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INTEGRATED WEED MANAGEMENT IN MUSTARD [(*BRASSICA JUNCEA* L. (CZERN AND COSS)] UNDER NORTH GUJARAT CONDITION

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ABSTRACT

A field experiment was conducted during the *Rabi* season of 2024–25 at the Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, to evaluate the effectiveness of "Integrated weed management in mustard [*Brassica juncea* L. (Czern and Coss)] Under North condition" on loamy sand soil. The experiment followed a Randomized Block Design with three replications and nine treatments. Mustard variety GM-6 was sown with a row spacing of 45 cm distance. The predominant weed flora observed in the experimental field were *Portulaca oleracea* L., *Boerhavia diffusa* L., *Tribulus terrestris* L., *Argemone mexicana* L., *Parthenium hystophorus* L. and *Amaranthus viridis* L. among broad leave weeds and *Cynodon dactylon* L., *Digitaria sanguinalis* L., *Dactyloctenium aegyptium* L. and *Cyperus rotundus* L., among narrow leave weeds. Besides weed free treatment, application of pendimethalin (PE) @ 383.5 g/ha *fb* inter culturing at 30 DAS significantly reduced weed density and weed dry weight of both broad and narrow leave weeds along with higher weed control efficiency, which was at par with pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS or pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) at 30 DAS. Based on the findings, it may be concluded that application of pendimethalin at 383.5 g/ha in combination with one cultural operation (either hand weeding or interculturing) or a timely post-emergence herbicide application can effectively manage weeds and improve yield in mustard under North Gujarat conditions. This integrated approach is recommended for adoption by farmers in the region.

Keywords **:** Density of weed, dry weight, hand weeding, interculturing, mustard, pendimethalin, quizalofop-p-ethyl

Introduction

In India, oilseeds rank second in importance among agricultural products, after grains state that, it makes up around 10% of the total value of agricultural goods and 5%.) of the gross national output Rai *et al*. (2014). The *Brassica* group includes Indian mustard, sometimes referred to as *rai* or *laha*, which is cultivated in a variety of Agro-climatic settings. *Brassica juncea* L. (Czern and Coss)] is the name of botanical mustard (2n=36). "China, India, and the Middle East" is the origin centre. Climates that are generally moderate are ideal for growing mustard. Additionally, it is grown as a cold-weather crop in some tropical and subtropical locations. In Indian mustard, the oil content ranges from 30 to 45.7%. The other significant producers are Gujarat, Madhya

Pradesh, Haryana, West Bengal and Assam. Productivity has improved significantly in India over the last ten years and the production of 2022-23 was 126.96 lakh tone (Anonymous, 2024[a]). Currently the area, production and productivity of rapeseed-mustard in Gujarat was 2.67 lakh ha, 5.35 lakh tonnes and 1999 kg/ha, respectively (Anonymous, 2024[b]). In Gujarat state mustard growing districts are Kachchh, Sabarkantha, Banaskantha, Ahmedabad, Mehsana and Patan. Weed infestation is the primary biotic factor causing reduced mustard productivity among a number of biotic and abiotic factors. Due to competition for nutrients, light, and space, weeds are thought to be one of the main causes of crop output loss; yield losses have been reported to be as high as 30-70% they caused a several problems in mustard fields, so they should be kept out of the field for the first 30-45 days after sowing. (Singh and Kumar 2020). The most common weeds found in mustard field *Argemone mexicana* L., *Boerhavia diffusa* L., *Cynodon dactylon* L., *Dactyloctenium aegyptium L., Digitaria sanguinalis*L., *Amaranthus spinasis* L. and *Tribulus terrestris* L. and others. One of the main factors preventing crops from growing and producing is weed competition for scarce resources, such as moisture, light, nutrients, and space. In addition, they increase the expense of cultivation, harbour pest, insect, and plant illnesses, and reduce land prices, production, and quality. Applying herbicides with one-time interculturing or hand weeding has better results in weed control and will have decreased cultivation costs. The most popular methods for controlling weeds are hand weeding and interculturing two to three times, which require labour that is readily available but will increase cultivation costs.

