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RESEARCH PAPER

Response of Indian mustard (*Brassica juncea* L.) varieties to irrigation for better growth, yield and quality of mustard crop

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Abstract : A field experiment was conducted during the *Rabi* season of 2008-09 at Agronomy Research Farm, N.D.U.A&T., Kumarganj, Faizabad, to evaluate the response of new released Indian mustard (*Brassica juncea* L.) varieties to irrigation for better growth, yield of mustard crop. Treatments consisted of four irrigation schedule I_1 (no irrigation), I_2 (one irrigation at branching), I_3 (one irrigation at siliqua formation), and I_4 (two irrigation at branching + siliqua formation) and three varieties (NDYR-8, Maya and NDR-8501). The experiment was conducted in Split Plot Design with four replications. All the growth and yield attributes and yield parameters were increased significantly with I_2 treatment (irrigations at branching + siliqua formation) which was significantly superior over rest of treatments. In case of varieties, all the parameters of the growth and yield attributes and yield of the crop were maximum under NDYR-8 which was significantly superior to Maya and NDR-8501.

Key Words : Indian mustard, Siliqua, Irrigation schedule

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INTRODUCTION

Indian mustard (*Brassica juncea* L.) is one of the most important winter oil seed crop grown in northern parts of India. The global production of rapeseed-mustard and its oil is around 38–42 mt and 12–14 mt, respectively. India contributes 28.3% and 19.8% in world acreage and production. India produces around 6.7 mt of rapeseed-mustard next to China (11-12 mt) with significant contribution in world rapeseed-mustard industry. The production of mustard is not being fully exploited because of the lack of proper information of nutritional and water requirement. It is well known that water management is one of the major factors responsible for achieving better harvest in crop production. Efficient irrigation through timely supply of water in desirable amount and with proper irrigation method not only improves the crop yields but also improve water use efficiency. Due to its hardy nature and capacity to thrive well under poor conditions of fertility and moisture, it is generally raised as rainfed crop, as consequence its average yield is low. Research studies indicated the beneficial effect of irrigation on performance of mustard. Phogat *et al.* (2009) reported that the growth yield attributes and yield of mustard increased significantly with the increase in number irrigation. Applications of three irrigations significantly increased seed yield by 15.5% and 52.8% over two and one irrigations, respectively. Adequate supply of moisture in soil helps in proper utilization of plant nutrients, resulting in proper growth and high yield. In the recent past, a number of mustard varieties have been developed for general cultivation. The higher growth and yield attributes and seed yield was recorded with variety 'Kranti', closely followed by 'CS-61' which was significant superior over other varieties (Chauhan, 2010).

The main cause for the low production of oilseed and inadequate growth rate is that oilseeds, though energy rich crops are cultivated largely under energy starvation condition

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in spite of this, oilseeds are mostly grown without irrigation and without the application of adequate quantity of either chemical or microbial fertilizers. In U.P., mustard is grown over 80% of the area as a mixed crop, mainly with wheat. Mustard gets the advantage of the better cultivation practices adopted for wheat but the yield of the farmers has not shown much improvement. This is because with the increase in the cultivation of dwarf varieties of wheat, there has been a shift in the dare of planting of wheat to November, which is rather late for mustard furthermore, the moisture requirements for dwarf wheat varieties are different mustard varieties suitable for late sowing and responsive to high fertility conditions are yet not available.

MATERIAL AND METHODS

A field experiment was conducted at Agronomy Research Farm of N.D.U.A. and T., Kumarganj, Faizabad (U.P.) during 2008-09. The experimental site was situated at 26.47^0 N altitude and 82.12^0E longitude and an altitude of 113 meters above mean sea level in the Gangetic region of eastern Uttar Pradesh. Soil of the experiment field was silt loam in texture. Soil has pH 7.9, low in organic carbon (0.32%) and also low in available nitrogen (180 kg ha^{-1}), phosphorus (8 kg ha^{-1}) and medium in potassium (210 kg ha^{-1}). The experiment was laid out in Split Plot Design with 3 replications. The treatments comprised of 4 irrigation schedule in the main plots, *viz*., the I_1 (no irrigation), I_2 (one irrigation at branching), I_3 (one irrigation at siliqua formation), and I_4 (two irrigation at branching + siliqua formation). The sub-plots comprised of three varieties (NDYR-8, Maya and NDR-8501). Irrigation was done as per treatment with 6cm water. All the varieties were sown in rows 45cm apart keeping a seed rate of 5 kg ha^{-1} on October 22, 2008 and were fertilized with 120 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} through urea, Single super phosphate and muriate of potash, respectively. The data were recorded randomly from five places in each plot on growth and yield attributing and yield characters. Oil content was estimated by oxford analytical new part 4000 NMR. The new part analyzer operates on the principle of nuclear magnetic resonance (NMR) to determine the concentration of mobile hydrogen proteins with in the oil content in mustard. Seed samples were analyzed for nitrogen content and multiplying with a factor of 6.25 protein content was computed in per cent. The data recorded in respect to different observations were analysed as per standard statistical procedure.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect on growth parameters:

