

Original Research Article

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Water Use Efficiency of Sunflower under Deficit Drip Irrigation in East and South-East Coastal Plain Agro-climatic Zone of Odisha, India

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ABSTRACT

Keywords

Deficit irrigation, Water use efficiency, MAD, FC, RBD

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A field experiment was conducted in Central Farm of OUAT, Bhubaneswar, to determine the water use efficiency of sunflower under deficit drip irrigation during the year 2018-19. Five treatment levels of irrigation i.e. at field capacity, 20 per cent, 40 per cent and 60 per cent MAD level of irrigation under drip irrigation method and one farmers practice under furrow irrigation method as control with 5 replications was considered for the experiment with RBD design. The maximum water use efficiency of 11.2 kg/ha-mm for sunflower was found in 40 per cent MAD level of drip irrigation followed by 10.89 kg/ha-mm in 20% MAD level of irrigation. The deficit drip irrigation produced 57.88% more sunflower yield consuming 26.83% less water at 40% MAD level over farmers practice. Considering the maximum water use efficiency, sunflower crop may be irrigated at 40 per cent MAD level by drip irrigation method for increasing the water use efficiency in East and South-East Coastal Plain Agro-climatic Zone of Odisha, India.

Introduction

Deficit irrigation, at present, has been widely considered as a valuable and sustainable production strategy in water scarce regions, which limits water applications to plants and thus maximize the water productivity. It has become necessary to grow short duration crops requiring less amount of water at the same time giving enough yields in the water scarce areas. More particularly, vegetable crops and oil seed crops should be preferred for growing over the high water requiring crops like paddy and other cereals.

Sunflower is recognized as an important oil seed crop having high source of nutritional value. The relatively shorter growing season of sunflower as a drought tolerant crop compared with other crops also reduces its irrigation needs making it a potential crop with limited irrigation water availability. In India sunflower cultivation occupies about 0.34 M ha area with average yield of 699 kg/ha. In Odisha, sunflower is grown on 0.02 million hectares with a production of 0.02 million tonnes at productivity level of 1185 kg/ha (GOI, 2017).

Terry *et al.*, (2015) studied about crop water use, water productivity and crop coefficients for irrigated sunflower in the U.S. Southern High Plains, where water productivity and crop coefficients for irrigation scheduling were not well known. Philippe *et al.*, (2017) have studied sunflower crop and its vulnerability, adaptation and mitigation potential under climate change in Europe. Elijah *et al.*, (2018) evaluated the root zone soil water balance under full, and deficit irrigated sunflower and sunflower yield and water use efficiency under deficit irrigated in Zambia and found that growth parameter decreased with a decrease in applied irrigation water. Sinha *et al.*, (2017) analyzed drip irrigation and fertigation improve economics, water and energy productivity of spring sunflower in Indian Punjab. Singh *et al.*, (2007) studied the response of sunflower to furrow irrigation in arid region of northern India. Abdul *et al.*, (2015) studied the effect of drip and furrow irrigation systems on sunflower yield and water use efficiency in dry area of Pakistan and found drip irrigation to produce 26% more yield with 56% less water and thus water use efficiency 3 times higher over furrow irrigation. Sam *et al.*, (2009) studied the deficit irrigation as an on-farm strategy to maximize crop water productivity in dry areas and found deficit irrigation to be successful in increasing water productivity for various crops without causing severe yield reductions. Eman *et al.*, (2015) studied crop water productivity for sunflower under different irrigation regimes and plants spacing in Sudan and obtained highest seed yield at 40 cm plant spacing with average crop water productivity in the range 0.31-0.43kg/m³.

In the present context, it has been aimed to determine the water use efficiency of sunflower under different deficit irrigation practices for providing sufficient information to the farmers for growing sunflower in the

water scarce areas of the state more particularly in East and South-East Coastal Plain Agro-Climatic Zone of Odisha.

Materials and Methods

The experiment was conducted in Central Farm, OUAT, Bhubaneswar, which is coming under East and South-East Coastal Plain Agro-Climatic Zone of Odisha with the GPS coordinates of 20° 17' 45" N and 85° 49' 28" E. The average maximum and minimum temperature of Bhubaneswar was 36 °C and 25°C during the experimentation period and average relative humidity was 70 per cent.

