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RESEARCH NOTE

Influence of irrigation levels and water soluble fertilizers on growth and yield of sunflower (*Helianthus annuus* L.)

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A field experiment was conducted to study the influence of irrigation levels and water soluble fertilizers on growth and yield of sunflower (*Helianthus annuus* L.) at the Main Agricultural Research Station, Dharwad, Karnataka during summer 2016. The experiment was laid out in Split Plot Design with twelve treatments along with one control. Irrigation scheduled at moisture depletion levels recorded significantly higher plant height (193.3 cm), leaf area (2,625 cm^2 $plant^{-1}$) and total dry matter production (85.1 g $plant^{-1}$) at 90 DAS as compared to other levels of irrigation. The growth parameters were influenced significantly on sunflower grain yield (2,067 kg ha^{-1}) and 100 seed weight (4.33 g) which were higher with irrigation scheduled at moisture depletion levels. Similarly, plant height (196.2 cm), leaf area (2,624 cm^2 $plant^{-1}$) and total dry matter production (84.2 g $plant^{-1}$) at 90 DAS and grain yield (2,166 kg ha^{-1}) and 100 seed weight (4.35g) were higher at foliar spray of 2.0 per cent (19:19:19) water soluble fertilizers (WSF) with RDF (90:90:60 kg N: P_2O_5: K_2O ha^{-1} + 10 kg $ZnSO_4$ ha^{-1} + 100 kg Gypsum ha^{-1} + 0.5 per cent Borax at ray floret initiation stage) as compared to other concentration levels. Control plot receiving RDF with irrigation interval once in 15 days recorded lower grain yield (1,652 kg ha^{-1}) and other growth parameters. The crude protein content did not differ significantly. The interaction effect due to irrigation levels and WSF with RDF was non significant. It may be concluded that irrigation scheduled at moisture depletion levels with spraying of WSF at 2.0 per cent with RDF was found superior.

Key words: Irrigation level, Foliar spray, Grain yield, Sunflower

Sunflower (*Helianthus annuus* L.) is an important annual oilseed crop and is one of the major edible vegetable oils consumed in India. It is also used in the preparation of vanaspati, manufacture of soaps and cosmetics. It has wider adaptability to different soils, agro-climatic conditions and varied soil moisture levels. It is grown in all seasons. However, the reasons for low productivity of this crop in India are due to unavailability of adequate soil moisture especially during winter and summer and erratic rainfall, imbalanced fertilizer use and bud necrosis during rainy season. Further, sunflower is deep rooted and heavy feeder of nutrients. Under intensive cultivation, it is essential to replenish the soil with nutrients. In this situation, utilization of soil nutrients may be slow and deficiency symptoms cannot be corrected if applied through soil alone. However, foliar application is the best option for quick correction of the deficiencies and to increase nutrient use efficiency for sustainable production.

The research work conducted by Das and Jana (2015) indicated significantly higher seed yield of pulses at three per cent foliar application of 19:19:19 without basal doses of fertilizer application. However, under basal doses of fertilizer application, the results showed a gradual increase in yield with increase in concentration of 19:19:19 fertilizer spray up to two per cent. Thus standardization of irrigation levels and foliar spray of WSF are required. Keeping this in view, the present study was conducted to assess the influence of irrigation levels and water soluble fertilizers on growth and yield of sunflower.

A field experiment was conducted at the Main Agricultural Research Station, Dharwad, Karnataka during summer 2016. The soil of the experimental site was black clayey with pH of 7.78, EC of 0.36 dS m^{-1}, 0.57 per cent organic carbon, and available N, P_2O_5 and K_2O were 261.40, 32.60 and 325.80 kg ha^{-1} respectively and available zinc was 0.61 ppm. The experiment was laid out in split plot design with three replications. The experiment consisted of three irrigation levels as main plot (I_1: Irrigation based on moisture depletion levels, I_2: Irrigation based on critical stages and I_3: Farmers practice of irrigation-once in 10 days interval) and four foliar nutrition levels as subplot i.e. F_1: 1.5 % 19:19:19 + RDF (90:90:60 kg N: P_2O_5: K_2O ha^{-1} + 10 kg $ZnSO_4$ ha^{-1} + 100 kg Gypsum ha^{-1} + 0.5 per cent Borax at ray floret initiation stage), F_2: 2.0 % 19:19:19 + RDF, F_3: 2.5 % 19:19:19 + RDF and F_4: 3.0 % 19:19:19 + RDF with one control (irrigation once in 15 days with RDF). Sowing of the potential hybrid KBSH-53 at a spacing of 60 cm × 30 cm. Water soluble fertilizer (19:19:19) was sprayed at one week before and one week after flowering at a concentration of 1.5, 2, 2.5 and 3 per cent as per the treatment. The irrigation was scheduled with sprinkler system immediately after sowing and continued up to crop establishment uniformly for all the treatments. However, subsequent irrigations were scheduled based on depletion of soil moisture, critical stages of crop and farmers practice (8 to 10 days interval).

