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Response of irrigation levels on productivity and moisture extraction pattern of late sown rapeseed (*Brassica campestris* var. toria) varieties under Assam condition

Joyjit Das[1,2*]. Abhijit Sarma[1]. Anup Das[2]

[1]Assam Agricultural University, Jorhat-785013, Assam

[2]ICAR Research Complex for NEH Region, Tripura Centre, Lembucherra, Agartala, Tripura

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ABSTRACT

Field experiment was conducted during the rabi season of 2013-14 at Instructional Cum Research farm of Assam Agricultural University, Jorhat, Assam, India to study the response of rapeseed (Brassica campestrisvar.toria) varieties to varying levels of irrigation under late sown conditions. Results revealed that production of seed, stover and oil yield increased up to the three irrigations at 20 days after sowing (DAS), flowering and siliqua formation stages, which were significantly higher than those with one irrigation at flowering and rainfed crop. However, crop performance with three irrigations and that of two irrigations (at flowering and siliqua formation) recorded similar yield performance of Rapeseed. Whereas, the maximum water use efficiency was observed under one irrigation at flowering. Considering varieties, the variety TS 67 being at par with TS 38 recorded significantly higher seed and stover yields than those of M 27 and TS 46.

1. Introduction

The significant transformation of Indian oilseed scenario from an importer status to the self-sufficiency during the eighties and an exporter in nineties is particularly known as “yellow revolution”. Rapeseed (Brassica campestris var. toria) is the second most important oilseed crop in India ranking next to groundnut. The oil content of rapeseed varies from 35% to 46% and young leaves are also used as vegetables. Oil is mainly used for culinary purpose. To sustain the late sown rapeseed production after sali rice, there is need to develop appropriate agronomic measures to obtain the higher crop yield. In late sown condition water management and quality seeds are the keyfactors that determines the crop yield. Rapeseed is usually sown from mid-October to mid-November in Assam. But for adoption of multiple cropping systems, particularly after transplanted winter rice, it has become essential to extend its sowing time beyond mid-November. But delay in sowing would adversely influence the crop performance, mainly due to depletion of soil moisture. Late sown crop cultivars causes substantial reductions in crop productivity. Water is very precious and scarce input during winter and its efficient utilization is quite necessary for plant physio-metabolic process such as photosynthesis, transpiration, stomatal conductance as well as nutrientuptake. Din *et al*. (2011) reported reduced yield in Brassica in response to water stress. It is found that the relative decreases in maximum potential yield of crop associated with abiotic stress vary between 54-82 per cent (Bray *et al.,* 2000). Therefore, irrigation levels and quality crop varieties are the major factors for increasing the productivity of late sown rapeseed. Hence, the present study was carried out to study the response of irrigation levels on production potential and moisture extraction pattern of late sown rapeseed varieties under Assam condition.

*Corresponding author: joyjit517275@gmail.com

2. Materials and Methods

A field experiment was conducted at Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during 2013-14. The experimental site is located at 26o44' N latitude, 94o10' E longitude and at an altitude of 91.0 meter above the mean sea level. The surface soil (0-15 cm) of the experimental field was sandy loam in texture (sand, silt and clay content of 65, 22 and 13%, respectively), moderately acidic in reaction (pH 5.2), medium in available nitrogen (298.3 kg/ha) and available phosphorus (30.9 kg/ha) and low in available potassium (91.5 kg/ha) with the soil field capacity, permanent wilting point and hydraulic conductivity of 24.48% w/w, 11.21% w/w and 0.37 cm/hr, respectively. During the crop season 40.9 mm rainfall was received. The mean weekly maximum and minimum temperature ranged from 21.8°C to 27.7°C and 8.3°C to 13.7°C, respectively. The mean weekly bright sun shine hours per day varied from 3.53 to 7.73 (hrs/day). The experiment was laid out in factorial randomized block design (RBD) with three replications consisting of four irrigation levels *viz.* Irrigation at flowering stage (I_1), Irrigation at flowering and siliqua formation stages (I_2), Irrigation at 20 days after sowing (DAS), flowering and siliqua formation stages (I_3) and rainfed (I_4) and four varieties *viz.* M 27 (V_1), TS-38(V_2), TS-46(V_3) andTS-67 (V_4). Irrigation to the crop was applied as per respective treatment.

