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Effect of irrigation and sowing time on growth and yield of Indian mustard (*Brassica juncea* L.) in central plain zone of UP

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Abstract
A field experiment was conducted at Agriculture Research farm, Rama University, Kanpur during *rabi* seasons of 2021-22 to study the Effect of Irrigation and Sowing time on Growth and Yield of Indian Mustard (*Brassica juncea* L.) in central plain zone of UP. The experiment was laid out in randomized block design with three replications and 12 treatments and 3 replication. The treatments considered The treatments consisted T_1 = Early sowing time + No nitrogen , T_2= Early sowing time + One irrigation(20 DAS), T_3 = Early sowing time + Two irrigation (20, 35 DAS), T_4 = Early sowing time + Three irrigation (20, 35, 50 DAS), T_5= Mid or Optimum sowing time + No irrigation T_6= Mid or Optimum sowing time+ One irrigation (20 DAS), T_7= Mid or Optimum sowing time + Two irrigation (20, 35 DAS), T_8 =Mid or Optimum sowing time + Three irrigation (20, 35, 50 DAS), T_9= Late sowing time + No irrigation, T_{10} = Late sowing time + One irrigation (20 DAS), T_{11} = Late sowing time +Two irrigation (20, 35 DAS) and T_{12} = Late sowing time + Three irrigation (20, 35, 50 DAS). Among the treatments it was found that mid sowing time 15th November , and Irrigation schedule 20, 35, 50 DAS have best result in terms of growth, development, yield and quality of mustard crop.

Keywords: Irrigation schedule, early sowing, late sowing and yield

Introduction
Indian mustard botanically known as *Brassica juncea* L. The family of mustard *Brassicaceae* (*Crucifereae*) and having 36 chromosomes (2n). It is annual in nature and one of the major *rabi* oilseed crop of India. It is commonly known as *Rai.* Or *Raya.*

Mustard is healthfully rich and its oil content ranges from 33 to 49 percent. Mustard is 2nd most basic oilseed crop after groundnut, accounts 30 percent of the total oilseeds cultivated in India. India is one of the major rapeseed-mustard growing nation in the world, having the chief position in zone and second in progress near China. Our country is an oil lacking economy.

There is a more gap between demand and supply of oil. The initiation of this issue lies in the way that oil usages in India has expanded quickly from under 6 kilogram capita^{-1} in 1992-93 to 18 kilogram. Total domain under rapeseed and mustard in India is million hectares with a making of 6.98 million tons and effectiveness of 1145 kilogram per hectare. The oilseed crop acting a huge capacity in country economy of our country because of oil and fats autonomously from molding on India pensile part of human food. Rapeseed, mustard, groundnut, linseed, castor, safflower and Niger. In India, rapeseed, mustard involved 6.33 million hectare domain with a creation 6.69 million tons and effectiveness of kg ha-1 during 2019-20. In UP, rapeseeds, mustard is an oilseed crop, addressing 19.81% district (0.95 million ha) and 20.23% outright creation (0.79 million tons) of the country during 2018-19 to 2019-20 with on a typical yield 962 kilogram per hectare which is extremely underhanded great.

Mustard is most responsive crop to weather and having different results in different sowing time. Sowing at time plays a prime role to provide growing conditions i.e. temperature, humidity, rain and light intensity. The development period of mustard should synchronize with ideal conditions for better articulation of growth and yield.

Goes with partition of biomass of plant parts. Mainly the cropping season of mustard winter season (October to March). The vegetative growth and the yield can be increased by the increasing number of irrigation. Around 52% and 15% more seed yield harvested by the application of 3-irrigationover one and two irrigations, respectively.

Proper water supply increase and maintain the supply of nutrients which results in the term of increased growth and more yield. Yield reduced in late sown mustard because of reduction in duration due to high temperature during reproductive phase.

It was demonstrated that mustard crop yield of October (first fortnight) crop is lower than the September (second fortnight) sown crop. October sown crop produces lower yield Comprehension of physiological and phenological reasons for yield decrease concerning date of planting can assist with creating systems for production of seed. Further, it will help in the affirmation that usefulness is obliged by advancement example and cycle physiology in light of climate.

Irrigation frequency has more effect on the yield and quality of a crop. Therefore, a sensible irrigation schedule is needed to avoid high or recurrence of water system and how much water is required which is upon such factors as cultivar, soil type, season, the measure of precipitation and illnesses; accordingly, it is hard to give positive suggestion. Higher and lower both results in low production because water efficiency and frequency play an important role in mustard crop production. This may be possible by adopting recently demonstrated irrigation practices. Both frequency and efficiency low irrigation and for significant result in mustard cultivation. Late sowing affect both the productivity of seed and oil yield. It would impact antagonistically the harvest execution attributable to

Change in abiotic and biotic conditions.