Various irrigation schedule and varieties were affected significantly on the growth attributing characters *viz*., plant height, number of primary and secondary branches per plant, leaf area index and dry matter accumulation per plant, of the crop. The data pertaining to growth attributes are given in Table 1. Among irrigation schedule, the highest plant height (195.55) and number of secondary branches per plant (16.18) at harvest were recorded with the application two irrigation at branching + siliqua formation which was the significantly superior over rest of the irrigation schedule. While the other characters, the highest number of primary branches (8.29,) per plant, dry matter accumulation per plant (52.80 g) at harvest stage and leaf area index (3.76) at 90 DAS were recorded with the application two irrigation at branching + siliqua formation which was at par with one

Table 1 : Growth characters as influenced by irrigation schedule and varieties at harvest stage

Treatments	Plant height(cm)	Primary branches	Secondary branches	Leaf area index at 90 DAS	Dry matter accumulation (g $plant^{-1}$)
Irrigation					
I_1	155.26	4.76	7.89	2.85	30.23
I_2	173.93	8.23	15.39	3.60	42.10
I_3	163.98	7.26	13.86	2.97	40.50
I_4	195.55	8.29	16.18	3.76	52.80
S.E.±	2.95	0.09	0.18	0.14	1.02
C.D. (P=0.05)	9.43	0.30	0.57	0.40	3.25
Varieties					
V_1	182.78	7.50	13.83	3.45	43.40
V_2	172.40	7.11	13.29	3.42	41.55
V_3	161.37	6.79	12.87	3.39	39.79
S.E.±	1.05	0.06	0.08	0.05	0.09
C.D. (P=0.05)	3.08	0.17	0.25	NS	0.26

irrigation at branching which was the significantly superior over rest of the irrigation schedule. The highest plant height (182.78 cm), no. of primary (7.50) and secondary branches per plant (13.83), dry matter accumulation per plant (43.40 g) at harvest stage and leaf area index (3.45) at 90 DAS were recorded in NDYR-8 variety which was significantly superior over rest of the varieties. This might be due to rapid cell elongation under adequate water supply to crop and also it increased the nutrient availability to the crop. Minimum plant height under no irrigation treatment was due to poor growth caused by moisture deficit conditions. Similar results were also reported by Panda *et al.* (2004) and Sharma *et al.* (2006). Highest dry matter accumulation was recorded due to increased plant height, number of branches and LAI under adequate moisture supply. All these contributed for cell turgidity and opened leaves which increased the photosynthetic activity of plants resulted in higher dry matter accumulation. Increased dry matter accumulation due to irrigation had also been reported by Sharma *et al.* (2006). In general, the growth parameters *viz*., plant height number of branch and dry matter accumulation per plant were observed significantly higher in NDYR-8 due to variety character. Similarly results were found by Jadhav *et al.* (1999).

Effect on yield attributing and yield character:

Effect on yield attributing character:

It is evident from the data presented in Table 2 that irrigation schedule and varieties influenced the yield attributing character like no. of siliqua plant^{-1}, length of siliqua, number of seed siliqua^{-1} significantly. The maximum no. of siliquae plant^{-1} (368.33), length of siliqua (5.65) and no. of seed siliqua^{-1} (18.66) were recorded with I_4 (two irrigations at branching + siliqua formation stage) which was the significantly superior over rest of the treatments. Minimum value was recorded under no irrigation treatment. The maximum no. of siliquae plant^{-1} (350.00), length of siliqua (5.24cm) and no. of seed per siliqua (17.50) were recorded in NDRY-8 which was the significantly superior over rest of the varieties. Irrigation schedule did not influence 1000-seed weight significantly. However, varieties influenced 1000-seed weight significantly. Yield attributes, which determine yield is the resultant of the vegetative development of the plant. It may be recalled the reproductive organs are determined much before the emergence of siliqua and are largely governed by the vegetative growth taken place initiation of flower premordia. More growth build up by the early irrigation reflected ultimately in to higher yield attributing characters. This might be due to favourable vegetative growth and development under adequate available soil moisture. As under adequate moisture, increased photosynthetic activity and translocation of photosynthesis from source to sink. Similar findings have also has reported by Nagdive *et al.* (2007) and Phogat *et al.* (2009). Yield contributing characters *viz*., number of siliqua plant^{-1}, length of siliqua and number of grains siliqua^{-1} influenced significantly due to variety character.

