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Effect of weed management on yield and nutrient uptake in mustard (*Brassica juncea)*

Sumitra Devi Bamboriya[1*], M.K. Kaushik[1], Shanti Devi Bamboriya[2] and Priyanka Kumawat[1]

[1]Department of Agronomy, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur-313001 (Rajasthan), INDIA
[2]Indian Agricultural Research Institute, Pusa, New Delhi-110 012, INDIA
*Corresponding author. E-mail: sumisaani@gmail.com

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Abstract: Field investigation was carried out during *rabi* season of 2014-15 at Udaipur to evaluate the effect of different weed management practices on yield and nutrient uptake of mustard. The maximum seed yield was registered with two hand weeding (1955.25 kg ha^{-1}) except weed free check and was at par with fluazifop-p-butyl 0.055 kg ha^{-1} 10 DAS + hoeing 40 DAS and fenoxaprop-p-ethyl 0.075 kg ha^{-1}10 DAS + hoeing 40 DAS. The highest amount of total N, P and K (112.61, 25.31 and 76.90 kg ha^{-1}, respectively) was removed by mustard in weed free treatment followed by two hand weeding while the lowest N, P and K with the values of 70.11, 16.05 and 51.86 kg ha^{-1}, respectively was removed by weedy check followed by isoproturon 0.75 kg ha ha^{-1}. Among the weed management practices, the total uptake of N, P and K by weeds was found significantly less in all the weed management practices as compared to weedy check(5.87, 0.86 and 5.51 kg ha^{-1}, respectively). The least nutrient depletion by weeds was registered with the hand weeding twice (0.52, 0.08 and 0.49 kg ha^{-1}, respectively) followed by fluazifop-p-butyl 0.055 kg ha^{-1} 10 DAS + hoeing 40 DAS and fenoxaprop-p-ethyl 0.075 kg ha^{-1}10 DAS + hoeing 40 DAS. Use of post emergence herbicides of 'fop' group such as fluazifop-p-butyl, quizalofop-p-ethyl, fenoxaprop-p -ethyl (which are mostly used in soybean and groundnut crop) in indian mustard found most effective in controlling grassy weeds in early stage whereas at latterly, one hoeing 40 DAS was found effective in controlling grassy as well as broad leaved weeds under irrigated conditions.

Keywords: Herbicides, Mustard, Nutrient uptake, Weed management

INTRODUCTION

Indian mustard [*Brassica juncea* (L.) Czern and Coss] is an important oilseed crop of India. The amount of edible oil produced from mustard does not meet the current requirement of the growing population of India. India has 6.7 million hectares mustard area with 8.0 million tonnes production and 1188 kg ha^{-1} productivity (ES, 2015). It is predominantly cultivated in Rajasthan, Uttar Pradesh, Haryana and Madhya Pradesh. This is a potential crop in winter (*Rabi*) season due to its wider adaptability and suitability to exploit residual moisture (Mukherjee 2010). For bridging the gap between demand and supply, productivity needs to be enhanced. Weed competition in mustard is more serious in early stage; because crop growth during winter season remains slow during the first 4-6 weeks after sowing. However, during later stage it grows vigorously and has suppressing effect on weeds. As this crop is grown in poor soil with poor management practices, weed infestation is one of the major causes of low productivity. The critical period of crop weed competition in rapeseed-mustard is 15-40 days and weeds cause alarming decline in crop production ranging from 15-30 per cent to a total failure yield (Shekhawat *et al*., 2012) depending on weed flora, its intensity, stage, nature and duration of the crop weed competition. Weeds being injurious, harmful or poisonous are a constant source of trouble for the successful growth and development of crops. Weeds compete with crops for light, moisture, space and plant nutrients and other environmental requirements and consequently interfere with the normal growth of crops (Upadhyay *et al*., 2012). Weeds pose severe problem for crop husbandry, reducing the soil fertility and moisture, act as alternate host for insect & pest and develop a potential threat to the succeeding crops. At present, one hand weeding 25 to 30 DAS is enough to control of the weeds during early stage, but in view of scanty availability of labour and ever increasing wages, the manual weed management has become costly and cumbersome. Therefore it has become essential to search out effective post-emergence herbicides which can take care of early flush of weeds. Herbicide combinations are more effective weapons in tackling weed menace and thereby nutrient depletion by them than a single herbicide

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approach (Upadhyay *et al*. 2013). Among agronomic factors known to augment crop production, fertilization stands the most crucial production factor and is considered as one of the most productive input in crop production. In view of the importance of the problem, the present study was undertaken to find out the influence of weed management practices on yield and nutrient uptake in mustard (*Brassica juncea)*.

