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Effect of different pre and post-emergent application of herbicides on the growth and yield of Indian mustard (*Brassica juncea* L.)

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Abstract
This study was carried out to evaluate the growth and yield of Indian mustard was influenced by application of different pre and post emergent herbicides at the research farm of School of Agricultural Sciences, GD Goenka University, Gurugram (Haryana) during *rabi* season of 2019-20. Seven treatments comprising weedy check, weed free check, Pendimethalin @ 1.0 kg ha^{-1} as pre-emergence (PE), Oxyfluorfen @ 0.15 kg ha^{-1} as pre-emergence, Quizalofop @ 0.06 kg ha^{-1} at 25-30 Days after Sowing (DAS), Isoproturon @ 1.0 kg ha^{-1} as pre-emergence and Isoproturon @ 1.0 kg ha^{-1} at 30 DAS were tested in randomized block design with three replications. Highest seed yield was noticed in weed free treatment with the value of 1957 kg ha^{-1}. Among the herbicidal treatments, Pendimethalin @ 1.0 kg ha^{-1} (PE) recorded maximum seed yield of 1742 kg ha^{-1} over other.

Keywords: Mustard, weed management, growth and yield

1. Introduction
In the agricultural economy of India, oilseeds are important next only to food grains in terms of acreage, production and value. Oilseeds constitute the second largest agricultural commodity in India after cereals accounting for nearly 6 per cent of gross national product and 10 per cent of the value of all agricultural products. India is the largest rapeseed-mustard growing country in the world occupying the first position in area and second position in production after China. Indian mustard (*Brassica juncea* L.) commonly known as raya, rai or laha is one of the most important oil seed crops of the country and it occupies considerably large acreage among the Brassica group of oil seed crops. It is the third important oilseed crop in the world after soybean and palm. The area, production and productivity of mustard in India is 5.96 million ha, 8.32 million tons and 1397 kg ha^{-1}, respectively (Anonymous, 2018). Indian mustard predominantly cultivated in Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh and Gujarat, also grown under some non- traditional areas of South India including Karnataka, Tamil Nadu and Andhra Pradesh. However, Indian mustard occupies the largest area in Uttar Pradesh (Awasthi *et al.* 2007) [2]. Yield losses due to crop weed competition in rapeseed and mustard have been estimated to the tune of 10-58% (Gill *et al.* 1989) or even beyond 23-70% depending upon the type of intensity and duration of competition (Chopra and Saini, 2007) [3]. Hence, there is need to remove weeds in the early stage of crop growth to avoid competition on the reserve moisture and also the critical period competition for mustard 20-40 Days After Sowing. It is well known that, weeds interfere with crop plant causing serious impacts either in the competition for light, water, nutrients and space or in the allelopathy. Weed competition in Indian mustard is more serious in early stage because, crop growth during *rabi* season remains slow during the first 4-6 weeks after sowing. However, in the later stage it grows vigorously and has suppressing effect on weeds. As the crop grown on poor soil with poor management practices, weed infestation one of the major causes of low productivity of the Indian mustard; weed alone causes 20-30% yield reduction which may go up to 62% (Singh, 1992) [6]. In order to achieve yield potential of mustard, timely weed management is very important. Manual weeding is common but, it expensive, labor-intensive and often not performed at critical stage due adverse soil and weather conditions. Further, the operation has to be repeated and the paucity of labor's particularly during peak period makes it further difficult. To reduce, the weed population intensive use of herbicides gaining popularity in recent years due to low cost, easy and timely application and its effectiveness against the weeds. By the use of new herbicides, we can judge the best herbicide for particular crop.

Material and Methods

The experiment was conducted during *rabi* season of 2019-2020 at Research farm of School of Agricultural Sciences, GD GOENKA University, Gurgaon, Haryana situated at 29° 10' N latitude and 75°46' E longitude at an elevation of 215.2 m above Mean Sea Level. A composite soil sample from four randomly selected spots in the field from 0-15 cm soil depth was prepared from the experimental area before sowing for the estimation of various major and minor nutrients. To examine the fertility status of experimental field, soil sample was air dried, sieved through 2 mm and subjected to further chemical analysis using standard procedures. Considering the nature of factors under study and the convenience of agricultural operation and efficiency, the experiment was laid out in Randomized Block Design (RBD) comprised of seven treatments (Table 1) combination along with three replications. A recommended dose of 80 kg N, 40 kg P_2O_5 and 40 kg K_2O ha^{-1} were supplied through urea, single super phosphate and muriate of potash, respectively. The half dose of nitrogen (40 kg) and full dose of phosphorus and potassium were applied as basal and the remaining half of nitrogen was top dressed after first irrigation (30 DAS).

