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Effect of integrated weed management on weed dynamics and performance of wheat (*Triticum aestivum* L.) + mustard (*Brassica juncea* L.) intercropping

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Abstract

A field experiment was undertaken during *Rabi* 2022-23 and 2023-24 at the Agricultural Research Farm of J.V. College, Baraut (Baghpat), Uttar Pradesh to evaluate the effect of integrated weed management practices on weed dynamics and productivity of wheat (*Triticum aestivum* L.) + mustard (*Brassica juncea* L.) intercropping system. The experiment was laid out in split plot design comprising two factors: main plot treatments included Sole Wheat (I_1), Sole Mustard (I_2), Wheat + Mustard (6:1) (I_3) and Wheat + Mustard (9:1) (I_4), while sub plot treatments consisted of Weed free (W_1), Two hand weeding at 30 & 45 DAS (W_2), Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE (W_3), Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding at 30 DAS (W_4) and Weedy check (W_5). The findings revealed that weed free & two hand weeding at 30 & 45 DAS (W_2) recorded maximum weed control efficiency at 45 DAS, 90 DAS and at harvest, followed by pendimethalin @ 1 kg ha^{-1} as PE + hand weeding 30 DAS (W_4), and both were significantly superior over remaining treatments during both years. Wheat sole gives the maximum grain yield of wheat, among cropping systems, Wheat + Mustard (9:1) (I_4) produced highest grain yield of wheat (4.65 & 4.82 t ha^{-1}) and minimum seed yield of mustard (4.1.0 &4.8 q ha^{-1}), which remained statistically at par with Wheat + Mustard (6:1) (I_3). Under weed management treatments, Next to weed free W_2 resulted in maximum grain yield of wheat (4.65 & 4.84 t ha^{-1}) and mustard (16.6 & 17.1 q ha^{-1}), closely followed by W_4 and W_5. The study indicated that two hand weeding at 30 - 45 DAS can be considered an efficient and practical weed management approach in wheat–mustard intercropping.

Key word: Intercropping systems, mustard, weed management, wheat, WCE

Wheat (*Triticum aestivum* L.) occupies a predominant position among cereal crops grown in India and contributes significantly to national food security. Although wheat production increased remarkably after the Green Revolution, the expansion led to reduced area under pulses and oilseed crops, resulting in shortage of edible oils. Therefore, increasing oilseed production without compromising wheat area has become essential. Rapeseed- mustard group of oilseed crops, namely, Indian mustard, oilseed rape, Indian rape, Taramira are often intercropped with wheat, chickpea, lentil, sugarcane, potato etc. under different agro- climatic zones of India (Sirivastava *et al.*, 2008).

Manual weeding, though effective, is laborious, expensive and often constrained by non-availability of labour during peak agricultural operations. Moreover, late-emerging weed flushes are not adequately controlled by hand weeding alone. Therefore, adoption of integrated weed management practices involving sequential ap-

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plication of pre- and post-emergence herbicides has gained importance.

Pendimethalin and clodinafop are being used successfully for control of these grassy weeds. However, continuous use of these herbicides may result in development of resistant biotypes (Chhokar and Malik, 2002).

Intercropping systems enhance resource utilization efficiency by exploiting differences in canopy structure, rooting pattern and nutrient requirements of component crops. Such systems can improve overall productivity and sustainability. Keeping these aspects in view, the present study was conducted to assess the impact of different integrated weed management strategies on weed dynamics and performance of wheat + mustard intercropping system.

