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Effect of integrated weed management on growth and yield of Indian mustard (*Brassica juncea* L.)

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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 Integrated weed management on growth and yield of Indian mustard (*Brassica juncea* L.) The experiment was laid out in randomized block design with three replications and 9 treatments. The treatments considered of T_1: Control, T_2: Straw mulch, T_3: Polyethelene Mulch, T4: One hand weeding (40 DAS), T_5: Two hand weeding (30 and 45 DAS), T_6: Three hand weeding (30 DAS, 45 DAS and 60 DAS), T_7: Pendimethalin @ 1.5 kg/ha (pre-emergence) + One hand weeding (40 DAS), T_8: Pendimethalin @ 1.0 kg/ha (pre-emergence) + Two hand weeding (30&45 DAS and T_9: Pendimethalin @ 0.5 kg/ha (pre-emergence) + Isoproturon @ 1.0 kg/ha (45 DAS). Among the weed management treatments, the growth and yield parameters of Indian mustard *viz.* plant height, number of primary and secondary branches per plant, dry matter weight per plant, leaf area, number of siliqua per plant, number of seeds per siliqua, 1000 seed weight, seed weight per plant, seed yield and stover yield per hectare, biological yield, Oil content, protein content were recorded highest with treatment T6 - Three hand weeding (30 DAS, 45 DAS and 60 DAS), followed by T_9, T_3, T_2, T_7, T_5, T_8 and T_4.
Henceforth, on the basis of this study, it can be revealed that application of treatment T_6 Three hand weeding (30 DAS, 45 DAS and 60 DAS) give better yield advantage from mustard and it can be suggested to farmers for this region.

Keywords: Mulch, Pre-emergence, protein content and hand weeding

Introduction
According to Prain, Bailey, and Sinsky, Rai originated in China, and was spread to India from there. Together with India and Pakistan, China is the world's top producer of rapeseed and mustard. They produce nearly 90% of the world's entire output. Rapeseed and mustard, among the other oilseed crops grown in India, are important to the national economy since they rank second in terms of area and production behind groundnut. Among the various kinds of rapeseed and mustard grown in India, Indian mustard [*Brassica juncea* (L.) Czernj and Cosson] is the most popular. Rapeseed and mustard are the second most widely grown oilseeds in India, accounting for 28.6% of total oilseed production, after groundnut, which accounts for 27.8% of the country's oilseed economy.
Oilseeds are the India's second largest agricultural commodities after cereals and accounts 13% of the gross cropped area and nearly 5% of Gross National Product and 10% of the value of all agricultural commodities. (Prabhu, Uma Keni, 2020) [11].
The mustard-growing zones of India have a wide range of agro-climatic conditions, and various rapeseed and mustard species are grown in different parts of the country. Mustard is a very promising crop in India's many agro-climatic areas due to its broad resilience to severe climatic conditions and great yield potential. Mustard oil is utilised in a variety of applications, including cooking and industry. Cake, the by-product left after extracting the oil, is useful feed for cattle and can also be used as manure.
Brassica species' seed and oil have a distinct pungency. This is due to presence of glucocide sinigrin [C10H16O9NS2K]. The percentage of oil fluctuates between 37 and 49 percent. Oil cake includes 25-30% oil, 5% nitrogen, 1.8% P2O5, and 1.2% K2O. For cattle, green stems and leaves are a good supply of green feed. Young plant leaves are utilised as green vegetables because they provide sufficient sulphur and minerals in the diet. Mustard oil is used to soften leather in the tanning business.
The area and production of rapeseed and mustard in India has been rapidly increasing. India is the leading producer of rapeseed and mustard, both in terms of area and production in world.

The country had a yellow revolution, with rapeseed and mustard production and productivity sky rocketing from 2.68 mt and 650 kg per ha in 1985-1986 to 6.96 mt and 1022 kg per ha in 1996-1997. Rajasthan is the leading producer of rapeseed-mustard, with Uttar Pradesh, Haryana, Madhya Pradesh, West Bengal, Gujarat, and Assam following closely behind. Orrisa and Bihar are two other states with limited production.