The amount of irrigation water was measured as follows: q = a x d. where, q = quantity of water needed (m^3), a =area to be irrigated (12 m2), d = depth of water (6 cm).Seeds were shown on 30th November, 2013. The sowing was done manually by placing the seeds in the furrows of 4-5 cm depth opened at 30 cm apart with seed rate 10 kg/ha and plant to plant spacing was maintaining at 8-10 cm. The crop was harvested on 7th March, 2014 (97 DAS). Two border rows on either side of the plot and 50 cm row length from both the ends of the rows were discarded. The plants from the net plot were uprooted by hand, tied into bundles separately for individual plot and were carried to threshing floor.In threshing floor, harvested plants from each plot were kept separately and weighed. After 4 days of drying, threshing was done by trampling under feet for individual plots. After threshing, seeds were collected by winnowing. Then the seed and stover yields were measured separately in kg/plot and convert to kg/ha. For determining the seed oil content percentage, seed samples of 10 g each from all the treatments were taken for extraction of oil. The crushed samples were placed in a thimble and extracted with light petroleum ether for six hours in a soxhlet extraction unit as per method described by AOAC (1960). The extract was transferred to a weighed flask, the solvent and moisture being removed by heating the flask at 100 – 150°C. Then the flask was cooled and reweighed. The formula used for calculation of percent oil content in seed was as follows:

Per cent oil = $\frac{W_2 - W_1}{X} \times 100$. Where, W_1 = Weight of the empty flask (g), W_2 = Weight of empty flask + weight of oil (g), X = Weight of sample taken for extraction (g)

The consumptive use of water by rapeseed crop was computed from the soil moisture data by using the following formula:

CU=

$$\sum_{i=1}^{n}(E_0 \times K_c K_p) + \sum_{i=1}^{n}\frac{(M_{1i} \quad M_{2i})}{100} \times ASG_i \times D_i + ER + GWC$$

Where, CU = Consumptive use of water (cm), E0= Pan evaporation value (mm) from USWB class A pan evaporimeter from the day of irrigation to the day when sampling in wet soil is possible, N= Time interval (days), M_{1i}= Per cent soil moisture of the ith layer on the date of sampling after irrigation, M2i= Per cent soil moisture of the ith layer on the date of sampling before irrigation, ASG_i= Apparent Specific Gravity of ith soil layer, D_i= Depth (cm) of the ith layer of the soil, ER= Effective Rainfall during the period under consideration, N= Number of soil layers, Kc= Crop coefficient, Kp= Pan coefficient and GWC= Ground water contribution (Determined with the help of the procedure describe by Anat*et al*. (1965).

Water use efficiency (WUE) of the crop for different treatments was calculated as follows:

WUE (kg/ha-cm) = $\frac{\text{Weight of seed (kg/ ha)}}{\text{CU of crop (cm)}}$

Where CU is the consumptive use of water.The data were analysed statistically using standard procedure. Fisher's least significant difference was used to test the significance of differences at p< 0.05 (Gomez and Gomez 1984).

3. Result and Discussions

3.1 Seed and stover yield

Seed and stover yield of rapeseed were affected significantly due to differentirrigation levels (Table 1). In the current research, irrigation at flowering and siliqua formation stages (1458kg/ha and 2580 kg/ha) (I2) and irrigation at 20 DAS, flowering and siliqua formation stages (1535 kg/ha and 2843 kg/ha) (I3) recorded higher yield as compared to irrigation at flowering (1370 kg/ha and 2543 kg/ha) (I1) and rainfed crop (930 kg/ha and 1745 kg/ha) (I4). Two irrigations at flowering and siliqua formation stages (I2) produced 6.4 and 56.8 per cent higher yield than one irrigation at flowering (I1) and rainfed crop (I4), respectively. Corresponding increases with three irrigations at 20 DAS, flowering and siliquae formation stage (I3) were 12.0 and 65.1 per cent. Seed yield per unit area is a result of plant population, number of siliquae/plant, number of seeds/siliqua and test weight besides good management practices.