The amount of the herbicide was calculated as per treatment on the basis of gross plot area. All herbicides were applied as solution in water of 600 liters ha^{-1} volume. The herbicide solutions were sprayed uniformly in the experimental plots as per treatment with the help of knapsack sprayer. Trifluralin was applied as pre plant incorporation uniformly on soil surface and mixed with the help of spade before sowing of seeds. Pendimethalin, Oxyfluorfen and Isoproturon were applied a day after sowing of the seed as pre-emergence herbicide. Quizalofop and Isoproturon were applied 30 DAS as post-emergence herbicide. For determining the significance between the treatment means and to draw valid conclusion, statistical analysis was made.

Data obtained from various observations were analysed as per the standard analysis of variance (ANOVA) procedure for randomized block design given by (Gomez and Gomez, 1984) [5].

Table 1: Treatment Details

Treatment. No	Treatment Details
T_1	Pendimethalin 1.0 kg ha^{-1} (pre-emergence)
T_2	Oxyflurofen 0.15 kg ha^{-1} (pre-emergence)
T_3	Quizalofop 0.06 kg ha^{-1} (25-30 DAS)
T_4	Isoproturon 1.0 kg ha^{-1} (pre-emergence)
T_5	Isoproturon 1.0 kg ha^{-1} (30 DAS)
T_6	Weedy check
T_7	Weed free

Results and Discussion

1. Plant height

The data pertaining to plant height (cm) as influenced by various treatments are presented in Table 2. In general, plant height increased with advancement of crop growth and was reached to maximum at harvest, irrespective of experimental variables. It evident from the table that, weed free treatment produced taller plant than all the herbicidal treatments. However, it remained at par to pendimethalin 1.0 kg ha^{-1} at 60, 90 DAS and at harvest but proved significantly superior over other herbicides.

Table 2: Plant height as influenced by herbicidal control of weeds in Indian mustard

Treatment	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At Harvest
Pendimethalin 1.0 kg ha^{-1} (P.E.)	28.07	87.17	170.98	172.00
Oxyfluorfen 0.15 kg ha^{-1} (P.E.)	27.31	85.54	168.64	170.40
Quizalofop 0.06 kg ha^{-1} (25-30 DAS)	24.08	81.40	163.93	166.67
Isoproturon 1.0 kg ha^{-1} (P.E.)	27.83	86.34	169.12	171.11
Isoproturon 1.0 kg ha^{-1} (30 DAS)	25.28	83.29	169.28	169.13
Weedy check	18.38	79.47	166.33	166.63
Weed free	30.35	89.46	173.33	175.35
S.Em (±)	0.63	1.03	1.03	1.13
CD (0.05)	1.90	3.08	3.10	3.38

2. Seed yield (kg ha^{-1})

The data pertaining to seed yield is presented in Table 3. Herbicidal weed control treatments influenced the seed yield significantly. The highest seed yield of 1957 kg ha^{-1} was recorded in weed free treatment and this treatment proved significantly superior to rest of the weed control treatments. However, all the herbicidal weed control treatments produced significantly more seed yield than weedy check which had the lowest yield of 1141 kg ha^{-1}.

Table 3: Yield as influenced by herbicidal control of weeds in Indian mustard

Treatment	Yield (kg ha^{-1})	
	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
Pendimethalin 1.0 kg ha^{-1} (P.E.)	1742	5739
Oxyfluorfen 0.15 kg ha^{-1} (P.E.)	1663	5650
Quizalofop 0.06 kg ha^{-1} (25-30 DAS)	1590	5438
Isoproturon 1.0 kg ha^{-1} (P.E.)	1704	5665
Isoproturon 1.0 kg ha^{-1} (30 DAS)	1614	5502
Weedy check	1141	4884
Weed free	1957	6038
S.Em (±)	63.42	161.57
CD	190.14	484.39

Conclusion

The highest seed and stover yield was recorded under weed free treatment. Weed free treatment, with regard to stover yield was statistically at par with pendimethalin 1 kg ha^{-1}, Oxyfluorfen 0.15 kg ha^{-1} and Isoproturon 1.0 kg ha^{-1} (pre-emergence) and all these treatments proved significantly superior to other weed control treatments.

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