Irrigation has/had positive effect on all the quantitative characters. Mid time sowing plays an role to fully exploit the genetic potentiality of a variety as it provides average crop production, environment such as temperature, humidity and light intensity etc. Time of sowing is one of the most important non-monetary input which influences to a great extent on both the quality and economics of mustard.

Materials and Methods

The experiment was carried out to study Effect of Integrated weed management on growth and yield of Indian mustard (*Brassica juncea* L. during rabi season of 2021-22 at Agriculture Research farm, Rama university, Kanpur. The experimental soil was clay loam in texture. The experiment was carried out in randomized block design with 12 treatments and 3 replications. The treatments consisted T_1 = Early sowing time + No nitrogen , T_2= Early sowingtime + One irrigation(20 DAS), T_3 = Early sowingtime + Two irrigation (20, 35 DAS), T_4 = Early sowingtime + Three irrigation (20, 35, 50 DAS), T_5= Mid or Optimum sowingtime + No irrigation T6= Mid or Optimum sowingtime+One irrigation(20 DAS), T_7= Mid or Optimum sowingtime + Two irrigation (20, 35 DAS), T_8 =Mid or Optimum sowingtime + Three irrigation (20, 35, 50 DAS), T9= Late sowingtime + No irrigation, T_{10} = Late sowingtime + One irrigation (20 DAS), T_{11} = Late sowing time +Two irrigation (20, 35 DAS)and T_{12} = Late sowingtime + Three irrigation (20, 35, 50 DAS). The sowing of mustard, variety Varuna was done on 1st, 15 and 30 November, 2021 with a spacing of 30 cm x 10 and harvested on 1th March,2022. The crop was protected from insect-pest and diseases by spraying chemicals on time. The crop was irrigated as per water requirement. During the crop growing period, the weekly mean rainfall was ranged from 0.0 to 12.5 mm.

Result and Discussion

Effect of Irrigation and sowing time on growth parameters of mustard

The maximum (9.25 and 10.44) IPP were recorded in the factor A S_2 (Mid sowing- 15 November) and factor B irrigation I_3 (20, 35, 50 DAS) followed late sowing (30 November) and I_2 (20, 35 DAS) irrigation. The presented data is significant over control in both of the factors. The IPP did not significantly influenced due to different sowing time and irrigations practice. The data of plant height was taken at 30, 60, 90 DAS and maturity At 30 DAS, the data was recorded which is not significant. Highest growth rate of mustard plant was found between 30 DAS to 90 DAS after that reproductive growth stated in the form of flowering and siliqua development. At 60 DAS stage, the highest plant height was observed in S_2(mid sowing time-15th Nov.) and in the irrigation schedule I_3 (Irrigation @ 20, 35 and 50 DAS) which is 138.492 cm and 158.40 cm respectively followed by the S_3 (late sowing 30th Nov.) and I_2 (Irrigation @ 20, 35 DAS). This result is significant over control. At 90 DAS stage, S_3 (Late sowing- 30th Nov.) and I_0 (control) have least plant height which is 150.367 cm and 128.53 cm respectively. The significant plant height of sowing time was 155.875 cm (S_2-Mid sowing- 15th Nov) and irrigation schedule was 170.33cm I_3 (Irrigation @ 20, 35 and 50 DAS). At maturity, the maximum plant height was recorded in the sowing and irrigation schedule combination were 159.950 cm (S_3) and 170.367 cm (I_3) respectively. This mentioned data is significant over control. Tomar and Mishra 1991. reported similar result. Data of primary branches have been recorded at 60, 90 DAS and maturity. At 60 DAS, The maximum no. of primary branches in factor A sowing time and irrigation schedule were recorded in S_2 (6.833) and I_3 (8.111) respectively. This d presented data is significant over control. At 90 DAS, the minimum no. of primary branches was recorded in the S_1 (Early sowing time- 1st Nov) 5.417 and irrigation schedule I_0 (control) 4.222. The highest no. of primary branches was observed in sowing time of S_3 (8.167) and Irrigations schedule I_3 (10.222). At maturity, the highest no of primary branches 9.750 and 11.222 were in the S_2 (Mid sowing- 15th Nov.) and irrigation time of I_3 (Irrigation @ 20, 35 and 50 DAS) respectively. This is significant over control. At 60 DAS, the maximum no. of secondary branches (11.250) were recorded in factor sowing time S2 (Mid sowing- 15th Nov.) followed by 9.917 in S1 Early sowing- 1st Nov.) and maximum branches (14.667) in factor irrigation schedule I3 (Irrigation @ 20, 35 and 50 DAS) followed by 11.111 in I_2 (Irrigation @ 20, 35 DAS). At 90 DAS and maturity there in nominal difference in secondary branches. At maturity, the highest no. of secondary branches were observed i.e 18.417 and 22.667 which were S_2 (Mid sowing- 15th Nov.) and I3 (Irrigation @ 20, 35 and 50 DAS) respectively. Kumar and Shakawat (1992) [6]. Reported similar result.