MATERIALS AND METHODS

A field experiment was laid out during *Rabi* season of 2014-15 at the Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan), to evaluate effect of weed management on productivity and nutrient uptake of mustard (*Brassica juncea* L.). The soil of experimental site was clay loam in texture (Brady and Well, 2002), having slight alkaline reaction as pH 7.9 (Richards, 1968) and medium in available nitrogen (281.40 kg ha^{-1}), phosphorus (24.46 kg ha^{-1}) and in available potassium (238.05 kg ha^{-1}) estimated by Jackson, 1967, Olsen *et al*., 1954 and Jackson, 1967 methods, respectively. The experiment comprises of 10 treatments, which consisted of weedy check, one hand weeding 20 DAS, two hand weeding 20 and 40 DAS, fenoxaprop-p-ethyl 0.075 kg ha^{-1}10 DAS, fluazifop-p-butyl 0.055 kg ha^{-1} 10 DAS, quizalofop-p-ethyl 0.050 kg ha^{-1}30 DAS, fenoxaprop-p-ethyl 0.075 kg ha^{-1}10 DAS + one hoeing 40 DAS, fluazifop-p-butyl 0.055 kg ha^{-1} 10 DAS + one hoeing 40 DAS, isoproturon 1.25 kg ha^{-1}30 DAS and weed free check. The experiment was laid out in a randomized block design and replicated four times. Mustard variety Bio-902 was sown on1st Nov, 2014 at 40 cm x 10 cm row and plant to plant spacing with a seed rate of 3 kg ha^{-1}. The 1/3 dose of nitrogen and full dose of phosphorus was applied as per treatments at sowing time and remaining 2/3 nitrogen was top dressed in two equal splits at first and second irrigation, respectively. Herbicides were sprayed by knapsack sprayer fitted with flat fan T-jet nozzle using a spray volume of 500 l ha^{-1}. The uptake of major nutrients in weed was worked out by multiplying per cent nutrient content with dry matter accumulation at harvest. The dry matter was then computed in terms of kg ha^{-1}. The dried crop seed and straw samples were subjected to nitrogen, phosphorus and potassium content as per standard procedure (Lindner, 1944; Richards, 1968 and Jackson, 1973, respectively). The uptake of N, P and K by mustard was worked out by multiplying their content in seed/ straw with yield, respectively, and the total uptake was computed by summing up the uptakes by seed and straw.

RESULTS AND DISCUSSION

Weed flora in the experimental field: Mustard was heavily infested with mixed flora of monocot and dicot weeds chiefly consisted of *Phalaris minor, Cyperus*

Table 1. Effect of weed control on yield and nutrient content of mustard.

Treatments	Yield (kg ha^{-1})			N (%)		P (%)		K (%)	
	Seed	Straw	Biological	Seed	Straw	Seed	Straw	Seed	Straw
Weedy check	1166.75	3943.00	5109.75	3.190	0.835	0.608	0.228	0.750	1.093
One hand weeding 20 DAS	1655.00	4894.75	6549.75	3.215	0.823	0.623	0.225	0.770	1.083
Two hand weeding 20 and 40 DAS	1955.25	5568.25	7523.50	3.288	0.828	0.620	0.225	0.762	1.093
Fenoxaprop-p-ethyl 0.075 kg ha^{-1} 10 DAS	1491.00	4694.75	6185.75	3.100	0.813	0.603	0.213	0.754	1.055
Fluazifop-p-butyl 0.055 kg ha^{-1}10 DAS	1499.25	4700.50	6199.75	3.175	0.818	0.613	0.220	0.759	1.050
Quizalofop-p-ethyl 0.050 kg ha^{-1}30 DAS	1518.00	4798.75	6316.75	3.200	0.820	0.608	0.220	0.765	1.090
Fenoxaprop-p-ethyl 0.075 kg ha^{-1} 10 DAS + one hoeing 40 DAS	1912.75	5205.75	7118.50	3.278	0.843	0.628	0.238	0.776	1.078
Fluazifop-p-butyl 0.055 kg ha^{-1}10 DAS + one hoeing 40 DAS	1914.00	5222.25	7136.25	3.325	0.825	0.628	0.238	0.778	1.077
Isoproturon 1.25 kg ha^{-1}30 DAS	1389.50	4557.00	5946.50	3.253	0.823	0.615	0.230	0.752	1.080
Weed free check	1977.25	5783.75	7761.00	3.283	0.825	0.623	0.225	0.758	1.070
SEm ±	63.26	161.27	158.31	0.072	0.011	0.014	0.004	0.015	0.020
CD at 5 %	183.58	467.95	459.38	NS	NS	NS	NS	NS	NS

Table 2. Effect of weed control on nutrient uptake (kg ha^{-1})by mustard.