The plant height, leaf area $plant^{-1}$ and total dry matter production at 90 DAS of sunflower as influenced by irrigation levels and water soluble fertilizers is presented in Table 1. At 90 DAS (days after sowing), irrigation scheduled at moisture depletion levels recorded significantly higher plant height of 193.3 cm leaf area of 2,625 cm^2 $plant^{-1}$ and total dry matter production of 85.1 g $plant^{-1}$ over farmers practice of irrigation (plant height 190.3 cm, leaf area 2,587 cm^2 $plant^{-1}$ and total dry matter production 81.2 g $plant^{-1}$) and irrigation at critical stages (plant height 185.7 cm, leaf area 2,553 cm^2 $plant^{-1}$ and total dry matter production 75.5 g $plant^{-1}$). The increment in plant height was due to higher availability of nutrients which accelerated the cell division and elongation. Hence its subsequent accumulation was noticed in sink. These results are in conformity with the findings of Yadav *et al.* (2009).

Similarly, foliar application of water soluble fertilizers (WSF) also had significant effect on plant height, leaf area $plant^{-1}$ and total dry matter production at 90 DAS of sunflower. At 90 DAS, spraying of water soluble fertilizers at 2.0 per cent with RDF recorded significantly higher plant height (196.2 cm), leaf area (2,624 cm^2 $plant^{-1}$) and total dry matter production

Table 1. Growth parameters of sunflower as influenced by irrigation levels and foliar spray of water soluble fertilizers at 90DAS

Treatment	Plant height (cm)				Leaf area plant^{-1} (cm^2)				Total dry matter production (g plant^{-1})			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
F_1	197.3	188.7	191.0	192.3	2,647	2,560	2,600	2,602	86.6	76.3	81.5	81.5
F_2	201.3	191.7	195.7	196.2	2,667	2,587	2,620	2,624	89.7	78.3	84.6	84.2
F_3	188.7	183.7	188.7	187.0	2,607	2,547	2,587	2,580	85.0	74.8	80.5	80.1
F_4	185.7	178.7	186.0	183.4	2,580	2,520	2,540	2,547	79.2	72.5	78.4	76.7
Mean	193.3	185.7	190.3		2,625	2,553	2,587		85.1	75.5	81.2	
Control	178.0				2,513				74.3			
SV	S. Em. ±		C. D. at 5 %		S. Em. ±		C. D. at 5 %		S. Em. ±		C. D. at 5 %	
Main	1.27		3.97		17		52		0.55		1.73	
Sub	0.75		2.21		10		28		1.16		3.45	
I x F	1.29		NS		16		NS		2.01		NS	
Control	1.71		4.99		19		56		1.78		5.20	

Main plot: Irrigation level (I)

I_1: Irrigation based on depletion (initial three weeks 40 %, 4 to 9 weeks 50 % and 10th \week onwards 60 %)

I_2: Irrigation based on critical stages (1. Establishment 2. Early vegetative 3. Vegetative 4. Button 5. Flowering and 6. Grain filling).

I_3: Farmers practice (irrigation once in 10 days)

Control: Irrigation once in 15 days (as per canal release of water) with RDF

RDF (90:90:60 kg N: P_2O_5: K_2O ha^{-1} + 10 kg $ZnSO_4$ ha^{-1} + 100 kg Gypsum ha^{-1} + 0.5 % Borax)

SV: Sources of variation

Sub Plot: Foliar spray with RDF (F)

F_1: 1.5 % 19:19:19 + RDF

F_2: 2.0 % 19:19:19 + RDF

F_3: 2.5 % 19:19:19 + RDF

F_4: 3.0 % 19:19:19 + RDF

Table 2. Yield and yield parameters crude protein content of sunflower as influenced by irrigation levels and foliar spray of water soluble fertilizers