Materials and Methods

The field experiment was conducted during the *Rabi* season of 2024-25 to investigation "Integrate weed management in mustard [*Brassica juncea* L. (Czern and Coss) Under North Gujarat]" at the Agronomy Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar, in plot No. 7 of Block-A. Geographically, Sardarkrushinagar is situated at 24°19' North latitude and 72° 19' East longitude with an elevation of 154.52 meters above the mean sea level in the North Gujarat Agro-climatic region (AES IV) of Gujarat. on loamy sand soil which having pH 7.30, low in organic carbon (0.27%) and available nitrogen (166.5 kg/ha), while medium in available phosphorus (36.85 kg/ha) and potassium (242.20 kg/ha). Total nine treatments were tried in randomized block design with three replications. The treatment given in Table 1.

Table 1 : Treatment details

T_1	Pendimethalin (PE) @ 383.5 g/ha
T_2	Pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS
T_3	Pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS
T_4	Pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS
T_5	Pendimethalin (PE) @ 383.5 g/ha + Mustard straw mulch @ 7.5 t/ha at 20 DAS
T_6	Mustard straw mulch @ 7.5 t/ha at 20 DAS
T_7	Interculturing and hand weeding at 30 DAS and 45 DAS
T_8	Weed free (up to 60 DAS)
T_9	Weedy check

Pendimethalin and quizalofop-p-ethyl, two liquid herbicide formulations, were measured using a measuring cylinder. Hand weeding was done by hand laborers, interculturing were done by a mini tractor, and mulching was done by hand labour. The spraying was done using a backpack sprayer with a flat fan nozzle and 500 litre of water per hectare. In the ring area of plots, the broad leave, grasses, and sedge weeds were removed from a 0.25 m^2 (50 cm × 50 cm) area. For optimal germination, the first irrigation was applied right away after seeding. Ten days later, a second, light irrigation was applied to improve seedling establishment. The final three irrigations were each applied at the proper interval.

Methodology of studied parameters

Weed Studies

Weed density (no. /m^2)

The monocot and dicot weeds density were recorded randomly at 30, 45 DAS and at harvest from each plot outside the net plot leaving border area using 50 cm × 50 cm quadrate (0.25 m^2/plot). Further, the data was multiplied with four to convert the data into No./m^2. Since the weed density data does not follow normal distribution, the weed density data were subjecting to $\sqrt{x+0.5}$ transformations before analysis

Weed dry weight (g/m^2)

After recording density of weeds at 30, 45 DAS and at harvest using 50 cm × 50 cm quadrate (0.25 m^2/plot) the same weeds samples were sun dried for estimating the dry weight of total weeds and expressed in g/m^2. Further, the data was multiplied with four to convert the data into g/m^2. Since the weed dry weight data does not follow normal distribution, the weed dry weight data were analyzed after subjecting to $\sqrt{x+0.5}$ transformation.

Weed control efficiency (%)

The weed control efficiency at harvest was calculated by using the following formula (Kondap and Upadhyay, 1985).

$$WCE(\%) = \frac{DWC - DWT}{DWC} \times 100$$

Where,

WCE = Weed Control Efficiency

DWC = Dry weight of weeds in unweeded plot *i.e.*, control plot

DWT = Dry weight of weeds in treated plot

Weed index (%)

Weed index at harvest was worked out on the basis of formula suggested by (Gill and Kumar, 1969).

$$WI(\%) = \frac{X - Y}{X} \times 100$$

Where,

X = Seed yield from the weed free plot

Y = Seed yield from the treated plot for which WI is to be worked out

Crop Studies

Number of siliquae per plant

The siliquae of five randomly tagged plants were counted from each net plot at the time of harvest and average number of siliquae per plant was calculated.

Seed yield (Kg/ha)

The produce from each net plot was threshed separately. After threshing and winnowing, seeds were weighed separately and recorded as seed yield in kilogram per net plot which was converted into hectare and expressed as kg/ha.

Stover yield (Kg/ha)

The weight of fully sun-dried crop plants from each net plot was measured before threshing. After threshing, quantity of seed produced from each net plot was deducted from total weight of plant and recorded as stover yield which was converted into hectare and expressed as kg/ha.