Materials and Methods

The field investigation was carried out at the Agricultural Research Farm of Janta Vedic College, Baraut (Baghpat), during *Rabi* 2022-23 and 2023-24. The region receives an average annual rainfall of about 852 mm, with more than 80% occurring during July to September through southwest monsoon. During the crop growth period, the weekly mean maximum temperature ranged from 15.4°C to 37.6°C, while minimum temperature varied between 5.9°C and 20.7°C. Relative humidity during the season fluctuated between 31.3 and 77.5%. Prior to sowing, soil samples were collected from 0–15 cm depth at ten random points in the experimental field. The samples were thoroughly mixed to obtain a composite sample, air dried, sieved through 2 mm sieve and analyzed for physico-chemical properties. The soil was sandy loam in texture, slightly alkaline in reaction (pH 7.4) with bulk density of 1.49 g cm^{-3}. It was low in available nitrogen and organic carbon (0.42%) and medium in available phosphorus and potassium. The experiment was laid out in split plot design with three replications. Main plot treatments consisted of: I_1 – Sole Wheat I_2 – Sole Mustard I_3 – Wheat + Mustard (6:1) I_4 – Wheat + Mustard (9:1) Sub plot treatments included: W_1 – Weed free W_2 – Two hand weeding at 30 & 45 DAS W_3 – Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE W_4 – Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding at 30 DAS W_5 – Weedy check. Gross plot size was 7.2 × 5.0 m^2. Crops were sown maintaining 20 cm row spacing and 10 cm plant-to-plant distance. A basal dose of 100 kg ha^{-1} DAP was applied at the time of field preparation. Pre-sowing irrigation was given to ensure proper germination, and subsequent irrigations were applied as per crop requirement. Pendimethalin @ 1 kg ha^{-1} was applied within 24 hours of sowing as pre-emergence treatment, while Clodinafop 60 g ha^{-1} was sprayed at 25 DAS as post-emergence. Other recommended agronomic practices were followed uniformly. Weed observations were recorded using a 0.25 m^2 quadrat at 45 DAS, 90 DAS and at harvest. Weed density was counted species-wise and expressed as number m^{-2}. For dry matter estimation, weeds collected from quadrat area were sun dried followed by oven drying at 70°C for 72 hours and expressed as g m^{-2}. Data on weed density were subjected to square root ($\sqrt{x+1}$) transformation before statistical analysis. The data were analyzed using analysis of variance (ANOVA) for split plot design and treatment means were compared at P=0.05 level using appropriate CD values.

Results and Discussion

Influence of weedicides on weeds: The data present Table 1 density of total weeds was affected significantly by various treatments involving weed management practices. Among intercropping treatments, the highest total weed density (10.0 & 10.5, 8.8 & 9.3 and 8.4 & 8.9 m^{-2}) was found under Sole Mustard (I_2) treatment, at 45, 90 and at harvest during 2022-23 and 2023-24. Among integrated weed management treatments, the highest total weed density (12.8 & 13.5, 12.1 & 12.8 and 11.7 & 12.3 m^{-2}) was found under weedy check (W_5) treatment, at 45, 90 and at harvest during 2022-23 and 2023-24. Among intercropping treatments, the lowest total weed density was observed (8.5 & 9.0 m^{-2}) in the treatment of Wheat + Mustard (9:1) (I_4), at 45 DAS. At 90 and at harvest, the lowest total weed density (7.1 & 7.5 and 6.8 & 7.2 m^{-2}) was observed with the application of Wheat + Mustard (9:1) (I_4) followed by Wheat + Mustard (6:1) (I_3) at 90 and at harvest during both the years, respectively. Total weed dry weight (Table 2) was affected significantly by various treatments involving integrated weed management practices.