Treatment	100 seed weight (g)				Grain yield (kg ha^{-1})				Crude protein (%)			
I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	
F_1	4.42	3.74	3.98	4.05	2,173	1,960	2,045	2,059	19.5	19.4	19.1	19.3
F_2	4.70	3.99	4.35	4.35	2,322	1,977	2,198	2,166	19.3	19.6	19.4	19.4
F_3	4.18	3.40	3.83	3.81	1,983	1,771	1,905	1,886	19.0	19.3	19.0	19.1
F_4	4.00	3.08	3.49	3.52	1,792	1,655	1,747	1,731	19.1	18.9	19.2	19.1
Mean	4.33	3.55	3.91		2,067	1,841	1,974		19.2	19.3	19.2	
Control	3.60	1,652	18.8									
SV	S. Em. ±		C. D. at 5 %		S. Em. ±		C. D. at 5 %		S. Em. ±		C. D. at 5 %	
Main		0.07		0.23		46		156		0.06		NS
Sub	0.05		0.15		17		50		0.10		NS	
I x F		0.09		NS		29		NS		0.17		NS
Control		0.09		0.26		48		141		0.19		NS

Main plot: Irrigation level (I)

I_1: Irrigation based on depletion (initial three weeks 40 %, 4 to 9 weeks 50 % and 10th week onwards 60 %)

I_2: Irrigation based on critical stages (1. Establishment 2. Early vegetative 3. Vegetative 4. Button 5. Flowering and 6. Grain filling).

I_3: Farmers practice (irrigation once in 10 days)

Control: Irrigation once in 15 days (as per canal release of water) with RDF

RDF (90:90:60 kg N: P_2O_5: K_2O ha^{-1} + 10 kg $ZnSO_4$ ha^{-1} + 100 kg Gypsum ha^{-1} + 0.5 % Borax)SV: Sources of variation

Sub Plot: Foliar spray with RDF (F)

F_1: 1.5 % 19:19:19 + RDF

F_2: 2.0 % 19:19:19 + RDF

F_3: 2.5 % 19:19:19 + RDF

F_4: 3.0 % 19:19:19 + RDF

(84.2 g plant^{-1}) over spraying of WSF at the rest of doses. The increase in plant height was significantly higher due to the foliar application of nutrients, which led to stimulatory effect on cell division and enlargement. Thus the crop responded to the applied nutrients throughout the growth stages. Increased total dry matter production were mainly due to additional foliar application of water soluble fertilizer which led to increased uptake of nutrients and in turn helped in increased plant height, number of branches, leaf area and LAI. Thus contributed for better plant growth and ultimately increased the dry matter production. These results are in conformation with the findings of Kumar *et al.* (2003).

Control plot receiving recommended doses of fertilizer (RDF) with irrigation interval once in 15 days recorded lower growth parameters. Yadav *et al.* (2009) confirmed that significantly lower growth and yield attributes were recorded in sunflower when irrigation was given at 16 days interval.

Significantly higher sunflower grain yield (2,067 kg ha^{-1}), and 100 seed weight (4.33 g) were recorded (Table 2) with irrigation scheduled at moisture depletion levels. The increased yield might be due to irrigation scheduled according to depletion levels (i.e. initial three weeks 40 %, 4 to 9 weeks 50 % and 10^{th} week onwards 60 % depletion). In turn it helped in maintaining adequate available soil moisture in the root zone. Besides, better uptake of nutrients resulted in beneficial effect on growth and yield contributing factors. Optimum soil moisture might have promoted the growth of beneficial micro organisms and thereby induced rapid mineralization of nutrients through higher enzymatic activity in rhizosphere, which resulted in higher nutrient uptake. Hence, there was higher translocation of assimilates from source to sink during seed formation and seed ripening stages.

In the present investigation, significantly higher sunflower grain yield (2166 kg ha^{-1}), and 100 seed weight (4.35 g) were recorded with spraying of water soluble fertilizers at 2.0 per cent with RDF at pre and post flowering stage. These results are in conformity with the findings of Vijay Kumar (2004) in sunflower.

The crude protein content of sunflower seed did not differ significantly with irrigation and foliar application of WSF. However, it ranged from 18.9 to 19.6 per cent. The significant role played by primary nutrients might have accounted for higher grain yield and protein content in sunflower. Similar kind of results was reported by Chandrasekaran (2004) in groundnut. The water productivity of sunflower ranged from 0.42 to 0.61kg m^{-3} with water use of 372 to 432 ha-mm. The interaction effect due to irrigation levels and foliar application of water soluble fertilizers did not differ significantly among various treatment combinations.

The present study revealed that irrigation scheduled at moisture depletion levels with spraying of WSF (19:19:19) at 2.0 per cent with RDF (90:90:60 kg N: P_2O_5: K_2O ha^{-1} + 10 kg $ZnSO_4$ ha^{-1} + 100 kg Gypsum ha^{-1} + 0.5 per cent Borax at ray floret initiation stage) recorded significantly higher growth, yield and water productivity.

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