Statistical analysis

Since the data related to weeds were not normally distributed, therefore data were transformed by using the $\sqrt{x+0.5}$ transformations as suggested by Gomez and Gomez (1984). The transformed data were analyzed statistically.

Results and Discussion

Weed studies

Table no.3 showing overall, the field was dominated with broad leave weeds followed by narrow leave and sedges. The emergence of different weeds was attributed to major weed flora of that particular region, weed seed bank, soil type, tillage intensity; previous crops/cropping system, weather parameters and congeniality of soil environment.

Table 3: Predominate weed flora observed in the experimental field

Sr. No	English name	Botanical name	Local name	Family
A	**Narrow leave weeds**			
1	Bermuda grass	*Cynodon dactylon* L.	Dharo	Poaceae
2	Duck grass	*Dactyloctenium aegyptium L*	Tarakiyu	Poaceae
3	Crab grass	*Digitaria sanguinalis* L.	Aarotaro	Poaceae
B	**Broad leave weeds**			
1	Roadside itschit	*Boerhavia diffusa* L.	Hong weed	Nyctaginaceae
2	Maxican prickle poppy	*Argemone mexicana L.*	Satyanasi	Papaveraceae
3	Pig weed	*Amaranthus spinasis*L.	Kantelichauli	Amaranthaceae
4	Benghal day flower	*Pathenium hystophorus* L.	Carrot weed	Astaraceae
5	Puncture vine	*Tribulus terrestris* L.	Gokhru	Zygophyllaceae
6	Indian purslane	*Portulaca oleracea* L.	Luni	Portulacaceae
C	**Sedges weeds**			
1	Purple nut Sedge	*Cyperus rotundus* L.	Motha	Cyperaceae

Effect on weed density (no./m^2)

The predominant weeds were noticed in the experimental field were *Cynodon dactylon* L., *Digitaria sanguinalis* L., *Dactyloctenium aegyptium* L. and *Cyperus rotundus* L., among narrow leave weeds and *Portulaca oleracea* L., *Boerhavia diffusa* L., *Tribulus terrestris* L., *Argemone mexicana* L., *Parthenium hystophorus* L. and *Amaranthus viridis* L. among broad leave weeds. At each stage (30, 45 DAS, and at harvest), the dominant species were *Cynodon*

dactylon L., *Digitaria sanguinalis* L., *Dactyloctenium aegyptium* L. and *Cyperus rotundus* L., among narrow leave weeds and *Portulaca oleracea* L., *Boerhavia diffusa* L., *Tribulus terrestris* L., *Argemone mexicana* L., *Parthenium hystophorus* L. and *Amaranthus viridis* L. among broad leave weeds. In weed free treatment significantly lowest weed density was observed, the evaluation and analysis of data concerning weed density revealed a consistent trend, mirroring that of weed density at 30 DAS. Among different weed control treatments, weed free treatment recorded significantly lower density of sedges, grasses, broad leaf and total weeds. After weed free the significantly lower broad leave and grasses weed density was observed under pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS, which was statistically at par with pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS and pendimethalin (PE) @ 383.5 g/ha *fb*quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS. The significantly minimum density of sedges and total weed density was found under pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS, which was statistically at par with pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS, pendimethalin (PE) @ 383.5 g/ha and pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS. The minimum weeds density in these treatments was due to pre-emergence, post-emergence herbicides application, adoption of interculturing and hand weeding. Wherein, significantly higher weed density sedges, grasses, broad leave, and total weeds were observed under the weedy check condition. At 45 DAS significantly lower density of broad leave was observed under pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS, which was statistically at par with application of pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS, pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS, interculturing and hand weeding at 30 DAS and 45 DAS and pendimethalin (PE) @ 383.5 g/ha. Significantly lower weed density of grasses was recorded under pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS which was statistically at par with pendimethalin (PE) @ 383.5 g/ha + Mustard straw mulch @ 7.5 t/ha at 20 DAS, pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS, pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS, interculturing and hand weeding at 30 DAS and 45 DASand pendimethalin (PE) @ 383.5 g/ha, significantly lower sedges density was recorded under pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS, which was statistically at par with pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS, and significantly lower total weeds was recorded under pendimethalin(PE) @ 383.5 g/ha *fb* interculturing at 30 DAS, which was statistically at par with pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS, pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS and interculturing and hand weeding at 30 DAS and 45 DAS. Under weed free treatment significantly lower weed density was reported at 40 DAS and at harvest due to complete control of weeds at these stages, Similar observations have also been reported by Jangir *et al*. (2017), Gupta *et al.* (2018) and Pandey *et al.* (2019).Weed density at harvest lower weeds density of broad leave and grasses was observed under pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS,which was at par withapplication of pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS. Significantly lower density of sedges and total weeds density was recorded under pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS, which was at par with pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS, pendimethalin (PE) @ 383.5 g/ha *fb*quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS and pendimethalin (PE) @ 383.5 g/ha + Mustard straw mulch @ 7.5 t/ha at 20 DAS. The similar findings were also supported by Kumar *et al*. (2020) and Raj *et al.* (2020).

