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Response of Summer Sesamum to Irrigation Scheduling and Nitrogen Levels under Drip Irrigation

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ABSTRACT

A field experiment was conducted during summer season 2007 and 2008 on clay soil under drip irrigation at Regional Agricultural Research Station, Warangal to know the effect of irrigation scheduling and nitrogen levels on growth and yield of summer sesamum. The results of the study revealed that significantly higher yield attributes and yield of sesamum are obtained when the crop is irrigated at 75% PE during summer season under drip irrigation and optimum response was observed with 60 kg N ha^{-1} through fertigation.

Key words : Consumptive Use,Crop Coefficient, Drip Irrigation, Fertigation,IW/CPE Ratio, Nitrogen, Potential Evaporation, Sesamum

Many farmers established drip irrigation system for cotton in A.P. After removal of cotton during December, another short duration crop can be taken up with same system under wells and bore wells with limited supply of water, where sesamum crop emerged as a best option. Among various agronomic inputs, irrigation is the most important for boosting the yield of summer sesame (Kundu and Singh, 2006). Considering the limited availability of irrigation water, application of water at proper time and in required quantity through drip along with suitable dose of nitrogen (fertigation) is essential to realize optimum yields with increased water use efficiency (Shelke and Lomte , 2004). Information on fertigation studies in summer sesamum are meager . Therefore, a field study was taken up to find out the suitable irrigation schedule and nitrogen dose under drip irrigation in sesamum during summer.

MATERIAL AND METHODS

Field experiment was conducted during summer 2007 and 2008 to study the performance of summer sesamum at different irrigation schedules and nitrogen levels under drip irrigation. The soil type is clay, consisting of 0.3% of organic carbon, 253 kg ha^{-1} of available N, 28 kg ha^{-1} of available P_2O_5, 392 kg ha^{-1} of available K_2O with P^H 8.2 and EC 0.12 d Sm^{-1}. The values of field capacity, permanent wilting point and bulk density were 35 %, 16 % and 1.43 kg/cm^3, respectively over a soil depth of 60 cm. The trial was laid out in split plot design with three irrigation schedules (I_1:75% PE; I_2:50% PE and I_3:0.8 IW/CPE ratio) as main plots and three nitrogen levels (N_1:30, N_2:60 and N_3:90 kg ha^{-1}) as subplots and replicated thrice. The crop period (February to May) was characterized by 28.7 to 38.7°C of mean monthly maximum temperature and 20.0 to 28.4°C of mean monthly minimum temperature over both the years of study. A total rainfall of 15.8 mm (3 rainy days) and 150.5 mm (8 rainy days) was received during 2007 and 2008, respectively. "Swetha " was used as a test variety and sown at inter- and intra-row spacing of 30 x 10 cm with a seed rate of 5 kg ha^{-1} . The crop was sown on 02-02-2007 and 04-02-2008 and harvested on 04-05-2007 and 09-05-2008 during the study period. The total pan evaporation (mm) during the crop growth was 488.3 and 374.4, respectively. The drip system was established keeping 120 cm between two lateral lines to accommodate cotton crop. The same system was utilized by keeping two lateral lines at spacing of 60 cm for summer sesamum. The distance between two lateral inline pipes was adjusted according to row width of crop to meet the crop water requirements. Distance between two drippers was 50 cm. Dripper discharge was 4 Lph. Diameter of lateral in line was 16 mm. The system was operated under a pressure of 1.2-1.5 kg/cm^2. Consumptive use of the crop was calculated as 341.8 and 262 mm, respectively during 2007 and 2008 by multiplying PE with Pan factor (0.7). Two common irrigations of 50 mm each were given, one at post sowing for emergence and second at 8th day after sowing for crop establishment. Thinning and gap filling were done at 15 days after sowing. The irrigation treatments were imposed based on the

Application rate of drip system (mm/hr.) = Lph (Liters per hour) / Distance between laterals x Distance between drippers
= 4 Lph / 0.5 m x 0.6 m = 13.33 mm/hr.

