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Effect of varying date of sowing and weed management practices on yield of Indian Mustard {*Brassica juncea* (L.) Czern and Coss}

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Abstract
A field experiment was carried out during *rabi* 2020-21 at Instructional Farm of Agronomy, Rajasthan College of Agriculture, Udaipur to study the performance of Indian mustard under varying date of sowing and weed management practices. Results revealed that minimum dry matter of weeds and the highest WCE, superior growth parameters, yield attributes and yield were recorded with pre-emergence application pendimethalin 38.7 CS @ 0.75 kg ha^{-1} + HW 30 DAS next to weed free treatment. Whereas 23rd October sown crop reported significant highest growth parameters, yield attributes and yield over 13th October and 3rd November sown crops.

Keywords: Indian mustard, pre-emergence, pendimethalin, yield

Introduction
Oilseeds are backbone of agricultural economy of India since long and considered as the second largest agricultural commodity in India after cereals. Rapeseed and mustard are usually sown by the end of the September to second fortnight of October in the north India. Sowing time has a profound effect on the growth and yield of mustard. The optimum time of sowing can provide favourable conditions to have maximum light interception, best utilization of moisture and nutrients from early growth stages to seed filling stage. One month delay in sowing from mid-October resulted in loss of 40.6% in seed yield (Lallu *et al.*, 2010) [4]. It suffers from exposure to low temperature during vegetative and early pod filling stage and relatively higher temperature during germination and maturity (Adak and Chakravarthy, 2010). Among various components of production technology, weed control in Indian mustard needs due attention. Weed competition in mustard crop is more serious in early stages because crop grows slowly during the first 4-8 weeks after sowing. However, during later stages crop grows vigorously and exerts a strong suppressing effect on weeds. Uncontrolled weed reduced mustard yield by 68% as compared to weed free condition (Degra *et al*., 2011) [2]. The traditional practice of hand weeding once during early stages of crop growth *i.e* 25-30 days after sowing (DAS) is not sufficient as new flushes of weeds appears after every mechanical weeding, irrigation and winter rainfall, and reinfest the crop and most importantly they take away major portion of the nutrients and moisture from the soil.. Weed infestation by species of the *Brassicaceae* and *Poaceae* is one of the most important challenges for mustard growers in India as a result of the lack of efficient selective herbicides. Competition by weeds at initial stages is a major limiting factor to its productivity. Therefore, different dates of sowing with weed management practices were tested in Indian mustard to carry out the experiment.

Materials and Methods
The experiment was conducted during *rabi* 2020-21 at Instructional Farm of Rajasthan College of Agriculture, MPUAT, Udaipur. The soil of the experimental site was clay loam in nature, with slightly alkaline reaction (pH 8.13) having bulk density 1.40 g cc^{-1} and electrical conductivity 0.78 dS m^{-1}. The nutrient status of the soil showed organic carbon content (0.71%), available nitrogen content (284.6 kg ha^{-1}), available phosphorus content (20.47 kg ha^{-1}) and available potassium content (292.34 kg ha^{-1}) depicting overall medium nutrient status of the soil. The treatments consisting of three date of sowing (13th October, 23rd October and 3rd November) and four weed management practices (Weed free, Weedy check, pendimethalin 30EC @ 0.75 kg ha^{-1} pre-emergence + Hand hoeing 30 DAS, pendimethalin 38.7 @ 0.75 kg ha^{-1} pre-emergence + Hand hoeing 30 DAS) were laid out in factorial randomized block design

(FRBD) and replicated thrice. Crop was sown at different dates with 5 kg ha^{-1} and sowing was done manually. Herbicides (Pendimethalin 30 EC and Pendimethalin 38.7 CS) were sprayed with knapsack sprayer fitted with flat fan nozzle using 500 litres of water per hectare after sowing. Three irrigations applied 1st irrigation at 30 DAS, 2nd irrigation at 55 DAS and 3rd at 75 DAS. Mustard variety Giriraj was used as test crop with recommended package of practices.

Results and Discussion

Crop heavily infested with mixed flora of monocot and dicot weeds, *viz*. *Cynodon dactylon* and *Cyperus rotundus* among monocot weeds and *Coronopus didymus* and *Chenopodium album* among dicot weeds.

Weed parameters: An examination of data (Table 1) implies that all the weed management treatments significantly reduced dry matter of total weeds at 30 DAS, 60 DAS and at harvest compared to weedy check. The minimum dry matter of weeds was noticed with pre-emergence application of pendimethalin 38.7 CS @ 0.75 kg ha^{-1} + HW 30 DAS (86.86, 183.98 and 290.14 kg ha^{-1}) followed by pendimethalin 30 EC @ 0.75 kg ha^{-1} + HW 30 DAS (95.78, 192.67 and 302.27). The highest WCE was recorded in pre-emergence application of pendimethalin 38.7 CS @ 0.75 kg ha^{-1} + HW 30 DAS (64.04%) followed by pendimethalin 30 EC @ 0.75 kg ha^{-1} (65.66%). Similar results were observed by Desai *et al*., 2016).

Growth characters: A perusal of data (Table 1) indicates that all the weed management treatments consistently influenced plant dry matter accumulation at 30 DAS, 60 DAS and at harvest and crop growth rate between 30 to 60 DAS. The highest plant dry matter at 30 DAS, 60 DAS and at harvest was observed under weed free treatment (11.44, 28.31 and 68.24 g $plant^{-1}$) followed by pendimethalin 38.7 CS @ 0.75 kg ha^{-1} + HW 30 DAS (8.95, 22.23 and 64.15 g $plant^{-1}$) compared to weedy check. Maximum CGR between 30 to 60 DAS was attained with weed free (0.562 g m^{-2} day^{-1}) treatment which was closely followed by pendimethalin 38.7 CS @ 0.75 kg ha^{-1} + HW 30 DAS (0.442 g m^{-2} day^{-1}). Various dates of sowing significantly influenced growth characters *viz.* dry matter accumulation at 30 DAS, 60 DAS and at harvest and crop growth rate between 30 to 60 DAS. The highest plant dry matter at 30 DAS, 60 DAS and at harvest was observed under 23rd October (9.96, 26.33 and 64.59 g $plant^{-1}$) sown crop followed by 13th October and 3rd November sown crops.

