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Y Yernaidu
M.Sc. Scholar, Department of Agronomy, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad, Telangana, India

YS Parameswari
Assistant Professor, Department of Agronomy, College Farm, College of Agriculture, Rajendranagar, Hyderabad, Telangana, India

M Madhavi
Senior Professor, Department of Agronomy, Associate Dean, Agriculture College, Aswaraopet, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad, Telangana, India

T Ramprakash
Principal Scientist (SSAC) & Head, AICRP on Weed Management, Diamond Jubilee Block, Rajendranagar, Hyderabad, Telangana, India

Corresponding Author:
Y Yernaidu
M.Sc. Scholar, Department of Agronomy, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad, Telangana, India

Effect of weed management practices on weed parameters and nutrient removal by weeds in mustard (*Brassica Juncea* (L.) Czerj and Cosson)

Y Yernaidu, YS Parameswari, M Madhavi and T Ramprakash

Abstract
A field experiment was conducted at College Farm, College of Agriculture, Rajendranagar, Hyderabad during *Rabi* 2020-21 on loamy sand soils to find out the effect of weed management practices on weed control in mustard. Among different weed management practices, lower weed density and weed dry weight were observed under intercultivation and hand weeding at 15 and 30 DAS and it was on par with oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* intercultivation at 30 DAS. Similarly higher weed control efficiency was noticed with intercultivation and hand weeding at 15 and 30 DAS and it was followed by oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* intercultivation at 30 DAS. Lower nutrient removal by weeds at harvest was recorded under intercultivation and hand weeding at 15 and 30 DAS and it was on par with oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* intercultivation at 30 DAS.

Keywords: Intercultivation, hand weeding, weed control efficiency, weed, nutrient removal

Introduction
Mustard is one of the most important oilseed crops in terms of worldwide trade. It is a member of the Cruciferae family. It is the second most important oilseed crop in India, after groundnut, among the seven edible oilseeds. Mustard seeds have an oil content ranging from 37 to 49% (Bhowmik *et al.*, 2014) [1]. The oil is used for human consumption and cooking in northern India. It's also utilised in the manufacture of hair oils and pharmaceuticals. It's a component in the production of greases. Young plant leaves are utilised as green vegetables because they provide sulphur and nutrients to the diet.
In India, rape seed and mustard occupy 6.23milion ha area with production and productivity of 9.34 million tonnes and 1499 kgha^{-1} respectively (India stat 2019-20). Weeds are the major biotic stress in mustard production. Weed competition in mustard is more serious during early stage, because crop growth during winter (*rabi*) season remains slow during the first 4-6 weeks after sowing. However, during later stages it grows vigorously and has suppressing effect on weeds. Weeds compete with crop for water, nutrients and light which effect growth and development of crop. The critical period of crop -weed competition in mustard is 15-40 days and weeds cause about 24% of yield loss (Yadav *et al.*, 2017) [11] depending on weed flora, intensity and stage of the crop. In mustard hand weeding is the traditional practice. But increasing wages, scarcity of labour at peak periods and high-cost involvement compels need to depend other alternatives which are technically feasible and economically viable. Keeping this in view, the present experiment was carried out with the objective to find out the effect of weed management practices on weed control in mustard.

Materials and Methods
A field experiment was conduct during *Rabi* season 2020-21 at College Farm, College of Agriculture, Rajendranagar, Hyderabad. The experimental field's soil had a loamy sand texture and a pH of 7.9 with available nitrogen (223 kg ha^{-1}), available phosphorus (30.87 kg ha^{-1}), available potassium (375.72 kg ha^{-1}) and organic carbon (0.69%), it was medium fertile. Mustard variety NRCHB-101 was sown with seed rate of 4 kg ha^{-1}. The seeds were sown manually with spacing of 40×10 cm. Recommended dose of fertilizers 80:40:40 Kg ha^{-1} N, P_2O_5 K_2O were applied. The entire phosphorus and potassium dosage was applied as a basal. Nitrogen was applied at basal, vegetative, and blooming stages. Urea, single super phosphate, and muriate of potash were used to provide nitrogen, phosphorus and potassium, respectively.

