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Performance of rapeseed (*Brassica campestris* L.) under varied irrigation and sowing methods

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ABSTRACT

A field experiment was conducted during rabi season of 2017-18 at the Instructional Farm, Jaguli, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal to study the effect of irrigation levels and methods of sowing on production potential of rapeseed (Brassica campestris L. Prain). The experiment was laid out in split-plot design with four (4) irrigation levels included in main plots viz. rainfed (I_1), IW:CPE of 0.6 (I_2), IW:CPE of 0.8 (I_3), IW:CPE of 1.0 (I_4) and three (3) methods of sowing viz. broadcasting (M_1), line sowing (M_2) and transplanting [(M_3), (10 days old seedlings)] arranged in sub-plots. The result of the experiment revealed that the growth attributes viz. plant height, leaf area index, dry matter production and crop growth rate; yield attributes viz. primary branches plant^{-1}, siliqua plant^{-1}, seeds siliqua^{-1} and test weight (g) and yield of rapeseed were recorded to be maximum under I_4 which recorded 55.69% increase in yield over control (I_1), however, M_2 registered 17.63 % increased yield over M_1. I_4M_2 performed the best with respect to yield (920.28 kg ha^{-1}) along with better (2.41 kg ha^{-1} mm^{-1}) water use efficiency (WUE); however, the highest WUE had been recorded in I_1M_2. I_4M_1 recorded the highest net return (Rs.45219.20) as well as B: C (2.13) among all the treatment combinations.

***Keywords*:** B: C, irrigation, methods of sowing, rapeseed and WUE

India is one of the four major players in the global oilseeds or vegetable oils scenario, being one of the important oil growers, producers, importers and exporters (De and Sinha, 2011). Rapeseed-mustard is the key oilseed crop that can help in addressing the challenge of demand-supply gap of edible oil in India. The country belongs among the largest vegetable oil economies across the world accounting for about 14 per cent of the world's oilseed area and 8 per cent of oilseed production and ranks second in rapeseed-mustard production. This crop accounts for nearly one-third of the oil produced in India, making it the country's key edible oilseed crop (Kumar and Chauhan, 2005). Despite the high quality of oil and also its wide adaptability for varied agro-climatic conditions, the area, production and productivity of oil rapeseed-mustard in India have been fluctuating due to various biotic and abiotic stresses. Ghosh *et al*. (1994) reported that two irrigations at flowering and at siliqua formation stage increased the seed yield by 28 per cent over rainfed plot. The highest plant height, branches plant^{-1}, filled siliqua plant^{-1}, seeds siliqua^{-1}, 1000 seed weight and stover yield were obtained from two irrigations and consequently it produced the highest seed yield. Sowing methods also had significant influence on almost all the yield contributing characters and yield. All the yield contributing characters were found to be best at line sowing methods and consequently it produced the highest seed yield. However, it could be noted from the study that the combination of two irrigations with line sowing was found to be better to get higher yield (Hossain *et al*., 2013). Keeping this view an experiment was conducted to evaluate the effect of different level of irrigation and methods of sowing on growth attributes, yield attributes and yields of rapeseed, the total water use, WUE and the economics of the crop.

The variety Benoy (B-9) is a short duration rapeseed variety released from pulse and oil research station, Bharatpur, Rajasthan in 1980. In our condition the crop can be grown as late sown and also under irrigated condition. The crop matures in 90 to 100 days. The seeds are round and smooth, light yellow in colour and the oil content varies from 39 to 42 per cent. The yield potential ranges from 1to 1.5 tons per hectare.