Table 4: Effect of different weed control treatments on periodical weed density in mustard

Treatments	Weed density at 30 DAS (no./m^2)				Weed density at 45 DAS (no./m^2)				Weed density at harvest(no./m^2)			
	BLW	Grasses	Sedges	Total	BLW	Grasses	Sedges	Total	BLW	Grasses	Sedges	Total
T_1	5.46 (29.33)	3.53 (12.00)	3.33 (10.67)	7.21 (52.00)	3.61 (12.67)	4.37 (18.67)	2.96 (8.33)	6.34 (39.67)	3.34 (10.67)	3.44 (11.33)	3.61 (12.67)	5.92 (34.67)
T_2	5.20 (26.67)	3.80 (14.00)	3.53 (12.00)	7.29 (52.67)	3.33 (10.67)	4.22 (17.33)	2.55 (6.00)	5.87 (34.00)	3.02 (8.67)	2.39 (5.33)	3.13 (9.33)	4.88 (23.33)
T_3	5.14 (26.00)	3.63 (12.67)	3.33 (10.67)	7.05 (49.33)	3.34 (10.67)	4.04 (16.00)	2.04 (3.67)	5.55 (30.33)	2.39 (5.33)	2.26 (4.67)	3.01 (8.67)	4.37 (18.67)
T_4	4.59 (20.67)	3.23 (10.00)	3.06 (9.33)	6.30 (40.00)	2.90 (8.00)	4.29 (18.00)	2.20 (4.33)	5.55 (30.33)	2.39 (5.33)	1.90 (3.33)	2.79 (7.33)	4.06 (16.00)
T_5	5.70 (32.00)	4.21 (17.33)	3.89 (14.67)	8.03 (64.00)	3.96 (15.33)	4.21 (17.33)	2.64 (6.67)	6.28 (39.33)	3.13 (9.33)	2.90 (8.00)	3.23 (10.00)	5.27 (27.33)
T_6	6.87 (46.67)	5.02 (24.67)	4.30 (18.00)	9.47 (89.33)	3.89 (14.67)	4.60 (20.67)	3.01 (8.67)	6.67 (44.00)	3.43 (11.33)	3.53 (12.00)	3.87 (14.67)	6.20 (38.00)

T_7	6.58 (43.33)	4.74 (22.00)	4.19 (17.33)	9.10 (82.67)	3.39 (11.33)	4.30 (18.00)	2.90 (8.00)	6.14 (37.33)	3.24 (10.00)	3.34 (10.67)	3.53 (12.00)	5.76 (32.67)
T_8	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_9	6.90 (47.33)	5.58 (30.67)	4.38 (18.67)	9.85 (96.67)	5.13 (26.00)	7.74 (22.00)	3.13 (9.33)	7.60 (57.33)	3.72 (13.33)	4.06 (16.00)	4.14 (16.67)	6.82 (46.00)
S. Em.±	0.25	0.14	0.23	0.28	0.24	0.18	0.16	0.21	0.13	0.15	0.18	0.15
CD at 5 %	0.75	0.42	0.71	0.86	0.72	0.53	0.50	0.64	0.40	0.47	0.56	0.46
C. V. %	8.3	6.4	12.1	6.9	12.4	7.9	11.8	6.7	8.2	10.1	10.4	5.5

