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Physiology of Summer Sesame (Sesamum indicum L.) as Influenced by Irrigation and Nitrogen Levels

KEYWORDS: AGR, Irrigation, IW/CPE, NAR, RGR, Sesame.

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ABSTRACT *Sesame is one of the oldest and most important oilcrops as main crop and second crop agriculture. This study was carried out to determine the effects of irrigation and nitrogen levels on physiology of summer sesame; var. AKT 101 was conducted at Agronomy Department Farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during summer season of 2012. Experimental results revealed that some growth parameters like AGR (Absolute growth rate for height and dry matter) was significantly higher with irrigation scheduling at1.0 IW/CPE (Irrigation water amount/Cumulative pan evaporation) at 45 to 60 DAS, NAR (Net assimilation rate) was highest with treatment 0.8 IW/CPE ratio (Irrigation water amount/Cumulative pan evaporation) at 60 to 75DAS and RGR (Relative growth rate for dry matter (g g-1 day-1)) was highest with treatment 0.4 IW/CPE ratio at 30 to 45 DAS. And all this growth parameters using for growth analysis found significantly higher with nitrogen application at 90 kg N ha-1. Over rest of the combinations except in RGR it was found significantly higher with treatment 30 kg N ha-1 at 30 to 45DAS.*

INTRODUCTION

Sesame (*Sesamumindicum*L.) is a member of the family Pedaliaceae which composed of 16 genera and some 60 species Sesame (*Sesamumindicum* L.) is an ancient oilseed crop, first recorded as a crop in Babylon and Assyria over 4,000 years ago. It is called as "Queen" of oilseeds because of its quality. The biggest area of production is currently believed to be India, but the crop is also grown in China, Korea, Russia, Turkey, Mexico, South America and several countries in U.S. and Africa. India ranks first in its area and production in world. In India sesame is cultivated on 1.86 million ha area with annual production of 0.81 million ton. Its average productivity (437 kg ha^{-1}) is below than that of the world (489 kg ha^{-1}) (FAO 2010). During the year 2010, Maharashtra produced 0.775 metric tons sesame from an area of 3.79 thousand hectare with the average productivity of 205 kg ha^{-1} (Anon., 2010). In Maharashtra, sesame is grown as semi-*rabi* crop in Gadchiroli, Chandrapur, Nagpur, Wardha, and Nanded districts. Vidarbha region comprising Nagpur and Amaravati revenue divisions are the most important sesame growing area.

Sesame is probably the second most important oilseed crop next to groundnut. Sesame seeds are rich source of food nutrition, edible oil (48-52%), protein (18-20%). Among agronomic inputs, irrigation and nitrogen are the most important input for boosting the yield and quality of summer sesame. Irrigation scheduling plays an important role in the higher production of summer sesame. Nitrogen is a structural constituent of plant cell and constitutes amino acids, proteins, nucleic acids, etc. It plays important role in plant metabolism and judicious use of limited water for economical crop production with the objective of effective wetting of root zone. (Wu *et al.*2009). Keeping in view the above facts a study was undertaken to find out the effect of Irrigation and Nitrogen Levels on Growth Parameters which are used in growth analysis of Summer Sesame.

MATERIALS AND METHODS

A field experiment was conducted on variety AKT 101 of sesame at University Department of Agronomy Farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during summer season of 2012. Experimental soil was clay lome in texture and slightly alkaline in reaction (pH 7.96), however, good for EC (0.37). It was analyzed low in available nitrogen (221.47 kg ha^{-1}), medium in organic carbon (0.43 %), medium in available phosphorus (16.86 kg ha^{-1}) and high in available potassium (387.25kgha^{-1}).

The experiment was laid out in split plot design with three replications. Treatments consisted of four levels of irrigation (Irrigation at 0.4 (I_1), 0.6 (I_2), 0.8 (I_3), and 1.0 (I_4) IW/CPE ratios(Irrigation water amount/Cumulative pan evaporation)) were taken as main plot treatment while three levels of nitrogen (30 kg (N_1), 60 kg (N_2) and 90 kg (N_3) N ha^{-1}) were taken as sub plot treatments. The crop was subjected to recommended package of agronomic practices to obtain a healthy crop. The net plot is converted in to quintal per hectare by using hectare factor.The growth analyses like AGR, RGR and NAR were carried out by following formulas

Absolute growth rate (AGR)

The rate of increase in the growth variable at time't' is called as absolute growth rate. It was measured by differential coefficient of 'w' with respect of time't'. Absolute growth rate was calculated for two growth variables by using following formula,expressed in cm per day.

AGR for height

$$AGR = \frac{H_2 - H_1}{t_2 - t_1} \text{ cm day}^{-1}$$

AGR for dry matter

$$AGR = \frac{W_2 - W_1}{t_2 - t_1} \text{ g day}^{-1}$$

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Where, H_1, H_2 and W_1, W_2 refer to the plant height (cm) and dry matter weight (g) at time t_1 and t_2, respectively.