Table 1. Effect of different irrigation levels and varieties on yield parameters

Treatment	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index	Seed oil (%)	Oil yield (kg/ha)
Irrigation level (I)					
I_1 : Irrigation at flowering	1370	2543	35.6	38.0	521
I_2 : Irrigation at flowering and siliqua formation	1458	2580	36.3	38.5	561
I_3 : Irrigation at 20 DAS, flowering and siliqua formation	1535	2843	35.3	38.7	594
I_4 : Rainfed	930	1745	35.0	38.6	359
SEm±	28	85	1.08	1.0	12
CD (P = 0.05)	80	247	NS	NS	34
Variety(V)					
V_1 : M 27	1309	2393	35.4	38.6	501
V_2 : TS 38	1326	2457	35.1	38.2	508
V_3 : TS 46	1266	2210	36.4	38.5	489
V_4 : TS 67	1392	2651	35.3	38.5	537
SEm±	28	85	1.08	1.0	12
CD (P = 0.05)	80	247	NS	NS	34

Higher seed yield might be assigned to the higher values of various yield components under these treatments. Irrigation had significant effects on growth characters as well as seed yield of rapeseed as reported by Barrak (2006). The beneficial effects of irrigation on yield attributes and seed yield were also reported by Hasanuzzaman and Karim (2007) and Sultan *et al*. (2009). In the present study, four varieties differed greatly in respect of seed and stover yield. It has been pointed out that an ideal variety would be one which is capable of giving consistently a higher seed yield with more or less constant cultural methods. Among the four varieties tested, TS-67 (1392 kg/ha and 2651 kg/ha) recorded 14.02, 6.43 and 8.43 percent higher yield than TS 46(1266 kg/ha and 2210 kg/ha), TS 38(1326 kg/ha and 2457 kg/ha) and M 27 (1309 kg/ha and 2393kg/ha), respectively. Mamun*et al*. (2014) and Rad *et al*. (2014) also reported varietal difference with respect to yieldattributing characters and seed yield of rapeseed and mustard.

3.2 Oil content and oil yield:

Different irrigation levels have no significant effect on seed oil content (table 1). However, differences in oil yield due to various irrigation levels were found to be significant. The irrigated crop produced significantly higher oil yield than rainfed one. The highest oil yield (594 kg/ha) was observed under three irrigations at 20 DAS, flowering and siliqua formation (I3) which was statistically at par with two irrigations at flowering and siliqua formation (561 kg/ha) (I2). However, the lowest yield was recorded by rainfed crop (359 kg/ha) (I4).Varieties also differed significantly with respect to oil yield. The variety TS67 (536 kg/ha) (V4) being at par with TS 38(507 kg/ha) (V2) recorded significantly higheroil yield as compared to TS 46 (488 kg/ha) andM 27.Yadav *et al*. (2010) also reported that irrigation at flower initiation and seed development stages resulted in the maximum oil yield.

3.3 Moisture extraction pattern and water use efficiency:

The evapo-transpiration of the crop increased with increase in the frequency of irrigation (Figure 1). Higher consumptive use of water by the crops under three irrigations at 20 DAS, flowering and siliquae formation stages (I3) might be due to the fact that under more frequent wetting cycle, evaporation was higher due to the availability of more water as compared to the crop irrigated at wider interval *viz.* two irrigations at flowering and siliqua formation stages (I2), one irrigation at flowering stage (I1) and rainfed crop (I4) (Figure 1). These results are in general agreement with those of Singh el al. (2003); Piri and Sharma (2006) and Kingraand Kaur (2012). The WUE expressed as kg seed yield/ha-cm was higher under one irrigation at flowering stage (I1) and decreased with the increase in irrigation levels (Figure 2). Under rainfed condition and one irrigation, soil moisture depleted gradually with advancement of crop age and it was held with progressively greater tension. On the other hand, under two and three irrigations higher crop evaporation was due to increased availability of soil moisture and fulfilment of evapo-transpiration (ET) demand of the crop. Thus, under three irrigations WUE was less as compared to one and two irrigations and rainfed crop due to proportionately greater increase in ET than the increase in seed yield of rapeseed. The results of present investigation are in close conformity with those of Sonowal (2012) and Sarma and Das (2013).