Yield attributes and yield: Yield attributes like number of siliquae $plant^{-1}$, number of seeds $siliquae^{-1}$ and number of secondary branches $plant^{-1}$ significantly influenced with all the weed management treatments over weedy check (Table 2). Weed free treatment resulted in the highest of all these yield attributes which was followed by pendimethalin 38.7 CS @ 0.75 kg ha^{-1} + HW 30 DAS and pendimethalin 30 EC @ 0.75 kg ha^{-1} + HW 30 DAS respectively. Among the treatments, pre-emergence application of pendimethalin 38.7 CS @ 0.75 kg ha^{-1} + HW 30 DAS reported higher seed yield, straw yield and biological yield (1220, 5549 and 6769 kg ha^{-1}) next to weed free treatment (1297, 5888 and 7185 kg ha^{-1}). The seed yield, straw yield and biological yield recorded under pendimethalin 30 EC @ 0.75 kg ha^{-1} + HW 30 DAS was 1153, 5079 and 6533 kg ha^{-1} respectively.

Yield attributes like number of siliquae $plant^{-1}$, number of seeds $siliquae^{-1}$ and number of secondary branches $plant^{-1}$ significantly influenced with the different dates of sowing. 23rd October (389.4, 15.67 and 13.83) sown crops reported maximum of all these yield attributes which was followed by 13th October and 3rd November sown crop respectively. Among the different dates of sowing maximum seed yield, straw yield and biological yield was reported under 23rd October (1195, 5531 and 6725 kg ha^{-1}) sown crop followed by 13th October (1127, 5302 and 6429 kg ha^{-1}) and 3rd November (1019, 5152 and 6172 kg ha^{-1}) respectively. Delayed sowing would influence adversely the crop performance owing to change in abiotic and biotic environmental conditions (Singh and Yaspal 2011) [5].

Table 1: Effect of varying date of sowing and weed management on weed dry matter, WCE, plant dry matter, CGR

Treatments	Dry matter of total weeds (kg ha^{-1})			WCE at 60 DAS	Dry matter accumulation by plants (kg ha^{-1})			CGR (g m^{-2} day^{-1}) between 30 to 60 DAS
	30 DAS	60 DAS	Harvest		30 DAS	60 DAS	Harvest	
Weed management								
Weed free	-	-	-	-	11.44	28.31	68.24	0.562
Weedy check	293.32	535.86	646.73	-	7.44	19.56	47.43	0.403
Pendimethalin 30 EC@ 0.75 kg ha^{-1}+ Hand HW 30 DAS	95.78	192.67	302.27	64.04	9.38	22.32	62.65	0.432
Pendimethalin 38.7 CS @ 0.75 kg ha^{-1} + Hand HW 30 DAS	86.86	183.98	290.14	65.66	8.95	22.23	64.15	0.442
S.Em±	0.17	0.12	0.16	0.01	0.17	0.22	0.70	0.009
C.D. (P = 0.05)	0.51	0.35	0.47	0.04	0.50	0.64	2.04	0.027
Sowing dates								
13th October	119.27	228.03	309.61	-	9.41	22.08	59.47	0.422
23rd October	118.77	228.34	310.01	-	9.96	26.33	64.59	0.545
3rd November	118.93	228.01	309.74	-	8.54	20.91	57.79	0.413
S.Em±	0.15	0.10	0.14	-	0.15	0.19	0.60	0.008
C.D. (P = 0.05)	NS	NS	NS	-	0.43	0.56	1.77	0.024

Table 2: Effect of varying date of sowing and weed management on yield attributes and yield

Treatments	No. of Siliquae plant^{-1}	No. of Seeds siliquae^{-1}	No. of Secondary branches plant^{-1}	Seed yield	Straw yield	Biological yield
Weed management						
Weed free	394.7	17.18	14.51	1298	5888	7185
Weedy check	370.5	12.04	12.24	784	4797	5581
Pendimethalin 30 EC @ 0.75 kg ha^{-1}+ Hand HW 30 DAS	382.6	15.44	13.46	1153	5079	6533
Pendimethalin 38.7 CS @ 0.75 kg ha^{-1} + Hand HW 30 DAS	386.9	16.08	13.95	1220	5549	6769
S.Em±	0.4	0.19	0.02	12	30.7	27
C.D. (P = 0.05)	1.14	0.56	0.07	36	90.0	79
Sowing dates						
13th October	382.3	14.87	13.40	1127	5302	6429
23rd October	389.4	15.67	13.83	1195	5531	6725
3rd November	379.3	15.01	13.39	1019	5152	6172
S.Em±	0.3	0.16	0.02	11	27	24
C.D. (P = 0.05)	1.0	0.48	0.06	31	78	69

Conclusion

Pre-emergence application of pendimethalin 38.7 CS @ 0.75 kg ha^{-1} + HW 30 DAS in mustard recorded seed yield of 1220 kg ha^{-1} which was higher than the seed yield recorded under pendimethalin 30 EC @ 0.75 kg ha^{-1} + HW 30 DAS (1153 kg ha^{-1}) treatment. Further, highest seed yield was observed under 23rd October (1195 kg ha^{-1}) sowing followed by 13th October and 3rd November sowing.

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