Treatments	N			P			K		
	Seed	Straw	Total	Seed	Straw	Total	Seed	Straw	Total
Weedy check	37.21	32.90	70.11	7.09	8.96	16.05	8.75	43.11	51.86
One hand weeding 20 DAS	53.21	40.26	93.47	10.31	11.01	21.32	12.74	52.98	65.72
Two hand weeding 20 and 40 DAS	64.43	46.13	110.56	12.12	12.54	24.66	14.90	60.60	75.50
Fenoxaprop-p-ethyl 0.075 kg ha^{-1} 10 DAS	46.26	38.16	84.42	8.98	9.98	18.96	11.23	49.53	60.76
Fluazifop-p-butyl 0.055 kg ha^{-1}10 DAS	47.62	38.37	85.99	9.18	10.34	19.53	11.37	49.34	60.71
Quizalofop-p-ethyl 0.050 kg ha^{-1}30 DAS	48.58	39.36	87.94	9.23	10.56	19.79	11.61	52.30	63.91
Fenoxaprop-p-ethyl 0.075 kg ha^{-1} 10 DAS + one hoeing 40 DAS	62.67	43.86	106.53	12.01	12.37	24.38	14.84	56.08	70.93
Fluazifop-p-butyl 0.055 kg ha^{-1}10 DAS + one hoeing 40 DAS	63.64	43.13	106.77	12.00	12.40	24.41	14.90	56.23	71.13
Isoproturon 1.25 kg ha^{-1}30 DAS	45.30	37.46	82.75	8.49	10.48	18.98	10.44	49.26	59.70
Weed free check	64.90	47.71	112.61	12.30	13.01	25.31	15.01	61.90	76.90
SEm ±	2.64	1.47	2.46	0.39	0.42	0.50	0.55	1.80	1.82
CD at 5 %	7.65	4.27	7.13	1.12	1.22	1.45	1.59	5.22	5.28

Table 3. Effect of weed control on nutrient uptake (kg ha^{-1}) by weeds.

Treatments	N			P			K		
	Monocot	Dicot	Total	Monocot	Dicot	Total	Monocot	Dicot	Total
Weedy check	3.21	2.66	5.87	0.45	0.40	0.86	3.05	2.46	5.51
One hand weeding 20 DAS	1.22	1.39	2.61	0.17	0.20	0.37	1.16	1.26	2.43
Two hand weeding 20 and 40 DAS	0.22	0.30	0.52	0.03	0.05	0.08	0.20	0.28	0.49
Fenoxaprop-p-ethyl 0.075 kg ha^{-1} 10 DAS	1.29	2.21	3.50	0.18	0.33	0.51	1.23	2.03	3.26
Fluazifop-p-butyl 0.055 kg ha^{-1}10 DAS	1.27	2.14	3.41	0.18	0.32	0.50	1.23	2.04	3.26
Quizalofop-p-ethyl 0.050 kg ha^{-1}30 DAS	1.09	1.91	3.00	0.16	0.28	0.44	1.06	1.80	2.86
Fenoxaprop-p-ethyl 0.075 kg ha^{-1} 10 DAS + one hoeing 40 DAS	0.31	0.32	0.63	0.04	0.05	0.09	0.29	0.30	0.59
Fluazifop-p-butyl 0.055 kg ha^{-1}10 DAS + one hoeing 40 DAS	0.25	0.31	0.56	0.03	0.05	0.08	0.24	0.30	0.54
Isoproturon 1.25 kg ha^{-1}30 DAS	1.58	1.86	3.44	0.23	0.28	0.51	1.54	1.73	3.26
Weed free check	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEm ±	0.06	0.08	0.10	0.01	0.01	0.01	0.05	0.07	0.10
CD at 5 %	0.18	0.23	0.30	0.02	0.04	0.04	0.16	0.22	0.28

rotundus and *Cynodon dactylon;Chenopodium album, Chenopodium murale, Rumex acetosella, Convolvulus arvensis, Parthenium hysterophorus, Anagallis arvensis* and *Cichorium intybus,* respectively.