An experiment was carried out in the Instructional Farm, Jaguli, BCKV, Nadia, during *rabi* season of 2017-2018 which is located at 22^{0}56′ N and 88^{0}32′ E and 9.75m above mean sea level. The experiment soil was alluvial in nature (entisol) and clay loam in texture having good water holding capacity with moderate fertility status. The experiment was laid out in split-plot design having four irrigation treatments in the main-plots, *i.e*. I_1-rainfed (no irrigation), I_2-IW: CPE of 0.6, I_3-IW: CPE of 0.8 and I_4- IW: CPE of 1.0 and three methods of sowing in sub-plots *i.e*. M_1-broadcasting, M_2-line sowing and M_3-transplanting (10 days old seedlings) replicated

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thrice. The variety B-9 (Benoy) was sown on 1st week of December with the spacing of 30 ×10 cm and fertilizer dose of N: P_2O_5: K_2O @ 80:40:40 kg ha^{-1}. The crop received 26.0 mm rainfall during the experimentation. Irrigation was applied up to 5 cm depth of soil. Soil moisture data was computed through 'gravimetric methods' (where soil samples were dried in oven at 105°C for 48 hours after recording wet soil samples) as follows:-

$$\text{Moisture percentage} = \frac{Wet\ sample\ weight - Dry\ sample\ weight}{Dry\ sample\ weight} \times 100$$

Growth attributes

The growth attributing characters of rapeseed like plant height, leaf area index (LAI), dry matter accumulation (DMA) and crop growth rate were significantly influenced both by level of irrigation and methods of sowing treatments and were increased with the age of the crop to till the observation recorded during investigation (Table 1). Among the irrigation treatments, plant height was found to be maximum (42.01 cm at 50 DAS and 77.60 cm at harvest) under IW: CPE of 1.0 (I_4) followed by IW: CPE 0.8 (I_3) irrigation treatments (38.82 cm at 50 DAS and 73.31 cm at harvest) which might be due to the presence of optimum soil moisture at different important physiological growth-stages which affected the growth parameters. Similar observation was also recorded by Panda *et al*. (2004) (Table 1). Likewise, maximum plant height was observed (50.30 cm at 50 DAS and 77.66 cm at harvest) under M_2 followed by M_1. The shortest plant was produced in transplanting methods (M_3).This result is partially in conformity with the result of Hossain *et al*., 2013 (Table 1). LAI was recorded to be maximum (1.40) in IW: CPE of 1.0 (I_4) irrigation treatment followed by IW: CPE of 0.8 (I_3) irrigation treatments (1.53 cm) at 50 DAS. Similarly, maximum LAI (1.30) had been recorded at 50 DAS under M_2 followed by M_1 (Table 1). DMA was registered to be maximum (37.24 g m^{-2}) in IW: CPE of 1.0 (I_4) followed by IW: CPE of 0.8 (I_3) at 50 DAS (30.23 g m^{-2}). Likewise, highest DMA (36.35 g m^{-2}) had been recorded at 50 DAS under M_2 followed by M_1 (Table 1). Line sowing (M_2) recorded maximum growth attributes followed by broadcasting (M_1) irrespective of date of observation during the period experimentation which might be due to the reason that plant favours equal spacing for their growth and development.

Yield attributes and yield

Yield attributing character like siliqua $plant^{-1}$ of rapeseed was significantly influenced both by levels of irrigation and methods of sowing treatments. Number of seeds per siliqua and test weight had been significantly influenced by methods of sowing irrespective of levels of irrigation (Table 2). Among irrigation levels the maximum yield was recorded under IW: CPE ratio of 1.0 (I_4) irrigation treatment followed by IW: CPE ratio of 0.8 (I_3) irrigation treatments. Among the methods of sowing treatments highest yield was recorded under line sowing (M_2) treatment followed by broadcasting (M_1). This might be due to production of higher growth attributes under optimum moisture condition with optimum plant geometry resulted in higher yield attributes and yield. Similar observations were recorded by Panda *et al.* (2004).

Economics

The maximum gross return (39016.64) was recorded under IW: CPE of 1.0 (I_4) due to higher grain and stover yield, however, the lowest gross return was recorded under rainfed (I_1) treatment due to poor yield of the crop. Line sowing (M_2) registered the highest gross return (Rs. 31987.39) among the different methods of sowing (Table 3). Similarly I_4 recorded the maximum net return among different levels of irrigation and M_2 registered the highest net return among methods of sowing (Table 3). The maximum benefit: cost (1.94) was obtained under IW: CPE of 1.0 (I_4) among different levels of irrigation and line sowing (M_2) recorded the highest benefit: cost (1.72) among sowing methods. This might be due to higher yield in line sowing (M_2) as compared to broadcasting (M_1) as well as transplanting treatment (M_3). Similar results were also opined by Parihar *et al*. (2000).