Among intercropping treatments, significantly the highest total weed dry weight (4.9 & 5.3, 8.0 & 8.5 and 8.5 & 9.0 g m^{-2}) was found in Sole Mustard (I_2). This was due to the fact that at later stage most of the weed growth ceased because of leaf senescence and thereby resulted in reduction in dry matter accumulation of weeds. Higher infestations of weeds under Sole Mustard were also reported by Sudha *et al.,* (2016). Among the herbicides at 45 DAS the total dry weight observed

Table 1. Density of total weeds (number per m^2) as influenced by different cropping system and integrated weed management

Treatment		Total weeds density (Number per m^{-2})					
		45 DAS		90 DAS		At harvest	
		2022-23	2023-24	2022-23	2023-24	2022-23	2023-24
Intercropping (Main Plot)							
Sole wheat	I_1	9.4(89.1)	10.0(99.0)	8.3(68.1)	8.7(75.5)	7.9(61.9)	8.3(68.6)
Sole mustard	I_2	10.0(100.1)	10.5(111.3)	8.8(78.0)	9.3(86.4)	8.4(70.6)	8.9(78.3)
Wheat + mustard (6:1)	I_3	9.1(82.3)	9.6(91.6)	7.7(59.3)	8.1(65.6)	7.4(54.7)	7.8(60.7)
Wheat + mustard (9:1)	I_4	8.5(72.6)	9.0(80.5)	7.1(50.6)	7.5(55.6)	6.8(46.5)	7.2(51.3)
SEm(±)		0.24	0.25	0.22	0.23	0.20	0.21
C.D. (P=0.05)		0.72	0.75	0.65	0.68	0.60	0.63
Integrated weed management (Sub-Plot)							
Weed free	W_1	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)
Two hand weeding 30 & 45 DAS	W_2	5.0(24.9)	5.5(29.7)	4.7(21.6)	4.9(23.1)	4.3(18.0)	4.3(17.5)
Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE	W_3	11.8(138.5)	12.3(152.5)	9.2(84.1)	9.7(94.1)	8.5(72.9)	9.0(81.0)
Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS	W_4	10.4(108.4)	10.9(118.6)	6.7(44.1)	7.0(48.6)	6.2(37.4)	6.6(43.2)
Weedy check	W_5	12.8(164.0)	13.5(181.9)	12.1(147.2)	12.8(162.9)	11.7(137.6)	12.3(152.4)
SEm(±)		0.25	0.27	0.24	0.26	0.22	0.24
C.D. (P=0.05)		0.74	0.83	0.71	0.76	0.64	0.70

Original values is parentheses and data subjected to square root (√x+1) transformation

Table 2. Total weeds dry matter accumulation (g m^{-2}) as influenced by different cropping system and integrated weed management

Treatment		Total dry weight of weeds (g m^{-2})					
		45 DAS		90 DAS		At harvest	
		2022-23	2023-24	2022-23	2023-24	2022-23	2023-24
Intercropping (Main Plot)							
Sole wheat	I_1	4.7(21.5)	5.1(25.6)	7.8(60.5)	8.2(67.8)	8.3(69.3)	8.7(76.4)
Sole mustard	I_2	4.9(23.2)	5.3(27.2)	8.0(64.0)	8.5(71.7)	8.5(72.8)	9.0(81.1)
Wheat + mustard (6:1)	I_3	4.6(20.6)	5.0(24.3)	7.5(56.2)	7.9(62.9)	8.0(63.8)	8.4(70.7)
Wheat + mustard (9:1)	I_4	4.5(19.8)	4.8(22.9)	7.1(49.6)	7.5(55.4)	7.5(55.5)	7.8(61.1)
SEm(±)		0.24	0.25	0.22	0.23	0.20	0.21
CD (P=0.05)		0.72	0.75	0.65	0.68	0.60	0.63
Integrated weed management (Sub-Plot)							
Weed free	W_1	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)
Two hand weeding 30 & 45 DAS	W_2	3.3(10.3)	3.5(11.5)	3.7(13.0)	3.9(14.8)	4.0(15.7)	4.3(17.8)
Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE	W_3	5.9(34.5)	6.4(40.5)	7.7(59.8)	8.2(66.9)	8.2(66.8)	8.7(74.9)
Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS	W_4	5.4(28.5)	5.9(34.5)	7.3(52.7)	7.7(58.7)	7.6(58.1)	8.1(65.0)
Weedy check	W_5	6.0(35.5)	6.5(41.4)	11.3(128.1)	11.9(142.5)	11.9(142.8)	12.7(160.5)
SEm(±)		0.25	0.27	0.24	0.26	0.22	0.24
C.D. (P=0.05)		0.74	0.83	0.71	0.76	0.64	0.70