Note: Square root transformation (√x+0.5) was applied (original values which are given in the parenthesis)

T_1: Pendimethalin (PE) @ 383.5 g/ha, T_2: Pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS, T_3: Pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS,T_4: Pendimethalin (PE @) 383.5 g/ha *fb* interculturing at 30 DAS, T5: Pendimethalin (PE) @ 383.5 g/ha + Mustard straw mulch @ 7.5 t/ha at 20 DAS, T_6: Mustard straw mulch @ 7.5 t/ha at 20 DAS, T_7: Interculturing and hand weeding at 30 DAS and 45 DAS, T_8: Weed free (up to 60 DAS), T_9: Weedy check.

Effect on weed dry weight (g/m^{2}and kg/ha)

The evaluation and analysis of data concerning weed dry weight revealed a consistent trend, mirroring that of weed dry weight at 30 DAS in weed free treatment significantly lowest weed dry weight was observed, besides weed free significantly minimum total weed dry weight at 30 DAS was observed under pendimethalin (PE) @ 383.5 g/ha, which was statistically at par with pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS, pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS, pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS and pendimethalin (PE) @ 383.5 g/ha + Mustard straw mulch @ 7.5 t/ha at 20 DAS. In case of 45 Day after sowing after weed free treatment, the significantly lower total weed dry weightwas observed under pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS which was at par with pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS, pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS and interculturing and hand weeding at 30 DAS and 45 DAS. The significantly highest total weed dry weight at 30 and 45 DAS was recorded under weedy check). These findings were also confirmed by Jangir *et al*. (2017), Pandey *et al*. (2019) and Yernaidu *et al*. (2021). Dry weight of total weed at harvest was significantly recorded at harvest was observed under weed free, after weed free lowest total weed dry weight was recorded under pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS, which was at parpendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS and pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS. Similar findings were also supported by Singh *et al*. (2020).

Table 5: Effect of different weed control treatments on periodical weed dry weight in mustard

Treatment details	Weed dry weight (g/m^2)			Weed dry weight (kg/ha)		
	At 30 DAS	At 45 DAS	At harvest	At 30 DAS	At 45 DAS	At harvest
T_1: Pendimethalin (PE) @ 383.5 g/ha	4.61 (21.05)	5.44 (29.10)	4.73 (18.76)	14.43 (210.53)	17.07 (290.90)	13.64 (187.60)
T_2: Pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS	4.93 (24.23)	4.09 (16.29)	3.52 (12.31)	15.46 (242.29)	12.78 (162.87)	10.92 (123.07)
T_3: Pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS	4.75 (22.12)	4.00 (15.53)	3.19 (9.69)	14.88 (221.20)	12.48 (155.30)	9.86 (96.93)
T_4: Pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS	4.92 (23.81)	4.04 (15.83)	2.91 (8.05)	15.41 (238.13)	12.60 (158.30)	8.45 (80.53)
T_5: Pendimethalin (PE) @ 383.5 g/ha + Mustard straw mulch @ 7.5 t/ha at 20 DAS	5.10 (25.71)	4.96 (24.63)	3.93 (15.35)	16.00 (257.07)	15.65 (246.30)	12.23 (153.47)
T_6: Mustard straw mulch @ 7.5 t/ha at 20 DAS	6.07 (36.65)	5.77 (32.93)	5.26 (27.37)	19.08 (366.53)	19.81 (392.60)	16.50 (273.73)
T_7: Interculturing and hand weeding at 30 DAS and 45 DAS	5.58 (31.05)	4.83 (22.90)	4.41 (19.12)	17.53 (310.35)	15.14 (229.00)	13.79 (191.20)
T_8: Weed Free	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_9: Weedy check	6.14 (37.55)	8.14 (65.86)	7.14 (50.53)	19.30 (375.47)	25.67 (658.73)	22.47 (505.33)
S. Em.±	0.18	0.31	0.28	0.56	0.87	0.90
CD at 5 %	0.53	0.92	0.84	1.69	2.63	2.72
C. V. %	6.5	11.4	12.4	6.6	10.4	12.9