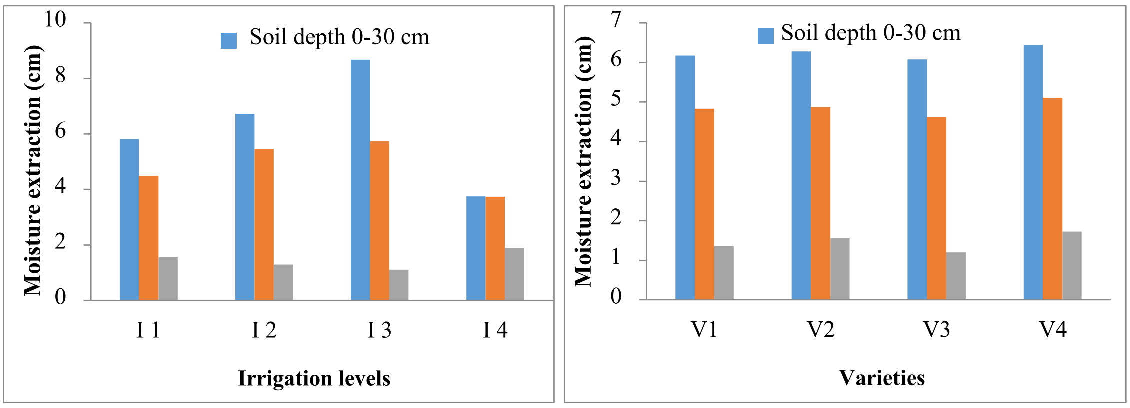

Figure 1. Effect of irrigation and varieties on moisture extraction (cm) pattern

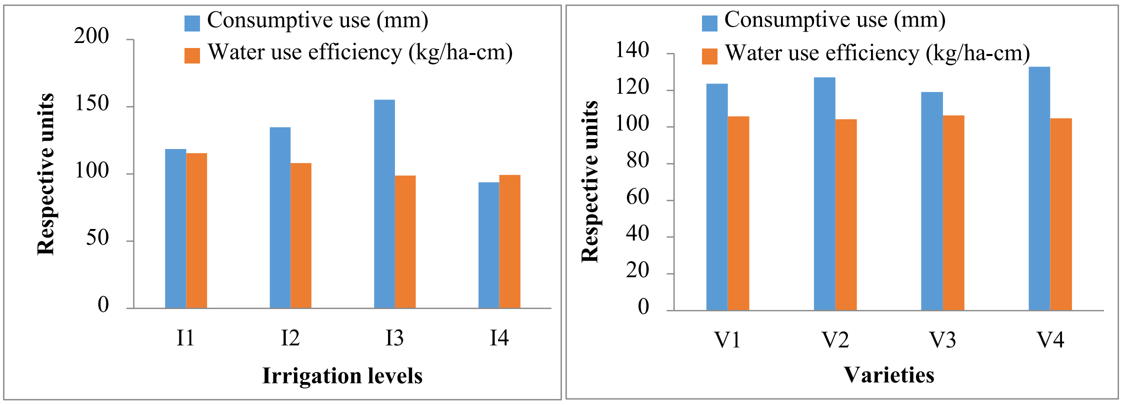

Figure2. Effect of irrigation and varieties on consumptive use and water use efficiency

Conclusion

Based on one year field experiment and laboratory studies, it may be concluded that two irrigations should be applied at flowering and siliqua formation stages for achieving higher yield and WUE. The variety TS 67 or TS 38 may be grown for late sown condition.

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