Effect of Irrigation and sowing time on yield parameters of mustard

The maximum no. of siliqua were recorded in the factor sowing time S_2 (Mid sowing- 15th Nov.) and factor irrigation I_3 (Irrigation @ 20, 35 and 50 DAS) were 188.250 and 229.22 respectively followed by S_1 (Early sowing- 1st Nov.) and I_2 (Irrigation @ 20, 35 DAS). This data is significant over control. The result are conformity with Tuteja *et al.* (2011).

The highest length of siliqua was recorded in factor A Sowing time S_2 (Mid sowing- 15th Nov.) 5.983 cm followed by S3 and factor B irrigation schedule I_3 (Irrigation @ 20, 35 and 50 DAS) 7.233 cm followed I2 (Irrigation @ 20, 35 DAS). The lowest length of siliqua was found in control. Such type of result was also reported by Giri (2001).

The least no. of seeds in a siliqua observed in an average of 9.833 and 6.556 which were in I_0 (control) and S_1 (Early sowing- 1st Nov.) respectively. The more count of seeds in a siliqua were recorded in the sowing time 10.500 S_2 (Mid sowing- 15th Nov.) and in irrigation time 13.444 I3 (Irrigation @ 20, 35 and 50 DAS) that is significant over control. The data often are also in good accordance with the data reported by Kumar *et al.* (2008). The maximum test weight of 4.092 g and 4.456 g were recorded in the treatment sowing time S_2 (Mid sowing- 15th Nov.)and irrigation schedule I_3 (Irrigation @ 20, 35 and 50 DAS). The least weight of test weight was found in control i.e 3.875 and 3.500 which were in early sowing time of 1 Nov. and I_0 control irrigation schedule respectively. These result was partially close with the findings of Lathif *et al.*(2006). The highest seed yield recorded in nitrogen treatment S_2 (Mid sowing- 15th Nov.) was 12.858 q/ha and in irrigation treatment I_3 (Irrigation @ 20, 35 and 50 DAS) was 16.978 q/ ha. The presented data is significant over control. The least stover yield of 37.817 q/ha and 18.411 q/ ha were recorded in different sowing time combination of S_3 (Late sowing- 30th Nov.) and irrigation combination of I_0 (control) respectively. The significant yield (39.317 q/ha and 52.733 q/ha) were recorded in S_2 (Mid sowing- 15th Nov.) and I3 (Irrigation @ 20, 35 and 50 DAS). The highest biological yield was recorded in S_2 (Mid sowing- 15th Nov.) and I_3 (Irrigation @ 20, 35 and 50 DAS) i.e 52.175 q/ha and 69.711 q/ha respectively. The above mentioned data have significant effect over control. The highest harvest index were recorded in S_2 (mid sowing time 15th Nov.) 27.698 and I0 (control) 24.517. That is because irrigation is the major factor required for the growth, development and yield of plants. Control of irrigation time produced lowest seed yield so the ratio of harvest index have been increased in zero irrigation treatment.

Effect of Irrigation and sowing time on quality parameters of mustard

The highest amount of oil content was recorded in the sowing time treatment S_2 (Mid sowing- 15th Nov.) and irrigation treatment I3 (Irrigation @ 20, 35 and 50 DAS) i.e. 37.400 % and 43.478 % respectively. In the treatment combination of late sowing time and zero irrigation had least oil content. The highest protein content have been record in the S_2 (Mid sowing- 15th Nov.) and I_3 (Irrigation @ 20, 35 and 50 DAS) i.e 16.292 % and 21.822 % respectively. The lowest amount of protein were observed in late sowing time (30th Nov.) and control of irrigation that is 15.817 % and 10.578 % respectively. The highest oil yield was recorded in nitrogen treatment S2 (Mid sowing- 15th Nov.) 449.508 kg/ha and in irrigation treatment I_3 (Irrigation @ 20, 35 and 50 DAS) 663.678 kg/ha. The lowest oil yield were recorded in late sowing time and control of irrigation schedule. This result is also agreement with the findings of Diri *et al.* (2012), Lallu *et al*. (2010) [10]. and Sharma *et al.* (2006) [12].