Weeds should be kept out of rapeseed and mustard fields for the first 45-60 days, after which weed development is suppressed by the smothering effect. Weeds are responsible for 25-35 percent of crop loss. The most common Weeds found in mustard crops include *Chenopodium album*, *Lathyrus spp.*, *Anagallis arvensis*, *Cynodon dactylon*, *Argemone mexicana*, and others. Depending on the weed infestation, one weeding and hoeing in rainfed areas and two weedings and hoeings in irrigated areas is usually sufficient. Weed competition for moisture, light, nutrients, and space is one of the key impediments to crop growth and productivity, as weed competes with the crop for moisture, light, nutrients, and space. Furthermore, they raise production costs, harbour insects, pests, and plant disease organisms, lower agricultural produce quality, and lower land prices. Mechanical hoeing and hand weeding are the most common methods of weed control. Not only that, but during peak crop growth, labour is scarce and labour costs are high due to farm labourers moving to industries for better and more secure income. The use of herbicides has better resulted in weed control, reduces the cost of cultivation and has resulted in the revolution of many conventional practices.

Material and Method

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 9 treatments and 3 replications. The treatments consisted T: Control, T_2: Straw mulch, T_3: Polyethylene Mulch, T4: One hand weeding (40 DAS), T_5: Two hand weeding (30 and 45 DAS), T_6: Three hand weeding (30 DAS, 45 DAS and 60 DAS), T_7: Pendimethalin @ 1.5 kg/ha (pre-emergence) + One hand weeding (40 DAS), T_8 Pendimethalin @ 1.0 kg/ha (pre-emergence) + Two hand weeding (30&45 DAS and T_9: Pendimethalin @ 0.5 kg/ha (pre-emergence) + Isoproturon @ 1.0 kg/ha (45 DAS). The sowing of mustard, variety Varuna was done on 15th November, 2021 with a spacing of 30 cm x 10 and harvested on 2th 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 different integrated weed control practices on growth, yield and quality attributes of mustard

Effect on Growth Parameters

Three hand weeding (30 DAS, 45 DAS and 60 DAS) produced significantly higher plant height than the other weed management methods (174.66 cm). However, it was comparable to the treatments straw mulch (T_2) Polyethelety mulch (T_3), Pendimethalin @ 1.5 kg/ha (pre-emergence) + One hand weeding (40 DAS) T_7 (having plant height of 170.33, 169.467 and 169 respectively. Similar result was reported by Sah *et al*. (2013) [13] Significantly increased dry weight per plant (44. 81 g) was obtained by the application (T_6). Such type of result was reported by Bhoyal and Yaduraju (2002) Three hand weeding (30 DAS, 45 DAS and 60 DAS), resulted in a significantly higher number of primary branches per plant (9.66). However, it was comparable to other treatments, with the treatment (unweeded check) (T_1) having significantly fewer primary branches (6.33). Similarly, the number of secondary branches was also highest in T_6 and lowest in the unweeded check plot (control). The result are conformity with Chauhan *et al.* (2004) [6].