The soil of the experimental site was determined to be sandy loam. The bulk density, particle density, the pH and the organic carbon content of the soil was determined to be 1.48 gm/cc, 2.85 gm/cc, 4.83 and 0.35 per cent respectively. The field capacity and wilting point of the soil was determined to be 19.5 per cent and 8 per cent respectively.

The experiment was conducted as per RBD design during the year 2018-19. Five irrigation treatments, namely one FC (T_{d1}), three deficit irrigations (T_{d2}: 20 per cent MAD level of irrigation, T_{d3}: 40 per cent MAD level of irrigation and T_{d4}: 60 per cent MAD level of irrigation) under drip method of water application and a farmers practice (T_c) under furrow irrigation as control were considered for the experiment. Each treatment had five replications and each plot size was 5×4m². Sunflower variety Swathi NSFH-145 of 90 to 95 days' duration crop was selected for the study. The field preparation was done and maintaining the crop spacing of 30 cm x 45 cm, drip irrigation system was laid in the field. The furrows were prepared for the control treatment. The crop was grown following the standard agronomical package of practices. Based upon the moisture status

of the soil the required quantity of irrigation water was applied through drip system of irrigation to bring the soil to the field capacity. The moisture content was observed using digital moisture meter. The depth of irrigation water was also determined considering the root zone depth and available moisture. The crop growth parameters such as plant height, leaf numbers and plant girth were recorded at an interval of 15 days during the entire growing period of sunflower. The yield of crop and the water use efficiency of the crop was also determined.

Results and Discussion

Plant growth parameters

The plant growth parameters such as height, leaf number and girth were measured at an interval of 15 days after sowing for all the treatments and were analyzed and have been presented in Figure 1 to 3.

It is observed from Figure 1 that the average plant height was 27.7, 22.3, 18.8, 15.4 and 30.1cm after 30 DAS and 152.2, 143.7, 136.5, 114.8 and 161.2 cm after 75 DAS at different MAD levels of irrigation at field capacity, 20%, 40%, 60% and farmers practice respectively. The Figure 2 reveals that the average plant leaf number was observed to be 31, 28, 26, 23 and 33 after 75 DAS at different MAD levels of irrigation of FC, 20, 40, 60% and farmers practice respectively.

From Figure 3, the average plant girth was observed to be 3.0, 2.4, 2.0, 1.4 and 3.2 cm after 30 DAS and 7.2, 6.4, 5.8, 5 and 7.7 after 75 DAS at different MAD levels of irrigation of FC, 20, 40, 60% and farmers practice respectively. The maximum plant height, girth and leaf numbers of sunflower was observed to be 161.2 cm, 7.7 cm and 33 numbers respectively in farmers practice followed by FC, 20 per cent, 40 per cent and 60 per cent MAD levels of drip irrigation practice.

Yield and water use efficiency

The yield and water use efficiency of sunflower under deficit irrigation and farmers practice has been presented in Table 1 and Figure 4 and 5. The Table 1 reveals that the maximum yield was 1971.6 kg/ha in T_{d1} i.e. irrigation at field capacity followed by 1732.6 kg/ha at 20% MAD level, 1680.2 kg/ha at 40% MAD level, 1388.0 kg/ha at 60% MAD level of irrigation and minimum of 1064.2 kg/ha in farmers practice.

Similarly, it is found from the table that he maximum water use efficiency was 11.2 kg/ha-mm in 40 per cent MAD level of irrigation followed by 20 per cent MAD level of irrigation with water use efficiency 10.89 kg/ha-mm. The minimum water use efficiency was found to be 5.19 kg/ha-mm in farmers practice, which might be due to the leaching of the nutrients.

Table.1 Water use efficiency of sunflower under different treatments

Treatments	Yield (kg/ha)	Depth of irrigation (mm)	Water Use Efficiency (kg/ha-mm)
T_{d1} (Field capacity)	1971.6	188	10.48
T_{d2} (20% MAD level)	1732.6	159	10.89
T_{d3} (40% MAD level)	1680.2	150	11.20
T_{d4} (60% MAD level)	1388.0	132	10.51
T_c (Control)	1064.2	205	05.19