Note: Square root transformation (√x+0.5) was applied (original values which are given in the parenthesis)

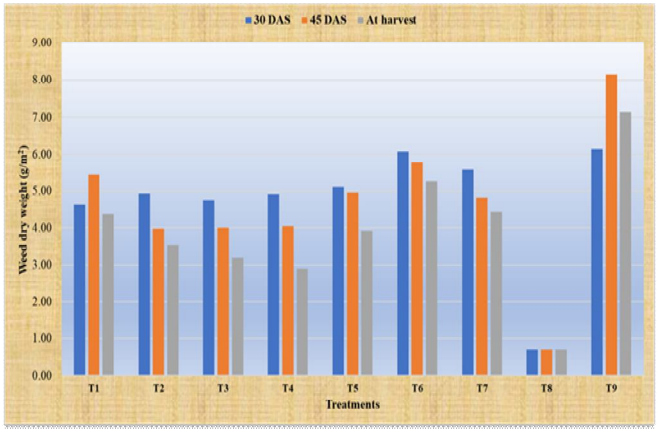

Fig. 1: Total dry weight of weed at 30 DAS, 45 DAS and at harvest in mustard as influenced by different weed control treatments

Effect on weed control efficiency and weed index (%)

Maximum weed control efficiency was recorded under weed freefollowed by pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS (84.06%) followed by pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS (80.82%) and pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS (75.63%). It might be due to effectively suppression of weeds by different weed management practices led to less weed dry matter. Lowest weed control efficiency was recorded under weedy check. Lower weed index might be due to lower weed population and dry weight of weeds and high weed control efficiency which led to higher yield. Lowest weed index has been recorded under weed free, after that application of pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS registered minimum weed index of (7.56%) followed by pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS (10.60%) followed by pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS (12.12%). These findings were also supported by Raj *et al*. (2020) and Chishi *et al*. (2021).

Table 6 : Weed control efficiency and weed index at harvest in mustard as influenced by different weed management practices

Treatment	WCE (%)	WI (%)
T_1:Pendimethalin (PE) @ 383.5 g/ha	62.87	32.42
T_2: Pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop- p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS	75.63	12.12
T_3: Pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS	80.82	10.60
T_4: Pendimethalin (PE) @ 383.5 g/ha *fb*interculturing at 30 DAS	84.06	7.56
T_5: Pendimethalin (PE) @ 383.5 g/ha + Mustard straw mulch @ 7.5 t/ha at 20 DAS	69.62	29.79
T_6: Mustard straw mulch @ 7.5 t/ha at 20 DAS	45.83	53.36
T_7: Interculturing and hand weeding at 30 DAS and 45 DAS	62.16	43.78
T_8: Weed Free	100	--
T_9: Weedy check	--	64.35
S. Em.±		
CD at 5 %		
C. V. %		

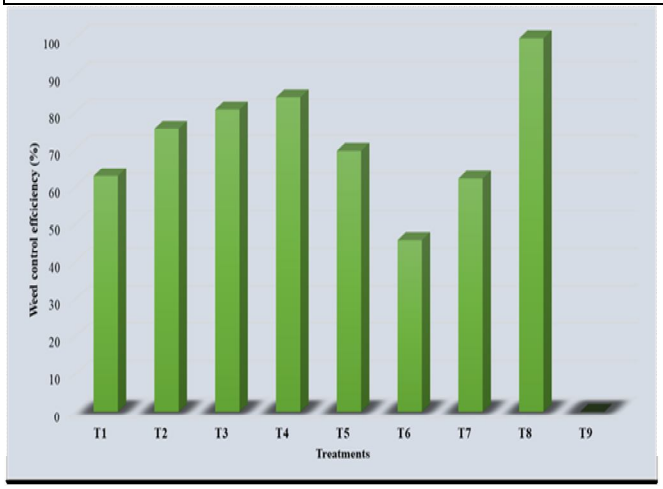

Fig. 2 : Weed control efficiency at harvest in mustard as influenced by different weed control treatments