Effect on Yield Attributes

The treatment hand weeding (T_9) had the highest number of siliquae per plant (217.00), while the treatment unweeded check (T_1) had the lowest amount of siliquae (105.00). The data obtained are also good accordance with the data reported by Degra *et al.* 2011 [11] The treatment hand weeding (T_6) produced the longest siliquae (6.83cm), which was statistically comparable to the treatments Pendimethalin @ 0.5 kg/ha (pre-emergence) + Isoproturon @ 1.0 kg/ha (45 DAS) (T_9), Pendimethalin @ 1.5 kg/ha (pre-emergence) + One hand weeding (40 DAS), Straw Mulch (T2), Pendimethalin @ 1.5 kg/ha (pre-emergence) + One hand weeding (40 DAS) (having length of siliqua 6.73, 6.30and 6.23). The smallest length of siliquae was 4.30 cm in the treatment Control (T1). Similar result was recorded by Bhullar *et al*. (2012) [4]. Because of the numerous treatments used in this experiment, the number of seeds per siliqua varied greatly. The treatment three hand weeding (T_6) had the highest number of seeds per siliqua (13.00), whereas the treatment unweeded check (T1) had the lowest number of seeds per siliqua (7.66). The effects of different treatments on test weight were considerable. Under three hand weeding, the maximum test weight (4.46g) was recorded followed by T_3, T_8, T_9 and T_7. Weight for treatment T_1 (control) was 3.26 g. The diverse weed control methods used in this experiment had a substantial impact on the yield of Indian mustard. The three hand weeded (T_6) showed its superiority by yielding 52.40 q per ha, which was significantly higher than the other treatments. However, statistically, it was comparable to the remaining treatments. The diverse weed control methods used in this experiment had a substantial impact on the seed output of Indian mustard. The three hand weeded (T6) showed its superiority by seed yield 17.20 q ha, which was substantially greater. Similar result was reported by Prithivi raj *et al.* (2020) [12]. The treatment hand weeding (T6) demonstrated its superiority by recording a substantially greater biological yield of 69.43 q per ha, whereas the treatment T1 recorded the significantly lowest biological yield (26.50 q per ha) (Control). Different treatments used in this study had a substantial impact on harvest index. Hand weeding (T6) produced a significantly higher harvest index (33.69%), which was comparable to the other treatments. The harvest index for treatment T7 (unweeded check) was substantially lower (26.99%). This result is accordance with Barborial *et al.* (2017) [3].

Table 1: Effect of treatments on growth and yield and quality parameters

Treatments	Plant height (cm)	Dry matter per plant (g)	No. of primary branches	No. of secondary branches	No. of Siliqua per plant	Siliqua length (cm)	No. of seeds per siliqua	Test weight (g)	Seed yield (q per ha)	Stover yield (q per hs)	Biological yield (q per ha)	Harvest index (%)	Oil content	Protein Content (%)
T1	116.60	33.54	6.33	11.66	105.00	4.30	7.66	3.26	6.70	19.80	26.50	25. 28	34.367	14.003
T2	170.33	40.56	8.33	17.33	141.00	6.30	11.66	4.00	12.80	44.30	57.20	22.41	39.800	18.467
T3	169.46	41.45	7.66	21.00	199.33	5.93	12.00	4.36	12.90	48.20	61.10	21.11	40.667	20.533
T4	165.03	36.68	6.66	17.33	158.66	5.53	10.00	3.93	10.00	44.30	54.30	18.40	38.967	17.600
T5	167.70	37.48	6.66	18.66	173.33	5.23	10.33	4.03	10.93	45.00	55.93	19.23	39.067	19.600
T6	174.66	44.81	9.66	23.00	239.00	6.83	13.00	4.46	17.20	52.24	69.43	24.70	43.000	22.367
T7	169.83	41.93	7.33	19.00	179.00	6.23	11.33	4.03	13.66	42.50	56.16	24.33	39.433	20.733
T8	167.90	42.52	7.66	18.00	186.66	5.76	11.33	4.33	14.56	43.36	57.93	25.14	40.667	21.633
T9	167.90	43.52	7.33	20.33	217.00	6.73	10.66	4.06	15.96	49.93	65.90	24.23	41.900	20.500
S.Em	0.81	0.18	0.40	0.69	1.00	0.23	0.52	0.06	0.14	0.41	0.45	0.24	NS	1.432
CD at 5%	2.46	0.54	1.21	2.09	3.03	0.72	1.59	0.18	0.44	1.24	1.37	NS	0.390	0.474

Effect on Quality parameters

Quality parameters *viz.* Oil content and protein content were significantly influenced with the application of different treatments. The treatment with application of The three hand weeded (T_6) produced significantly maximum oil content (43.00%) followed by T_9, T_3, T_2, T_7, T_5, T_8 and T_4. These result are closely conformity with Kumar *et al.* 2012. Whereas minimum oil content was recorded in Control. When crop receiving three hand hoeing produced maximum protein content 22.36% followed by T_9, T_3, T_2, T_7, T_5, T_8 and T_4. Whereas minimum protein content (14.003%)b was found in control. Similar result was reported by Patel *et al*. (2013).

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