Table 1. Monthwise PE and ETc during study period

Month	Summer 2007		Summer 2008	
	PE (mm)	ETc(mm)	PE(mm)	ETc(mm)
February	138.8	94.4	83.9	57.0
March	156.1	171.4	101.5	111.7
April	152.0	152.0	128.5	128.5
May	41.4	10.4	60.5	15.1
Total	**488.3**	**428.2**	**374.4**	**312.3**

ETc= PE x Crop coefficient (Kc) ETc=Crop evapotranspiration

Table 2. Sesamum crop coefficient values (Kc)

Kc values	Crop stages (DAS)				
	I(0-20)	II(20-40)	III(40-60)	IV(60-80)	V(80-95)
	0.35	1.0	1.1	1.0	0.25

pan evaporation and rainfall received during the crop growth period taking into account of potential evaporation (mm) , crop evapotranspiration (mm) mentioned in Table 1 and crop coefficients mentioned in Table 2. Drip system was operated on every alternate day. The source of irrigation water is open well fitted with 3 H.P. electrical motor. Quantity of water applied was measured treatment-wise with water meter fixed to the system by taking into account of area of each treatment and depth of irrigation (IW) (50 mm).Scheduling of irrigation was started whenever the cumulative pan evaporation (CPE) reached the value of 62.5 mm in I_3 treatment. A common dose of 40 kg P_2O_5 and 60 kg K_2O ha^{-1} was applied basally.. Nitrogen was applied through drip as per the treatments in five equal splits at 20, 35, 50, 65 and 80 days after sowing with a ventury fixed to the system. In I_3 treatment, nitrogen was applied in three equal splits by placement method as basal, 20 and 40 days after sowing. The other recommended cultural and pest management practices were adopted.