Relative growth rate is an important parameter which indicates rate of growth per unit dry matter. It is similar to compound interest wherein the increment in any interval adds to the capital for subsequent growth. This rate of increment is known as relative growth rate. Relative growth rate at various stages was calculated as suggested by Radford [20]: expressed in g per g dry weight per day.

$$RGR = \frac{Log_e W_2 - Log_e W_1}{t_2 - t_1} \quad g\,g^{-1}\,day^{-1}$$

Where,

W_1 = Weight of dry matter (g) at time t_1
W_2 = Weight of dry matter (g) at time t_2

$t_2 - t_1$= Time interval in days
Log_e = Natural logarithms
(Logarithms to the base of 2.3026)

Net assimilation rate (NAR) was worked out by adopting the formula of Radford (1967) and expressed as g m^{-2} day^{-1}.Net assimilation rate is also known as the of photosynthetic activity of plant. It is expressed as g of dry matter produced per dm^2 of leaf area in day. For calculating NAR, leaf area of individual plants has to be used. It was expressed as g $g^{-1}dm^2$ day^{-1}.

$$NAR = \frac{W_2 - W_1}{t_2 - t_1} \cdot \frac{(Log_e L_2 - Log_e L_1)}{(L_2 - L_1)} \quad g\,g^{-1}dm^2\,day^{-1}$$

Where,

L_1 and W_1 = Leaf area and dry weight of plant at time t_1
L_2 and W_2 = Leaf area and dry weight of plant at time t_2
Log_e = Natural logarithms
(Logarithms to the base of 2.3026)
$W_1$and W_2 = Weight of total dry matter at t_2 and t_1 time, respectively,

RESULTS AND DISCUSSION

Absolute growth rate

The absolute growth rate (AGR) derived from vegetative stage (30 DAS) to physiological maturity (75 DAS) and the results have been presented in Table 1. Results showed that AGR in all irrigation levels differed significantly at all growth stages. Result revealed that Absolute growth rate (AGR) for height was highest with treatment 1.0 IW/CPE at 45 to 60 DAS and AGR for dry matter recorded highest with irrigation at 1.0 IW/CPE at 60 to 75 DAS. AGR for height and dry matter recorded lowest with irrigation at 0.4 IW/CPEratios at 30-45 DAS. Among the nitrogen treatment the absolute growth rate for height was found highest with treatment 90 kg N ha^{-1} at 45 to 60DAS while treatment 60 kg N ha^{-1} was found lowest AGR for height at 30 to 45DAS. AGR for dry matter recorded significantly higher with 90 kg N ha^{-1} at 60 to 75DAS. The lowest AGR for dry matter was recorded with 30 kg N ha^{-1} at 30 to 45DAS.

Relative growth rate

Relative growth rate (RGR) is the increase of plant dry matter per unit time per unit materials and it represents the efficiency of a plant as producer of new materials. The variation in RGR assessed from 30 DAS until 90 DAS and the results are plotted in Table 02.In the current study (RGR) was found higher with irrigation at 0.4 IW/CPE ratio at 30 to 45 DAS and lowest RGR recorded with 1.0 IW/CPE ratio at 60 to 75 DAS. RGR for dry matter recorded higher with 30 kg N ha^{-1}at 30 to 45DAS and lowest RGR for dry matter was recorded with treatment 90 kg N ha^{-1} at 60 to 75DAS.

Net assimilation rate (NAR)

Net assimilation rate (NAR) means net amount of produced matters per unit leaf surface area per time unit. Its value is obtained by dividing crop growth rate (CGR) to leaf area index (LAI). In this study it is observed that NAR is higher with treatment 0.8 IW/CPE ratio at 30 to 45DAS and treatment of irrigation at 0.4 IW/CPE recorded the lowest RGR at 60 to 75DAS. Among the nitrogen treatments, maximum net assimilation rate was found in treatment 90 kg N ha^{-1} at 30 to 45DAS. The lowest NAR was recorded with treatment 90 kg N ha^{-1} at 60 to 75DAS

Table 1. Mean Absolute growth rate for height (cm day^{-1}) and Absolute growth rate for dry matter (g plant day^{-1}) as influenced by various treatments

Treatments	AGR For Height			AGR For Dry matter		
	Days after sowing			Days after sowing		
	30-45	45-60	60-75	30-45	45-60	60-75
Main Plot						
A. Irrigation levels						
I_1- 0.4 IW/CPE	0.527	2.528	1.452	0.266	0.28	0.303
I_2- 0.6 IW/CPE	0.677	3.081	1.137	0.358	0.299	0.434
I_3- 0.8 IW/CPE	0.788	3.299	0.957	0.424	0.371	0.513
I_4- 1.0 IW/CPE	0.862	3.471	1.07	0.489	0.487	0.518
Sub Plot						
A. Nitrogen levels						
N_1- 30Kg Nha^{-1}	0.773	2.853	1.293	0.343	0.318	0.422
N_2- 60Kg Nha^{-1}	0.668	3.181	1.148	0.385	0.342	0.488
N_3- 90Kg Nha^{-1}	0.7	3.251	1.021	0.424	0.418	0.417
General mean	0.714	3.095	1.154	0.384	0.359	0.442

Table 2. Relative growth rate for dry matter (g g^{-1} day^{-1}) and Net assimilation ratio as influenced by different irrigation nitrogen levels.

Treatments	RGR			NAR		
	Days after sowing			Days after sowing		
	30-45	45-60	60-75	30-45	45-60	60-75
Main Plot						
A. Irrigation levels						
I_1- 0.4 IW/CPE	0.141	0.054	0.032	0.269	0.09	0.069
I_2- 0.6 IW/CPE	0.12	0.04	0.039	0.321	0.088	0.087
I_3- 0.8 IW/CPE	0.126	0.044	0.037	0.336	0.096	0.092

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I_4- 1.0 IW/CPE	0.136	0.044	0.031	0.316	0.102	0.088
Sub Plot						
A. Nitrogen levels						
N_1- 30Kg Nha^{-1}	0.14	0.048	0.037	0.292	0.092	0.085
N_2- 60Kg Nha^{-1}	0.125	0.044	0.037	0.314	0.091	0.093
N_3- 90Kg Nha^{-1}	0.127	0.045	0.031	0.325	0.099	0.074
General mean	0.13	0.046	0.035	0.31	0.094	0.084

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