Water use and water use efficiency (WUE)

The total water use increased with increase in the number of irrigation as well as the time of application at different stages which might be due to the fact that surface layer under higher frequency remain wet for longer time and thereby favouring condition for higher rate of evaporation as compared to drier condition. Thus, total water use by the crop gradually lower down up to IW: CPE ratio of 0.6 (I_2) irrigation treatments. Total water use was recorded to be maximum under line sowing (M_2) treatment due to optimum plant population with proper crop geometry which increase the evapo-transpiration at a high rate as compared to other sowing treatments. Water use efficiency (WUE) was the highest (3.35 kg ha^{-1} mm) under rainfed irrigation treatment i.e. no irrigation treatment. Among the different levels of

Table 1: Effect of levels of irrigation and methods of sowing on growth attributes of rapeseed

Treatment	Plant height (cm)		Leaf Area Index		Dry matter accumulation (g m^{-2})		Crop growth rate (g m^{-2} day^{1})	
	50 DAS	Harvest	50 DAS	Harvest	50 DAS	Harvest	50 DAS	Harvest
Levels of irrigation (I)								
I_1	37.07	72.20	1.26	0.26	20.34	71.09	0.47	1.58
I_2	38.30	72.80	1.35	0.32	26.34	88.13	0.52	1.93
I_3	38.82	73.31	1.30	0.33	30.23	95.37	0.60	2.03
I_4	42.01	77.60	1.40	0.37	37.24	112.97	0.74	2.36
SEm(±)	**0.83**	**1.18**	**0.04**	**0.01**	**1.65**	**3.51**	**0.05**	**0.10**
CD (p≤0.05)	**2.95**	**NS**	**NS**	**0.03**	**5.82**	**12.38**	**0.17**	**0.35**
Methods of sowing (M)								
M_1	39.38	74.19	1.23	0.22	28.96	96.45	0.58	2.11
M_2	50.30	77.66	1.53	0.52	36.35	117.44	0.72	2.52
M_3	27.45	70.08	1.21	0.21	20.30	61.75	0.45	1.30
SEm(±)	**1.45**	**0.57**	**0.03**	**0.01**	**0.96**	**2.84**	**0.04**	**0.09**
CD (p≤0.05)	**4.39**	**1.72**	**0.08**	**0.03**	**2.89**	**8.58**	**0.11**	**0.29**

*Note: * I_1- rainfed, I_2- IW: CPE of 0.6, I_3- IW: CPE of 0.8 and I_4- IW: CPE of 1.0, M_1- broadcasting, M_2- line sowing, M_3- transplanting, NS- non significant*

Table 2: Effect of levels of irrigation and methods of sowing on yield attributes and seed yield of rapeseed

Treatment	No. of primary branches $plant^{-1}$	No. of siliqua $plant^{-1}$	No. of seeds $siliqua^{-1}$	1000 Seed Weight (g)	Seed yield (kg ha^{-1})
Levels of irrigation (I)					
I_1	3.66	62.85	15.75	1.90	360.62
I_2	4.35	66.61	16.31	2.25	507.73
I_3	4.62	77.08	15.67	2.33	622.41
I_4	4.85	81.60	16.92	2.44	806.39
SEm(±)	**0.17**	**3.00**	**0.640**	**0.13**	**87.88**
CD (p≤0.05)	**0.61**	**10.59**	**NS**	**NS**	**24.91**
Methods of sowing (M)					
M_1	4.42	71.25	16.20	2.24	563.15
M_2	4.97	91.16	17.43	2.51	662.45
M_3	3.72	53.70	14.86	1.94	497.26
SEm(±)	**0.06**	**1.83**	**0.23**	**0.03**	**57.54**
CD (p≤0.05)	**0.20**	**5.53**	**0.69**	**0.10**	**19.03**