Effect on yield:

A perusal of the data summarized in Table 2 that irrigation schedule and varieties were influenced significantly on seed and stover yield. The maximum seed yield (2141 kg ha^{-1}) and stover yield (5746 kg ha^{-1}) was recorded under I_4 (two irrigation at branching + siliqua formation) which was significantly superior over rest of the irrigation schedule. Seed yield was 31.83, 45.65 and 83.15% more than I_3 (one irrigation at branching), I_2 (one irrigation at siliqua formation) and I_1 (no irrigation), respectively. Minimum seed yield was recorded under no irrigation treatment. The varieties were also influenced significantly on seed and stover yield. Significantly higher seed yield (1718 kg ha^{-1}) and stover yield

Table 2 : Yield attributing and yield character and quality parameters as influenced by irrigation schedule and varieties

Treatments	No. of siliquae plant^{-1}	Length of siliqua (cm)	No. of seeds siliqua^{-1}	1000 seed weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index	Oil content (%)	Oil yield (kg ha^{-1})	Protein content (%)	N uptake (kg ha^{-1})
Irrigation											
I_1	255.00	4.53	9.66	4.20	1169	3545	24.73	40.13	469	24.33	45.50
I_2	346.66	5.28	15.66	4.37	1624	4596	26.80	40.15	652	25.38	65.93
I_3	330.00	4.90	15.33	4.37	1470	4580	24.79	40.00	588	25.00	58.80
I_4	368.33	5.65	18.66	4.38	2141	5746	27.17	40.00	856	25.47	87.35
S.E.$_{\pm}$	3.25	0.13	1.08	0.12	35	200	-	0.15	3.00	0.10	0.48
C.D. (P=0.05)	10.40	0.36	2.92	NS	112	641	-	NS	11.00	0.32	1.55
Varieties											
V_1	350.00	5.24	17.50	3.76	1718	5067	25.90	40.10	688	25.31	69.62
V_2	317.50	5.07	14.00	4.62	1594	4502	25.87	40.07	638	25.00	63.69
V_3	307.50	4.96	12.50	4.60	1490	4281	25.85	40.05	596	24.79	59.15
S.E.$_{\pm}$	1.70	0.05	0.40	0.05	27	111	-	0.05	1.00	0.04	0.01
C.D. (P=0.05)	4.96	0.13	1.12	0.13	79	326	-	NS	3.00	0.13	0.02

(5067 kg ha^{-1}) was recorded with NDRY-8 which was significantly superior over rest of the varieties. Seed yield in NDYR-8 was 7.78 % and 15.30 % more than Maya and NDR-8501, respectively. However, harvest index was found not significant due to varieties. Yield is the result of coordinated interplay of growth characters and yield attributes. Seed and and Stover yields significantly in the need by different irrigation schedule. Higher seed and stover yields were recorded with two irrigations at branching + siliqua formation stages. This might be due to adequate moisture availability, which contributed to better growth parameters and yield attributes. The findings are in close formity of Lal *et al.* (2000) and Sharma *et al*. (2006). Yield grain, stover yield and harvest index influenced significantly due to variety. These values were significantly higher under NDYR-8 (Chauhan, 2010).

Effect on quality:

Oil content in mustard seed was measured after grinding the seeds of mustard and data have been presented in Table 2. Oil content was not significantly influenced due to irrigation schedule and varieties. Oil yield (856 kg ha^{-1}), protein content (25.47%) and N uptake (87.35 kg ha^{-1}) was influenced significantly due to irrigation schedule and varieties performance. Significantly higher oil yield was recorded with I_4 (two irrigation at branching + siliqua formation) which was significantly superior over rest of the treatments. Minimum oil yield was recorded under no irrigation schedule treatment. Quality parameter was also influenced significantly due to varieties. Significantly higher oil yield (688 kg ha^{-1}), protein content (25.31%) and N uptake (69.62 kg ha^{-1}) was recorded with NDYA-8 which was highly superior over rest of the varieties. Apart from the yield, the quality of the seed also counts much in cultivation of the crops and its adoption. The chemical analysis carried out indicated that the effect of irrigation on the oil and protein content of seed did not turn out to be significant. These findings are in close conformity with the findings of Ghanbahadur and Layewar (2006). Quality parameter *viz*., oil yield, protein content and N uptake influenced significantly due to variety. These values were significantly higher under NDYR-8. Significant variation among test varieties was perhaps due to genetic character of varieties under this investigation.

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