The experiment was laid out in randomised block design replicated thrice with twelve treatments *viz.,* T_1**:** Pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* quizalofop ethyl 5% EC 0.05 kg ha^{-1} PoE, T_2: Oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* quizalofop ethyl 5% EC 0.05 kg ha^{-1} PoE, T_3: Oxyfluorfen 23.5% EC 0.1 kg ha^{-1} PE *fb* quizalofop ethyl 5% EC 0.05 kg ha^{-1} PoE, T_4: Pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* straw mulch 5 t ha^{-1}, T_5: Oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* straw mulch 5 t ha^{-1}, T_6: Oxyfluorfen 23.5% EC 0.1 kg ha^{-1} PE *fb* straw mulch 5 t ha^{-1}, T_7: Pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* intercultivation at 30 DAS, T_8: Oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* intercultivation at 30 DAS, T_9: Oxyfluorfen 23.5% EC 0.1 kg ha^{-1} PE *fb* intercultivation at 30 DAS, T_{10}: Intercultivation and hand weeding at 15 and 30 DAS (weed free), T_{11}: Intercultivation at 15 and 30 DAS, T_{12}: Unweeded control. Pre-emergence herbicides were applied within in 24 hours after sowing. All post-emergence herbicides were sprayed at 2-3 leaf stage of weeds. Straw mulch was laid at 15 DAS. Intercultivation was done with push hoe at 15 and 30 DAS. Hand weeding was done at 15 and 30 DAS. The observations were noticed on total weed population, weed dry matter accumulation and weed index. For weed dry matter samples were dried in hot air oven at 65 ± 5°C. The weed density, weed dry matter production and weed control efficiency were recorded at 20 and 40 DAS. The data on weed density and dry weight was square root transformed ($\sqrt{x+1}$) before analysis. The data was analysed using standard statistical techniques.

Table 1: Weed parameters as influenced by integrated weed management practices in mustard

Treatments	Weed density (No. m^{-2})	Weed dry weight (g m^{-2})	Weed control efficiency (%)	Weed index (%)
T_1: Pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* quizalofop ethyl 5% EC 0.05 kg ha^{-1} PoE	5.83 (32.97)	3.51 (11.29)	80.63	39.67
T_2: Oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* quizalofop ethyl 5% EC 0.05 kg ha^{-1} PoE	5.68 (31.14)	3.38 (10.43)	82.12	38.19
T_3: Oxyfluorfen 23.5% EC 0.1 kg ha^{-1} PE *fb* quizalofop ethyl 5% EC 0.05 kg ha^{-1} PoE	5.78 (32.39)	3.45 (10.88)	81.33	38.73
T_4: Pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* straw mulch 5 t ha^{-1}	5.26 (26.70)	3.08 (8.48)	85.46	26.89
T_5: Oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* straw mulch 5 t ha^{-1}	5.12 (25.20)	2.98 (7.89)	86.46	25.54
T_6: Oxyfluorfen at 23.5% EC 0.1 kg ha^{-1} PE *fb* straw mulch 5 t ha^{-1}	5.21 (26.15)	3.03 (8.18)	85.97	26.37
T_7: Pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* intercultivation at 30 DAS	4.32 (17.66)	2.58 (5.66)	90.29	14.60
T_8: Oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* intercultivation at 30 DAS	3.85 (13.81)	2.29 (4.24)	92.72	9.03
T_9: Oxyfluorfen 23.5% EC 0.1 kg ha^{-1} PE *fb* intercultivation at 30 DAS	4.22 (16.82)	2.53 (5.38)	90.77	10.98
T_{10}: Intercultivation and hand weeding at 15 DAS and 30 DAS (weed free)	3.34 (10.16)	2.01 (3.05)	94.77	0.00
T_{11}: Intercultivation at 15 and 30 DAS	5.34 (27.48)	3.17 (9.03)	84.52	27.85
T_{12}: Unweeded control	11.68 (135.53)	7.70 (58.30)	-	-
SE (m) ±	0.17	0.11		
CD (P=0.05)	0.53	0.35		

Note: Values in the parenthesis are original and ($\sqrt{x+1}$) transformed

Results and Discussion

Effect on weed flora, weed density and dry matter

The experimental field was infested with grasses like *Digitaria sanguinalis, Chloris barbata, Echinochloa crusgalli, Cynodon dactylon, Dactyloctenium aegyptium, Dinebra retroflexa, Eleusine indica* and sedges like *Cyperus rotundus* and broad-leaved weeds like *Parthenium hysterophorus, Alternanthera sessilis, Trianthema portulacastrum, Cleome viscosa, Datura stramonium, Euphorbia hirta, Commelina benghalensis, Sonchus arevensis* and *Digera arevensis.*

The data on weed density and dry matter were presented in table 1. Lower weed density and dry matter were noticed with intercultivation and hand weeding at 15 and 30 DAS and it was found to be on par with oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* intercultivation at 30 DAS. Oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* intercultivation at 30 DAS in turn on par with oxyfluorfen 23.5% EC 0.1 kg ha^{-1} PE *fb* intercultivation at 30 DAS and pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* intercultivation at 30 DAS. It might be due to weeds have been effectively controlled initially with pre-emergence application of herbicide and later emerged weeds were controlled by intercultivation resulted lower weed density and dry matter (Das, 2016, Yadav *et al.,* 2017 and Jangir *et al.,* 2018) [2, 11, 4].