Original values is parentheses and data subjected to square root (√x+1) transformation

(5.4 & 5.9 g m^{-2}) was lowest with the application of Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS (W_4) than rest of the treatments. At 90 DAS total dry weight observed (7.3 & 7.7 g m^{-2}) was significantly lowest with the application of Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS (W_4), which was statistically at par with Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE (W_3). Significantly lower total dry weight at harvest (7.6 & 8.1 g m^{-2}) observed with the application of Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS (W_4), which was statistically at par with Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE (W_3) and significantly lower than the remaining treatments during both year.

*Weed control efficiency (WCE):*Weed control efficiency data presented in Table 3 was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments significantly the highest weed control efficiency (100.0%) was found in weed free at 45, 90 and at harvest, respectively. Among the herbicides highest weed control efficiency (19.7 & 16.7%), (58.9 & 58.8%) and (59.3 & 59.5%) with the application of Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS (W_4) followed by Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE (W_3) (2.8 & 2.2%, 53.3 & 53.1 & 53.2 & 53.3%) at 90 and at harvest during 2022-23 and 2023-24. This result is in corroboration with the findings of Pandey *et al*. (2007).

Influence on Wheat yield: Grain yield of wheat was affected significantly by various treatments involving weed management practices. Among intercropping treatments, the lowest grain yield (4.38 & 4.49 t ha^{-1}) was found in Wheat + Mustard (6:1)(I_3). The highest grain yield (4.72 & 4.96 t ha^{-1}) was found in Sole Wheat (I_1), which was at par with Wheat + Mustard (9:1) (I_4) treatment during both the years. Among the herbicide treatments the significantly highest grain yield (4.42 & 4.57 t ha^{-1}) was recorded with the application of Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS (W_4), which was statistically at par with Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE (W_3) treatment during both the years. Straw yield of wheat was affected significantly by various treatments involving integrated weed management practices. Among intercropping treatments, the lowest straw yield (5.93 & 6.08 t ha^{-1}) found in Wheat + Mustard (6:1)(I_3). The highest straw yield (6.36 & 6.53 t ha^{-1}) was found in Sole Wheat (I_1). Among the herbicide treatments the highest straw yield (5.97 & 6.12 t ha^{-1}) was recorded with the application of Pendimethalin @ 1

Table 3. Weed control efficiency at 45, 90 DAS and at harvest as influenced by different cropping system and integrated weed management

Treatment		Weed control efficiency					
		45 DAS		90 DAS		At harvest	
		2022-23	2023-24	2022-23	2023-24	2022-23	2023-24
Intercropping (Main Plot)							
Sole wheat	I_1	-	-	-	-	-	-
Sole mustard	I_2	-	-	-	-	-	-
Wheat + mustard (6:1)	I_3	-	-	-	-	-	-
Wheat + mustard (9:1)	I_4	-	-	-	-	-	-
SEm(±)		-	-	-	-	-	-
C.D. (P=0.05)		-	-	-	-	-	-
Integrated weed management (Sub-Plot)							
Weed free	W_1	100.0	100.0	100.0	100.0	100.0	100.0
Two hand weeding 30 & 45 DAS	W_2	71.0	72.2	89.9	89.6	89.0	88.9
Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE	W_3	2.8	2.2	53.3	53.1	53.2	53.3
Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS	W_4	19.7	16.7	58.9	58.8	59.3	59.5
Weedy check	W_5	0.0	0.0	0.0	0.0	0.0	0.0
SEm(±)		-	-	-	-	-	-
C.D. (P=0.05)		-	-	-	-	-	-