Table 1: Effect of Irrigation and sowing time on growth parameters of mustard

Treatments	IPP	Plant Height (cm)				No. of primary branches			No. of secondary branches		
		30 DAS	60 DAS	90 DAS	Maturity	60 DAS	90 DAS	Maturity	60 DAS	90 DAS	Maturity
A. Sowing time											
S1 (Early)	9.12	17.433	129.742	150.625	157.375	5.417	6.917	7.500	9.917	15.333	17.500
S2 (Mid)	9.25	17.508	138.492	155.875	159.950	6.833	8.083	9.750	11.250	16.750	18.417
S3 (Late)	9.20	17.500	134.033	150.367	158.767	6.083	8.167	8.667	9.667	14.917	17.417
SE(m)	0.242	0.026	0.701	0.634	0.117	0.304	0.226	0.248	0.446	0.344	0.192
C.D.	NS	NS	2.825	2.557	0.471	NS	0.910	0.999	NS	1.385	0.776
B. Irrigation											
I0 (Control)	8.33	17.256	111.900	128.533	139.689	4.222	5.111	6.222	6.111	9.667	13.222
I1 (20 DAS)	9.11	17.233	124.711	151.10	158.022	5.667	7.222	8.111	9.222	14.667	16.222
I2 (20, 35 DAS)	8.88	17.589	141.344	159.189	161.711	6.444	8.333	9.000	11.111	17.667	19.00
I3(20,35,50 DAS)	10.44	17.844	158.400	170.333	170.367	8.111	10.222	11.222	14.667	20.667	22.667
SE(m)	0.242	0.035	0.897	0.593	0.462	0.327	0.380	0.364	0.335	0.381	0.505
C.D.	0.725	0.104	2.685	1.775	1.383	0.979	1.136	1.091	1.003	1.140	1.512

Table 2: Effect of Irrigation and sowing time on yield parameters of mustard

Treatments	No of siliquae per plant	Length of siliqua (cm)	Number of seeds per siliqua	Test weight (g)	Seed yield (q/ha)	Stover yield (q/ha)	Biological yield (q/ha)	Harvest Index
A. Sowing time								
S1 (Early)	181.167	5.567	9.833	3.992	12.100	38.292	49.392	24.478
S2 (Mid)	188.250	5.983	10.500	4.092	12.858	39.317	52.175	24.724
S3 (Late)	177.417	5.808	9.833	3.875	11.567	37.817	49.383	23.373
SE(m)	0.674	0.068	0.537	0.030	0.107	0.141	0.191	0.190
C.D.	2.716	0.276	NS	NS	0.433	0.568	0.769	0.766
C. Irrigation								
I0 (Control)	129.556	4.333	6.556	3.500	5.989	18.411	24.400	24.516
I1 (20 DAS)	175.00	5.378	8.889	3.889	11.356	37.311	48.667	23.335
I2 (20, 35 DAS)	195.333	6.400	11.333	4.100	14.378	44.111	58.489	24.573
I3 (20,35,50 DAS)	229.22	7.033	13.444	4.456	16.978	52.733	69.711	24.343
SE(m)	0.754	0.096	0.259	0.028	0.110	0.243	0.313	0.178
C.D.	2.256	0.289	0.774	0.083	0.328	0.729	0.938	0.533

Table 3: Effect of Irrigation and sowing time on quality parameters of mustard

Treatments	Oil content (%)	Protein content (%)	Oil yield (kg/ha)
B. Sowing time			
S1 (Early)	36.600	16.000	446.108
S2 (Mid)	37.400	16.292	449.508
S3 (Late)	36.033	15.817	445.058
SE(m)	0.293	0.245	0.287
C.D.	NS	NS	1.158
D. Irrigation			
I0 (Control)	29.378	10.578	181.011
I1 (20 DAS)	33.933	15.244	377.267
I2 (20, 35 DAS)	39.922	16.500	565.611
I3 (20,35,50 DAS)	43.478	21.822	663.678
SE(m)	0.261	0.322	0.800
C.D.	0.783	0.964	2.234

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