irrigation treatment, total water use efficiency was highest under I_3 irrigation scheduled at IW: CPE ratio of 0.8 followed by I_2 irrigation treatment *i.e.*, irrigation scheduled at IW: CPE ratio of 0.6 and being the lowest under I_4 treatment *i.e.* irrigation scheduled at IW: CPE ratio of 1.0. The fact is that irrigation increased the seed yield when applied in important growth stages which resulted enhanced water use by the crop in a better way and thus WUE decreased under irrigated conditions. Among the methods of sowing, WUE was recorded to be highest under M_2 sowing treatment *i.e.*, line sowing. The lowest WUE was recorded under M_3 sowing treatment *i.e.* transplanting which might be due to the fact that in transplanting treatment canopy development rate is comparatively slow which led to higher evapo-transpiration (2.05). Similarly, in combination treatments highest water use was recorded under I_1M_2 treatment combination as the yield per mm of water was more as compared to other treatment combinations and the lowest value was registered under I_4M_3 (Table 4). Similar observation was observed by Parihar (2001) and Panda *et al.* (2004).

Table 3: Effect of levels of irrigation and methods of sowing on cost of cultivation, gross return, net return and B : C ratio of crop

Treatment	Cost of cultivation (Rs.)	Gross return (Rs.)	Net return (Rs.)	Benefit : Cost
Levels of irrigation (I)				
I_1	17392.67	17290.17	-102.49	1.00
I_2	18792.67	24419.78	5627.11	1.31
I_3	18792.67	30174.81	11382.15	1.62
I_4	20192.67	39016.64	18823.98	1.94
SEm(±)	**—**	**3404.76**	**3404.75**	**0.18**
CD (p≤0.05)	**—**	**965.14**	**965.14**	**0.05**
Methods of sowing (M)				
M_1	17726.00	27174.55	9448.55	1.51
M_2	18326.00	31987.39	13661.39	1.72
M_3	20326.00	24014.11	3688.11	1.17
SEm(±)	**—**	**2270.54**	**2270.54**	**0.12**
CD (p≤0.05)	**—**	**750.89**	**750.89**	**0.04**

*Note: * I_1- rainfed, I_2- IW: CPE of 0.6, I_3- IW: CPE of 0.8 and I_4- IW: CPE of 1.0, M_1- broadcasting, M_2- line sowing, M_3- transplanting, NS- non significant*

Table 4: Interaction effect of levels of irrigation and methods of sowing on seed yield, total water use and water use efficiency (WUE)

Treatment combinations (kg ha^{-1})	Seed yield (mm)	Total water use (kg ha^{-1} mm)	WUE
I_1M_1	343.94	103.82	3.31
I_1M_2	416.27	124.40	3.35
I_1M_3	321.67	100.75	3.09
I_2M_1	493.78	204.12	2.42
I_2M_2	608.40	239.68	2.54
I_2M_3	421.01	184.88	2.28
I_3M_1	628.10	227.36	2.76
I_3M_2	704.86	245.43	2.87
I_3M_3	534.26	199.94	2.67
I_4M_1	786.79	364.53	2.16
I_4M_2	920.28	381.17	2.41
I_4M_3	712.10	347.94	2.05
SEm(±) (M×I)	**43.15**	**—**	**—**
CD (p≤0.05)	**NS**	**—**	**—**
SEm(±) (I×M)	**39.83**	**—**	**—**
CD (p≤0.05)	**NS**	**—**	**—**

*Note: * I_1- rainfed, I_2- IW: CPE of 0.6, I_3- IW: CPE of 0.8 and I_4- IW: CPE of 1.0, M_1- broadcasting, M_2- line sowing, M_3- transplanting, NS- non significant*

It can be concluded from the experiment that I_4 (IW: CPE of 1.0 *i. e*. two irrigations) and M_2 (line sowing) performed better. So line sowing with two irrigations may be recommended to the farmers of NAZ for higher yield and better benefit- cost ratio.

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