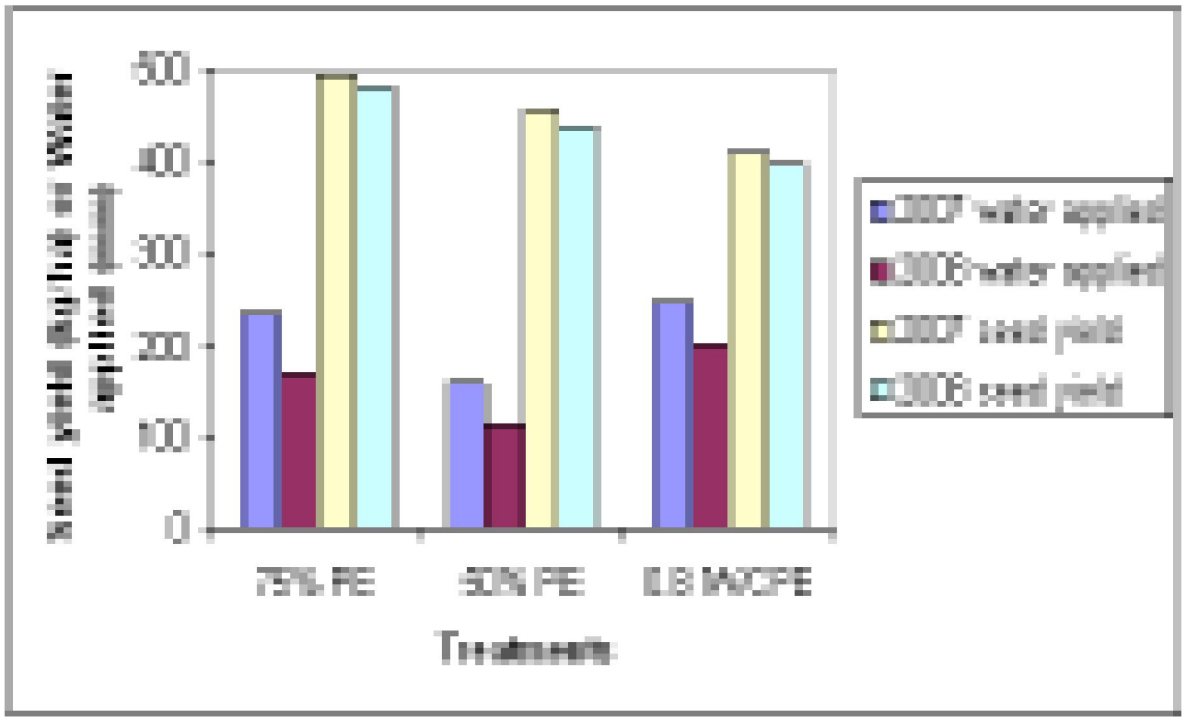
RESULTS AND DISCUSSION

Growth parameters

Irrigation schedules significantly influenced the plant height (cm) of sesamum under drip irrigation at harvest during both the years of study. Significantly taller plants were found when irrigations were scheduled at 75% pan evaporation (82 and 81 cm, respectively) or at 50% PE (81 and 80 cm, respectively), which were at par with each other (Table 3). The pooled data showed increased trend of plant height from irrigating sesamum at 0.8 IW/ CPE ratio to 75% PE. Similarly higher plant dry weight (g) per plant at 75 days after sowing was recorded with irrigation schedule of 75% PE during 2007 and 2008 (8.9 and 8.7 g, respectively) which was superior over the other two schedules *i.e,* 50% PE and 0.8 IW/CPE ratio, between which 50% PE (8.3 and 8.2 g, respectively) was superior to 0.8 IW/ CPE ratio (7.9 and 7.7 g, respectively). The pooled data of two years also showed similar trend (Table 3). Improvement in these growth parameters can be attributed to optimum soil moisture, available for crop growth throughout it's life cycle (Malliswari *et al*., 2008).

Among the nitrogen levels, sesamum responded significantly to 90 kg ha^{-1} of nitrogen in terms of plant height (cm) (83 and 82 cm, respectively) at harvest and plant dry weight (g) (9.1 and 8.9 g, respectively) at 75 days after sowing over

Figure 1. Response of sesamum to the amount of water applied during summer season under different irrigation schedules.



60 (80 and 80 cm; 8.4 and 8.2 g, respectively) and 30 kg N ha^{-1} (77 and 79 cm; 7.6 and 7.5 g, respectively), which again were statistically different with each other during the both the years of study. The pooled data also revealed the same (Table 3). The higher leaf area with greater photosynthetic activity together result in increased dry matter accumulation at higher level of nitrogen (Dhanjal *et al*., 2003). The interaction effect of irrigation schedules and nitrogen levels was non-significant.

Yield attributes

The number of capsules $plant^{-1}$ significantly increased when sesamum was irrigated at 75 % PE (28 and 27, respectively during 2007 and 2008) than 50% PE (25 and 24, respectively) and 0.8 IW/CPE ratio (22 and 20, respectively), while 50% PE was again superior to 0.8 IW/CPE ratio under drip irrigation, during both the years (Table 4). However, the irrigation schedules of 75% PE (38 and 36, respectively) and 50% PE (36 and 34, respectively) were at par with each other during 2007 and 2008 with respect to number of seeds $capsule^{-1}$ and both were superior to 0.8 IW/CPE ratio (33 and 31, respectively). The irrigation treatment differed statistically for 1000-seed weight (g) during 2007 only. Significantly more test weight was recorded in 75% PE (2.8 g) and 50% PE (2.8 g) schedules than 0.8 IW/CPE ratio (2.7 g), which were at par with each other. The pooled data of all the above yield attributes followed the similar trend (Table 4). These observations are in conformity with Kassab *et al*., (2005).

Graded levels of nitrogen application from 30 to 90 kg ha^{-1} significantly affected the number of capsules $plant^{-1}$ and number of seeds $capsule^{-1}$. A progressive increase of the above yield attributes was observed from 30 to 60 and 60 to 90 kg N ha^{-1} during 2007 and 2008 (Table 4). However, the test weight was not significantly influenced by the levels of nitrogen during both the years. Similar results were shown by the pooled data. These findings are in agreement with Hossain and Khan (2003). The positive response to N may be due to its role in pronounced vegetative growth which result in more branching, protein formation and photosynthetic activity (Saxena and Verma, 1995). This resulted in increased number of capsules $plant^{-1}$ and number of seeds $capsule^{-1}$.

Table 3. Effect of irrigation scheduling and nitrogen levels on growth parameters of summer sesamum under drip irrigation

Treatments	Plant height (cm) at harvest			Plant dry weight (g) at 75 DAS		
	2007	2008	Mean	2007	2008	Mean
Irrigation scheduling						
I1	82	81	82	8.9	8.7	8.8
I2	81	80	81	8.3	8.2	8.3
I3	78	77	78	7.9	7.7	7.8
SEm±	0.32	0.59		0.08	0.06	
CD (P=0.05)	1.3	2.3		0.31	0.25	
Nitrogen levels						
N1	77	79	78	7.6	7.5	7.6
N2	80	80	80	8.4	8.2	8.3
N3	83	82	83	9.1	8.9	9.0
SEm±	0.84	0.6		0.06	0.06	
CD (P=0.05)	2.60	1.8		0.17	0.18	
Interaction						
SEm±	1.45	1.73		0.09	0.10	
CD (P=0.05)	NS	NS		0.29	0.31	