Effect on weed control efficiency and weed index: Different weed management practices had a significant impact on weed control efficiency and weed index (Table 1). Higher weed control efficiency was observed with intercultivation and hand weeding at 15 and 30 DAS and this treatment was followed by oxadiargy l6% EC 0.09 kg ha^{-1} PE *fb* intercultivation at 30 DAS, oxyfluorfen 23.5% EC 0.1 kg ha^{-1} PE *fb* intercultivation at 30 DAS, pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* intercultivation at 30 DAS, oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* straw mulch at 5 t ha^{-1}, oxyfluorfen 23.5% EC 0.1 kg ha^{-1} PE *fb* straw mulch at 5 t ha^{-1}, pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* straw mulch at 5 t ha^{-1}, intercultivation at 15 and 30 DAS, It might be due to effective control of weeds led to reduced weed dry matter resulted in higher weed control efficiency (Singh and Kumar, 2020). Significantly lower weed index was obtained with oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* intercultivation at 30 DAS and this was followed by oxyfluorfen 23.5% EC 0.1 kg ha^{-1} PE *fb* intercultivation at 30 DAS, pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* intercultivation at 30 DAS, oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* straw mulch at 5 t ha^{-1},oxyfluorfen 23.5% EC 0.1 kg ha^{-1} PE *fb* straw mulch at 5 t ha^{-1}, pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* straw mulch at 5 t ha^{-1}, intercultivation at 15 and 30 DAS. 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 (Patel *et al.,* 2013, Kour *et al.,* 2013 and Mukherjee, 2014) [8, 5, 7]. Unweeded control recorded higher weed index.

Table 2: Nitrogen, phosphorus and potassium (kg ha^{-1}) removal by weeds at harvest as influenced by integrated weed management practices in mustard

Treatments	N	P_2O_5	K_2O
T_1: Pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* quizalofop ethyl 5% EC 0.05 kg ha^{-1} PoE	8.47	1.51	6.85
T_2: Oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* quizalofop ethyl 5% EC 0.05 kg ha^{-1} PoE	7.60	1.36	6.14
T_3: Oxyfluorfen 23.5% EC 0.1 kg ha^{-1} PE *fb* quizalofop ethyl 5% EC 0.05 kg ha^{-1} PoE	8.23	1.47	6.60
T_4: Pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* straw mulch 5 t ha^{-1}	5.73	1.00	4.61
T_5: Oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* straw mulch 5 t ha^{-1}	5.11	0.87	4.10
T_6: Oxyfluorfen at 23.5% EC 0.1 kg ha^{-1} PE *fb* straw mulch 5 t ha^{-1}	5.40	0.92	4.37
T_7: Pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* intercultivation at 30 DAS	3.96	0.68	3.20
T_8: Oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* intercultivation at 30 DAS	3.09	0.50	2.50
T_9: Oxyfluorfen 23.5% EC 0.1 kg ha^{-1} PE *fb* intercultivation at 30 DAS	3.69	0.64	2.98
T_{10}: Intercultivation and hand weeding at 15 DAS and 30 DAS (weed free)	2.58	0.41	2.05
T_{11}: Intercultivation at 15 and 30 DAS	6.03	1.02	4.86
T_{12}: Unweeded control	27.47	5.16	21.97
SE (m) ±	0.31	0.07	0.26
CD (P=0.05)	0.95	0.20	0.80

Effect on nutrient removal by weeds (N, P and K) (kg ha^{-1})

Nutrient removal by weeds is a function of dry matter and content of the nutrients, it follows the trend of dry matter. Different weed management practices significantly influenced nutrient removal by weeds (Table 2). Intercultivation and hand weeding at 15 and 30 DAS recorded lower nutrient removal by weeds and it was found to be on par with oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* intercultivation at 30 DAS. In turn oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* intercultivation at 30 DAS on par with oxyfluorfen 23.5% EC 0.1 kg ha^{-1} PE *fb* intercultivation at 30 DAS and pendimethalin 30% EC 1.0 kg ha^{-1} PE *fb* intercultivation at 30 DAS. It might be due to different weed management treatments may result in decreased nutrient loss by weeds owing to effective control of weeds during critical period of crop growth (Kumar *et al.*, 2012 and Raj *et al.*, 2020) [6, 9]. Highest nutrient removal by weeds was recorded with unweeded control.

Conclusion

On the basis of the above-mentioned findings, it may be inferred that, intercultivation and hand weeding at 15 and 30 DAS is excellent weed management practices It was on par with oxadiargyl 6% EC 0.09 kg ha^{-1} PE *fb* intercultivation at 30 DAS.

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