Productivity: Undoubtedly, the highest seed, straw and biological yield of mustard were recorded under the weed free conditions (1977, 5783 and 7761 kg ha^{-1}, respectively). Among the weed management practices, two hand weeding 20 and 40 DAS found most effective in achieving significantly higher seed and straw yield being at par with fluazifop-p-butyl 0.055 kg ha^{-1}10 DAS + hoeing 40 DAS and fenoxaprop-p-ethyl 0.075 kg ha^{-1}10 DAS + hoeing 40 DAS. This could be attributed to decreased crop-weed competition at the critical stages for longer growth period which facilitated better growth and development resulting in better expressions of yield-attributing characters, viz. siliquae $plant^{-1}$, seed $siliqua^{-1}$ and test weight, culminating in higher seed yield. Kour *et al*. (2014) in chickpea + mustard intercropping system and Singh *et al.* (2015) in mustardalso reported similar beneficial effect of integrated approach for better weed management and higher mustard yieldand also obtained the results for highest seed and straw yield in indian mustard under weed free check . Seed yield of mustard linearly decreased as the weeds dry matter increased.(r = -0.987**).

Nutrient uptake by mustard: All the weed management practices had significant effect on N, P and K removal by mustard over weedy check (Table 2). After weed free check significantly higher uptake of N, P and K was recorded under two hand weeding 20 and 40 DAS by mustard followed by fluazifop-p-butyl 0.055 kg ha^{-1}10 DAS + hoeing 40 DAS and fenoxaprop-p-ethyl 0.075 kg ha^{-1}10 DAS + hoeing 40 DAS compared to rest of the treatments, although the N, P and K removal under these treatments were statistically at par. The higher uptake of nutrients was due to the suppression of weed growth that might have been the driving force behind higher dry matter and nutrient uptake in mustard under these treatments. Such higher uptake might be attributed to higher seed yield production under better weed management treatments. The results of higher uptake of nutrients at harvest by crop confirm the findings of Chander *et al*. (2013) in soybean-wheat cropping system and Mukherjee (2014) in Indian mustard. The minimum nutrient uptake was noticed when mustard allowed to grow in weedy check conditions which might be attributed to production of least seed yield.

Nutrient uptake by weeds: Nitrogen, P and K uptake by weeds varied significantly due to weed management practices (Table 3). Weeds had lower N, P and K uptake than that of mustard crop. The highest N, P and K uptake by weeds was observed in weedy check and the lowest uptake by two hand weeding 20 and 40 DAS. The per cent reduction in total N , P and K uptake by weeds under two hand weeding was 91.14, 91.08 and 91.17, respectively. Reduction in nutrient uptake might be due to lower density and dry matter production of weeds under these weed management treatments which eventually led to higher uptake of these nutrients by mustard crop. The results of the highest N, P and K uptake at harvest by weeds are in accordance with the findings of Kour *et al*. (2013) in chickpea + mustard intercropping system and Mukherjee (2014) in mustard. This indirectly by reducing the nutrient uptake by weeds due to lower weed density and dry matter shows that these treatments were the best in controlling weeds.

Twice hand weeding at 20 and 40 DAS treatment controlled all types of weeds very effectively and minimized the weed competition at 60 DAS and at harvest. As a result, it recorded more number of siliquae $plant^{-1}$, number of seed $siliqua^{-1}$, test weight and produced seed yield (1955 kg ha^{-1}), where as the integration of the post emergence herbicide with hoeing 40 DAS were also found significantly superior over their counter parts applied alone. Undoubtedly, weed free check recorded maximum seed yield of 1977 kg ha^{-1} as against 1167 kg ha^{-1} under weedy check similarly reported by earlier workers.

Conclusion

On the basis of results and evaluation of treatments, it is concluded that after weed free check,two hand weeding 20 and 40 DAS recorded the highest seed yield of mustard 1955.25 kg $ha^{-1}$and all the weed control measures tended to significantly (at 5 % level of significance) improve the uptake of nitrogen, phosphorus and potassium by seed and straw compared to weedy check. The total uptake of N, P and K by the mustard crop decreased with increase in weed dry matter accumulation with the corresponding 'r' values as -0.990, -0.989 and -0.981 respectively.

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