Seed yield (kg ha^{-1})

The seed yield (kg ha^{-1}) of sesamum during summer season under drip irrigation was significantly affected by irrigation schedules and nitrogen levels during 2007 and 2008 (Table 4). Higher seed yield was obtained when the crop was irrigated at 75% PE (494 kg ha^{-1}) ,which was superior to 50% PE (455 kg ha^{-1}) and 0.8 IW/CPE ratio (411 kg ha^{-1}) during 2007. Even though, the same treatment produced higher yields (480 kg ha^{-1}) during 2008 over 0.8 IW/CPE (398 kg ha^{-1}), it was at par with 50% PE (438 kg ha^{-1}) ,which was in turn at par with 0.8 IW/CPE ratio . Amount of water applied in 75 % PE,50 % PE and 0.8 IW/CPE treatments during 2007 and 2008 was 235,157 and 250 mm (5 irrigations); 168, 112 and 200 mm (4 irrigations), respectively. The response of seed yield to the amount of water used in different treatments was shown in Figure 1.There is a positive response between seed yield and amount of water used. The pooled average data over two years revealed that 20 per cent higher yield of sesamum was obtained with the irrigation schedule at 75% PE over 0.8 IW/CPE ratio. Similarly, 10 percent increased yield was observed in 50% PE over 0.8 IW/CPE ratio. Availability of optimum soil moisture at all the stages of the crop growth in this treatment might have favoured the vegetative growth, branching, helped in maintaining the size, duration and photosynthetic activity of the green plant parts after flowering and also in translocation of the photosynthates to the sink (Wardlaw, 2002), besides improving the availability of the nutrients (Kundu and Singh, 2006).

Every incremental dose of N as 30, 60 and 90 kg ha^{-1}, improved the seed yields of sesamum under drip irrigation. However, the response was significant upto 60 kg ha^{-1} with respect to seed yield during 2007 and 2008, even though an increase of 4 per cent was recorded in 90 kg ha^{-1} over 60 kg N ha^{-1}. The increase of seed yield in 60 kg N ha^{-1} over 30 kg N ha^{-1} was 43 percent (Table 4), revealed by the pooled average data for two years. Enhanced nitrogen assimilation due to adequacy of instant nitrogen ions, might have led to increased dry matter production and better partitioning to yield (Sumathi *et al.,* 2007).The interaction effect between the irrigation schedules and nitrogen levels was not significant during two years.

In conclusion, the investigation revealed that scheduling irrigation at 75 % pan evaporation (PE) and application of 60 kg Nitrogen ha^{-1} to summer sesamum under drip irrigation (fertigation) in clay soil was found to improve the seed yield.

Table 4. Effect of irrigation scheduling and nitrogen levels on yield attributes and yield of summer sesamum under drip irrigation

Treatments	Capsules plant^{-1}			Seeds capsule^{-1}			1000-seed weight (g)			Seed yield (kg ha^{-1})		
	2007	2008	Mean	2007	2008	Mean	2007	2008	Mean	2007	2008	Mean
Irrigation scheduling												
I_1	28	27	28	38	36	37	2.8	2.7	2.8	494	480	487
I_2	25	24	25	36	34	35	2.8	2.8	2.8	455	438	447
I_3	22	20	21	33	31	32	2.7	2.7	2.7	411	398	405
SEm±	0.73	0.49		0.36	0.56		0.06	0.08		3.9	15.6	
CD (P=0.05)	2.86	1.93		2.49	2.18		0.25	NS		15.3	61.3	
Nitrogen levels												
N_1	20	18	19	28	26	27	2.6	2.6	2.6	357	347	352
N_2	26	24	25	38	36	37	2.8	2.7	2.8	492	475	484
N_3	30	29	30	41	40	41	3.0	2.9	3.0	512	494	503
SEm±	0.68	0.67		0.86	0.92		0.07	0.08		9.6	13.2	
CD (P=0.05)	3.03	2.07		2.65	2.84		NS	NS		29.6	40.8	
Interaction												
SEm±	1.71	1.16		1.49	1.59		0.11	0.13		16.7	22.9	
CD (P=0.05)	NS	NS		NS	NS		NS	NS		NS	NS	

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