kg ha^{-1} as PE + Hand weeding 30 DAS (W_4), which was at par with Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE (W_3) during both the years. Harvest index was non-significantly affected by various treatments involving integrated weed management practices. Among intercropping treatments, the lowest harvest index (42.48 & 42.47%) was found in Wheat + Mustard (6:1)(I_3), while the highest harvest index (42.57 & 43.14%) in Sole Wheat (I_1). Among the herbicides the highest harvest index (42.53 & 42.77%) recorded with the application of Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS (W_4) than rest of the treatments. Lowest harvest index (39.1 and 39.5%) was recorded in weedy check treatment. Similar findings were reported by Chavda *et al.* (2021).

***Influence on Mustard yield*:** The data presented Table 7 seed, stover and biological yield and harvest index of mustard. Seed yield of mustard was affected significantly by various treatments involving weed management practices. Among intercropping treatments, the lowest seed yield (4.1 & 4.8 q ha^{-1}) was found in Wheat + Mustard (9:1)(I_4). The highest seed yield (17.0 & 17.3 q ha^{-1}) was found in Sole Mustard (I_2), followed by Wheat + Mustard (6:1) (I_3) treatment during both the years. Among the herbicides the significantly highest seed yield (14.9 & 15.4 q ha^{-1}) was recorded with the application of Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS (W_4), which was statistically at par with Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE (W_3) treatment during both the years. Stover yield of mustard was affected significantly by various treatments involving integrated weed management practices. Among intercropping treatments, the lowest stover yield (24.5&26.7 q ha^{-1}) found in Wheat + Mustard (9:1)(I_4). The highest stover yield (73.8 & 75.2 q ha^{-1}) was found in Sole Mustard (I_2). Similar findings were reported by Kumar *et al.*, (2021). Among the herbicides, the highest stover yield (68.4 & 70.2 q ha^{-1}) was recorded with the application of Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS (W_4), which was at par with Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE (W_3) during both the years. Biological yield of mustard was affected significantly by various treatments involving integrated weed management practices. Among intercropping treatments, the lowest biological yield (28.6&31.5 q ha^{-1}) found in Wheat + Mustard (9:1)(I_4). The highest biological yield (90.8 & 92.5 q ha^{-1}) was found in Sole Mustard (I_2). Among the herbicides, the highest biological yield (83.3 & 85.6 q ha^{-1}) was recorded with the application of Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS (W_4),

Table 4. Effect of cropping system and integrated weed management on grains, straw, biological yield (t ha^{-1}) and harvest index (%) of wheat

Treatments		Yield (t ha^{-1})				Harvest index (%)	
		Grain		Straw			
		2022-23	2023-24	2022-23	2023-24	2022-23	2023-24
Intercropping (Main Plot)							
1. Sole wheat	I_1	4.72	4.96	6.36	6.53	42.57	43.14
2. Sole mustard	I_2	-	-	-	-	-	-
4. Wheat + mustard (6:1)	I_3	4.38	4.49	5.93	6.08	42.48	42.47
4. Wheat + mustard (9:1)	I_4	4.65	4.82	6.25	6.41	42.50	42.92
SEm(±)		**0.37**	**0.39**	**0.45**	**0.47**	**0.497**	**0.610**
C.D. (P=0.05)		1.10	1.15	1.30	1.40	NS	NS
Integrated weed management (Sub-Plot)							
1. Weed free	W_1	5.01	5.27	6.63	6.89	43.03	43.35
2. Two hand weeding 30 & 45 DAS	W_2	4.65	4.84	6.24	6.45	42.72	42.87
3. Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE	W_3	4.11	4.23	5.66	5.74	42.07	42.41
4. Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS	W_4	4.42	4.57	5.97	6.12	42.53	42.77
5. Weedy check	W_5	1.88	1.96	2.94	3.02	39.01	39.35
SEm(±)		**0.45**	**0.48**	**0.52**	**0.56**	**0.608**	**0.750**
C.D. (P=0.05)		**1.32**	**1.42**	**1.54**	**1.65**	**NS**	**NS**