Fig.1 Plant height of sunflower under different treatments

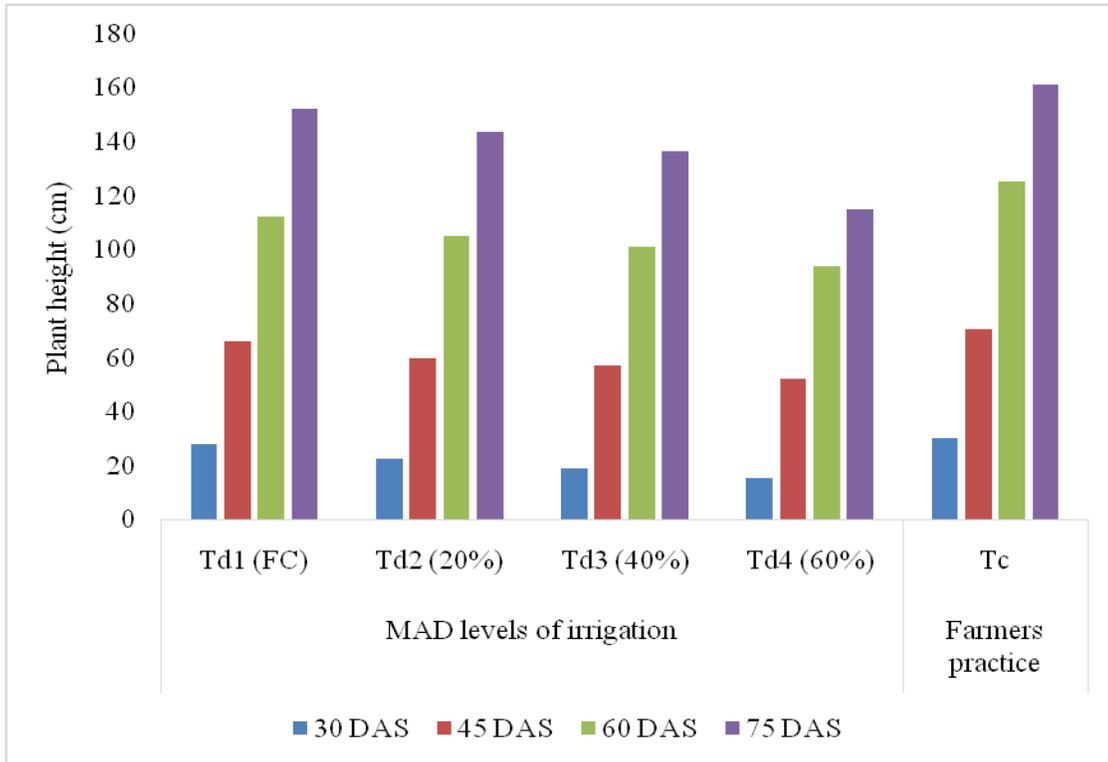


Fig.2 Sunflower leaf numbers under different treatments

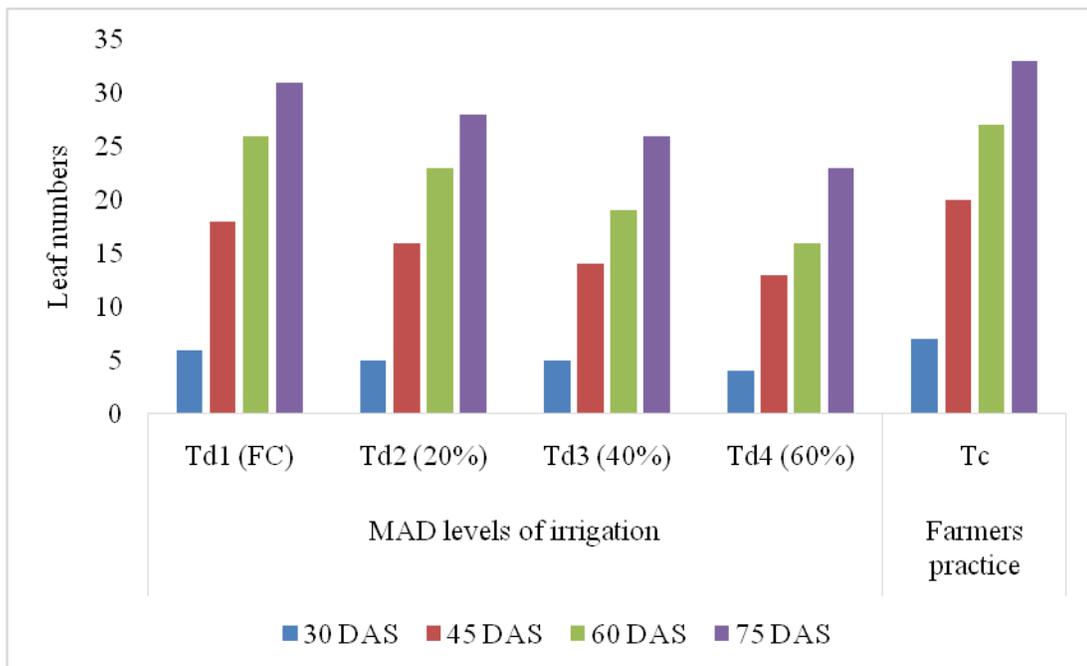


Fig.3 Plant girth of sunflower under different treatments

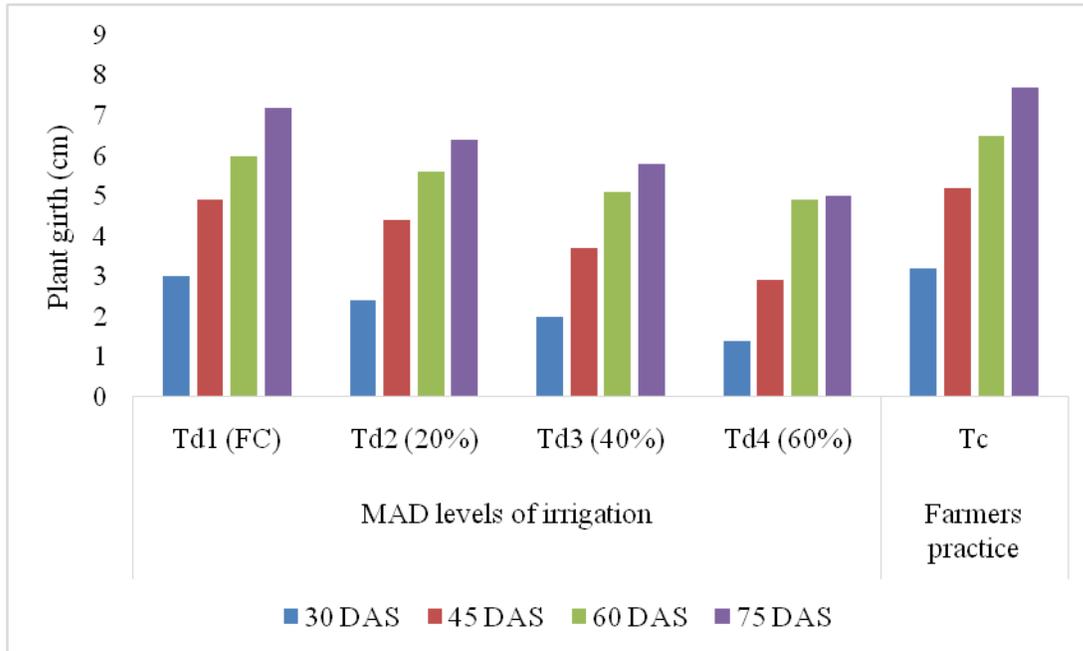


Fig.4 Yield of sunflower under different treatments of irrigation

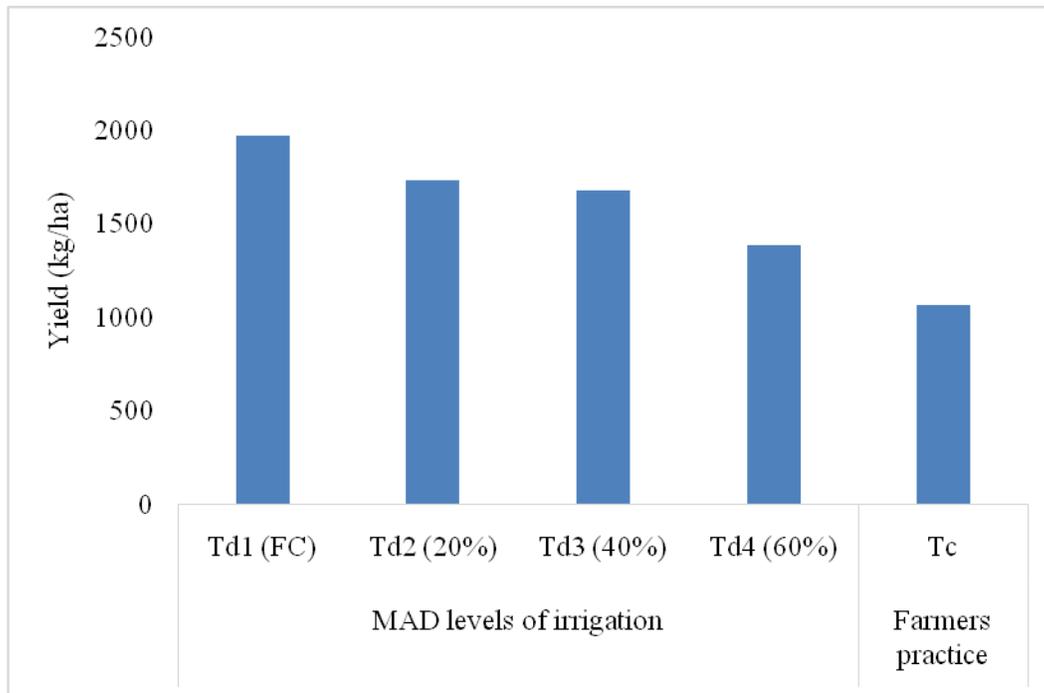
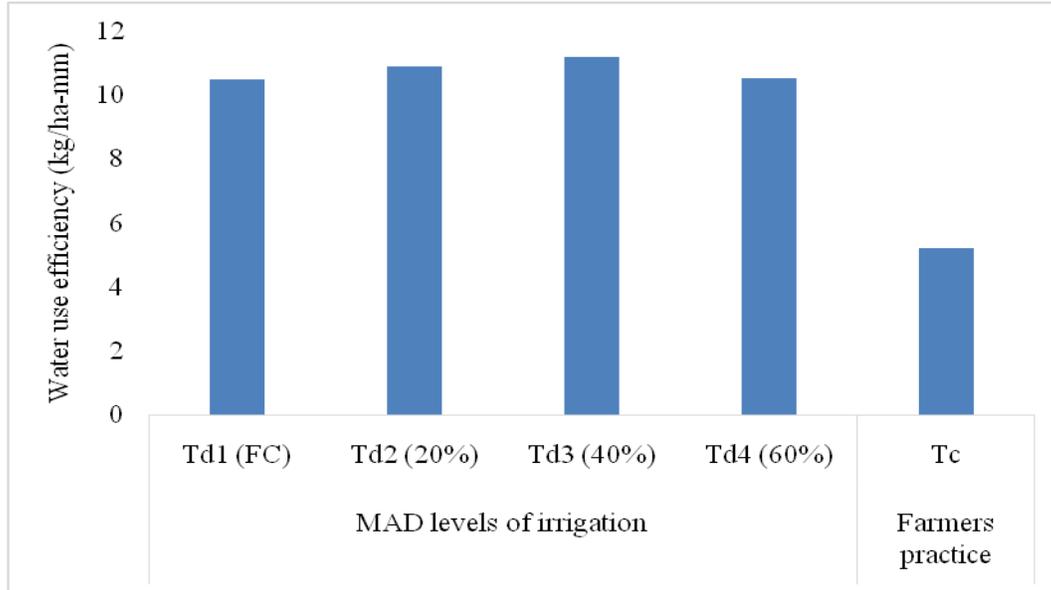


Fig.5 Water use efficiency of sunflower under different treatments of irrigation



In conclusion, the maximum sunflower seed yield of 1971.6 kg/ha was observed under drip irrigation practice maintained at field capacity. The maximum water use efficiency of 11.2 kg/ha-mm for sunflower was found in 40 per cent MAD level of drip irrigation. Although maximum plant height, girth and leaf numbers of sunflower was observed in farmers practice, but the yield and water use efficiency was lowest. Water use efficiency for sunflower under drip irrigation of all MAD levels was found to be almost twice as that of the of farmers practice. The drip system produced 57.88 per cent more sunflower yield with 26.83 per cent less water at 40 % MAD level of irrigation compared to farmers practice. Considering the maximum water use efficiency, sunflower crop may be irrigated at 40 per cent MAD level by drip irrigation method for increasing the water use efficiency in East and South-East Coastal Plain Agro-climatic Zone of Odisha.

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