS	NS	NS	NS	NS
Irrigation regimes at same or different levels of fertigation :						
SEm ±	0.6	42.5	1.7	121	52	0.15
C.D (P=0.05)	NS	NS	NS	NS	NS	NS

CONCLUSION:

Drip irrigation scheduled at 1.0 Epan and 1.2 Epan reported higher values in growth and yield parameters of *rabi* sunflower. Among the different fertigation levels, significantly highest yield was reported with 100% RD of N & K_2O and 120% RD of N & K_2O. Soil moisture deficit and lack of nutrients in soil are the most important constraint for crop production during *rabi* season. Therefore,

inclusion of efficient water distribution system with irrigation scheduling at 1.0 Epan and fertigation with 100% R D of N & K_2O is found to perform better in enhancing the crop yield. Irrigation at 1.0 Epan and Fertigation with 100% R D of N & K_2O is effective way to improve water and nutrient use efficiency.

REFERENCES:

Akanksha, K. 2015. Response Of Sunflower (*Helianthus Annuus* L.) Varieties To Nitrogen Levels. M. Sc.(Ag.) Thesis Submitted To Mahatma Phule Krishi Vidyapeeth, Rahuri, India.

DRMR, 2011 Vision. 2030. Directorate Of Rapeseed-Mustard Research, Bharatpur, Rajasthan.

Gardner, F.P., Pearu, R.B And Mitchell, R.L. 1985. Physiology Of Crop Plants. Iowa State University Press. *Iowa*. 327.

Gomez, K.A And Gomez, A.A. 1984. *Statistical Procedures For Agricultural Research*. John Wiley & Sons, Singapore.

Himaja, I. 2017, Response Of Maize, Sorghum And Sunflower To Different Fertigation Levels. *M. Sc. (Ag.) Thesis.* Professor Jayashankar Telangana State Agriculture University, Hyderabad, India.

IIOR, 2018. Area, Production And Yield Trends Of Sunflower In India, Ministry Of Agriculture, Department Of Agriculture And Cooperation, Government Of India, New Delhi. *Www.Nmoop.Gov.In.* Acessed In 2019.

Jaleel, C.A., Manivannan, P., Wahid, A., Farooq, M., Somasundaram, R And Panneerselvam, R. 2009. Drought Stress In Plants: A Review On Morphological Characteristics And Pigments Composition. *International Journal Of Agriculture And Biology.* 11: 100-105.

Kaur, Amandeep And Brar, A.S. 2016. Influence Of Mulching And Irrigation Scheduling On Productivity And Water Use Of Turmeric (*Curcuma Longa* L.) In North Western India. *Irrigation Science*. (34): 261–269.

Kumar, K.A., Neelima, S And Munirathnam, P. 2014. Influence Of Subsurface Drip Irrigation System On Growth And Yield Of Sunflower (*Helianthus Annuus* L.) In Scarce Rainfall Zone Of Andhra Pradesh In Subtropical India. *Helia*. *37*(60): 69-75.

Preethika, R., Devi, M.U., Ramulu, V And Madhavi, M. 2018. Effect Of N And K Fertigation Schedules On Yield Attributes And Yield Of Sunflower (*Helianthus Annuus* L.). Journal Of Research PJTSAU. 46 (2/3): 95-98.

Sathya, S., Pitchai, G.J., Indirani, R And Kannathasan, M. 2008. Effect Of Fertigation On Availability Of Nutrients (N, P & K) In Soil - A Review. *Agricultural Reviews*. 29(3): 214-219.

Tahir, M., Khaliq, A., Waseem, M., Ali, A., Tanveer, A., Iqbal, A And Khan, M. A. 2011. Influence Of Different Nitrogen Application Methods And Sowing Techniques On Sunflower Hybrid. *Legume Research: An International Journal*. *34*(2): 90-97.