Table 5. Effect of cropping system and integrated weed management on seed, stover and biological yield (q ha^{-1}) and harvest index of mustard

Treatments		Yield (q ha^{-1})				Harvest			
		Seed yield		Stover yield		Biological yield		index (%)	
		2022-23	2023-24	2022-23	2023-24	2022-23	2023-24	2022-23	2023-24
Intercropping (Main Plot)									
1. Sole wheat	I_1	-	-	-	-	-	-	-	-
2. Sole mustard	I_2	17.0	17.3	73.8	75.2	90.8	92.5	18.67	18.74
4. Wheat + mustard (6:1)	I_3	6.2	6.9	28.5	30.8	34.7	37.7	17.86	18.30
4. Wheat + mustard (9:1)	I_4	4.1	4.8	24.5	26.7	28.6	31.5	14.33	15.23
SEm(±)		0.32	0.35	1.20	1.26	1.90	1.97	0.007	0.008
C.D. (P=0.05)		0.95	1.02	3.54	3.75	5.65	5.87	0.021	0.024
Integrated weed management (Sub-Plot)									
1. Weed free	W_1	19.4	20.1	82.9	85.4	102.3	105.5	18.98	19.05
2. Two hand weeding 30 & 45 DAS	W_2	16.6	17.1	71.7	74.7	88.4	91.7	18.83	18.62
3. Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE	W_3	14.3	14.7	64.0	65.6	78.3	80.3	18.14	18.22
4. Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS	W_4	14.9	15.4	68.4	70.2	83.3	85.6	18.29	18.25
5. Weedy check	W_5	10.2	11.6	50.3	52.4	60.5	64.0	16.85	18.10
SEm(±)		0.42	0.46	1.80	1.95	2.20	2.31	0.018	0.022
C.D. (P=0.05)		1.24	1.36	5.38	5.82	6.56	6.90	0.052	0.062

which was at par with Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE (W_3) during both the years. Harvest index was significantly affected by various treatments involving integrated weed management practices. Among intercropping treatments, the lowest harvest index (14.33&15.23%) was found in Wheat + Mustard (9:1)(I_4), while the highest harvest index (18.67 & 18.74%) in Sole Mustard (9:1) (I_2). Among the herbicides the highest harvest index (18.29 & 18.25%) recorded with the application of Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding 30 DAS (W_4) than rest of the treatments. Lowest harvest index (17.92 and 18.01%) was recorded in weedy check treatment. Similar findings were reported by Punia and Dharambir (2019).

It can be concluded that on the basis of the experimental findings the intercropping systems Sole Wheat recorded maximum grain yield of wheat and Sole Mustard seed yield of mustard in both the year of the experiment and weed management treatments were effective in suppressing weed growth in wheat and mustard resulted in significantly higher grain and seed yield compared to the weedy check. However, the magnitude of effectiveness varied among treatments. Among the different weed management measures, maintaining the crop under weed free condition and two hand weeding 30 & 45 DAS proved to be the most efficient practice and it recorded the highest weed control efficiency throughout the crop growth period. This treatment also resulted in superior yield performance of both wheat and mustard. The next best treatment was Pendimethalin @ 1 kg ha^{-1} as PE + Hand weeding at 30 DAS, which provided effective early-season weed suppression followed by removal of later emerging weeds. This integrated approach produced maximum grain yield of wheat as well as seed yield of mustard, remaining statistically comparable with the weed free treatments. Pendimethalin @ 1 kg ha^{-1} as PE + Clodinafop 60 g ha^{-1} as PoE also showed satisfactory weed control and yield improvement over weedy check, indicating the usefulness of sequential application of pre- and post-emergence herbicides in managing mixed weed flora.

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