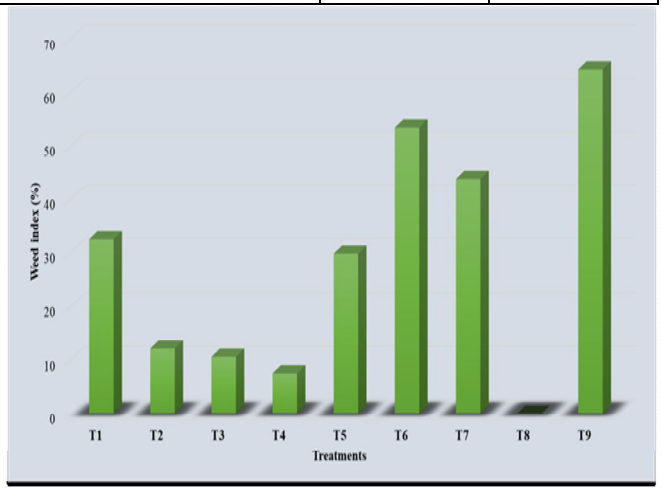

Fig. 3 : Weed index as influenced by different weed control treatments

Effect on yield attributes and yield

Significantly higher number of silique per plant were observed under weed free treatment (T_8: 347), which was statistically at par with pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS (T_4: 336), pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS (T_3: 314) and pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS (T_2: 314), while the treatment weedy check had the significantly lowest number of silique (T_9: 121). In case length of silique, weed free produced the longest length of silique of 4.90 cm. Similar result was recorded by Patel *et al.* (2013) and Gupta *et al.* (2018). The number of seeds per silique varied greatly. The significantly higher number of seeds per silique were observed under weed free (15.87), which was statistically at par with pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS (15.80), pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS (15.73), pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS (15.20) and pendimethalin (PE) @ 383.5 g/ha + mustard straw mulch @ 7.5 t/ha at 20 DAS (14.13). Significantly lowest seeds per silique were recorded under weedy check (11.60). The results are in conformity with the findings by Patel *et al.* (2013), Gupta *et al.* (2018) and Hadke *et al.* (2021). The different weed control treatments used in this experiment had a substantial impact on the yield of mustard. Weed free up to 60 DAS showed superiority in seed and stover yield (2037 and 6492 kg/ha, respectively), which was statistically at par with pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS (1883 and 6228 kg/ha respectively), pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS (1821and 6197kg/ha, respectively) and pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop-p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS (1790 and 5984kg/ha respectively).Analogous findings have been reported by Chishi *et al.* (2021), Anathapadmanabhan *et al* (2022) and Dipak *et al.* (2022).

Table 7: Yield attributes and yield of mustard as influenced by different weed management practices

Treatment	No. of silique per plant	Seed yield (kg/ha)	Stover yield (kg/ha)
T_1:Pendimethalin (PE) @ 383.5 g/ha	261	1289	3580
T_2: Pendimethalin (PE) @ 383.5 g/ha *fb* quizalofop- p-ethyl (PoE) @ 0.05 kg/ha at 30 DAS	302	1790	5984
T_3: Pendimethalin (PE) @ 383.5 g/ha + hand weeding at 30 DAS	314	1821	6197
T_4: Pendimethalin (PE) @ 383.5 g/ha *fb* interculturing at 30 DAS	336	1883	6228
T_5: Pendimethalin (PE) @ 383.5 g/ha + Mustard straw mulch @ 7.5 t/ha at 20 DAS	270	1430	4626
T_6: Mustard straw mulch @ 7.5 t/ha at 20 DAS	181	950	3210
T_7: Interculturing and hand weeding at 30 DAS and 45 DAS	259	1145	3515
T_8: Weed Free	347	2037	6492
T_9: Weedy check	121	753	1375
S. Em.±	16.35	94.67	292.55
CD at 5 %	49.02	284	877
C. V. %	10.66	11.29	11.07

Conclusion

Pendimethalin at 383.5 g/ha, in conjunction with one cultural operation (either hand weeding or interculturing) or post-emergence herbicide *i.e.* quizalofop-p-ethyl application, can effectively manage weed population, dry weight and increased mustard yield under North Gujarat conditions.

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