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Weed indices as influenced by different weed management practices in fenugreek (*Trigonella foenum-graecum* L.)

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Abstract

A field experiment conducted at Instructional farm, Rajasthan College of Agriculture, MPUAT, Udaipur during rabi 2016-17 and 2017-18 to study the effect of weed management practices on weed control and seed yield of fenugreek. The experiment consists of thirteen weed management treatments comprising imazethapyr (70 g ha⁻¹, 70 g ha⁻¹ fb hoeing at 40 DAS), imazethapyr 50 g ha⁻¹ at 2-4 leaf stage of weeds, imazethapyr + imazamox 50 and 60 g ha⁻¹ at 2-4 leaf stage of weeds, pendimethalin 750 g ha⁻¹ PE, oxyfluorfen (120, 150 g ha⁻¹ and 120 g ha⁻¹ fb hoeing at harvest, oxadiargyl (100 g ha⁻¹ and 100 g ha⁻¹ fb hoeing at 40 DAS) including weed free and weedy check in main plot treatments and levels of vermicompost, viz. control and 5 t ha⁻¹ in sub plot treatments. The experiment was laid out in split plot design with three replications. The soil of experimental field was clay loam in texture, slightly alkaline in reaction, medium in organic carbon, available nitrogen, available phosphorus and high in available potassium. Fenugreek variety RMT-305 was sown at 30 cm distance with 25 kg ha⁻¹ seed rate and fertilize with recommended dose of fertilizers. Pre-emergence application of oxadiargyl 100 g ha⁻¹ followed by hoeing at 40 DAS recorded significantly lower weed density (15.00 m⁻²) and weed dry matter (54.20 g m⁻²), higher weed control efficiency (86.29%), crop resistance index (10.20), weed persistence index (1.79%) and lowest weed index (3.03%). Also the same treatment recorded higher growth, yield attributes and seed yield (2820 kg ha⁻¹) of fenugreek however this treatment was remained at par with weed free check.

Keywords: Weed indices as influenced, (*Trigonella foenum-graecum* L.), fenugreek

Introduction

India occupies prime position among the fenugreek growing countries of the world. In India, it is mainly grown in Rajasthan, Gujarat, Uttar Pradesh and Tamil Nadu. In India, during the year 2014-15, fenugreek occupied an area of 123000 ha with production and productivity of 131000 tonnes and 1065 kg ha⁻¹, respectively (Agriculture Statistics at a glance, 2016). Among the states, Rajasthan is the largest fenugreek producing one which contributes 64.42 per cent of total production and occupies an area of 81699 hectare with the production of 84186 tonnes during 2014-15 (Agriculture Statistics at a glance, 2016).

The average yield of this crop is very low than its potential, which may be due to many factors but among these weed infestation appears to be most important. Weeds have been identified as a serious drawback since they create biotic stress in realizing the genetic yield potential of this valuable crop. They dictate most of the crop production practices and cause enormous losses (37 per cent) due to their interference compared to insect pests and diseases (Verma *et al.*, 2015) [17]. Weeds reduce grain yield of this crop upto an extent of 86 per cent (Tripathi and Singh, 2008) [18]. Weeds offered maximum competition up to 25-30 days of sowing in fenugreek resulting in drastic reduction in seed yield. Manual weeding at right stage is difficult because of its time consuming, expensive and labour intensive nature. Under such conditions, use of herbicide with suitable dose remains the pertinent choice for controlling the weeds. In present study imazethapyr + imazamox (RM), oxyfluorfen and oxadiargyl have been taken for testing at different doses for control of diversified weed flora along with pendimethalin and imazethapyr. Sometimes herbicides in isolation are not able to complete weed control because of their selective kill. Their use can be made more effective, if supplemented with hand

weeding or hoeing or sequential application of herbicides. A judicious combination of chemical and cultural methods of weed control would not only reduce the expenditure on herbicides, but would benefit the crop by providing aeration and conservation of moisture.

Keeping the above fact the study was undertaken to judge the different herbicides on the basis of weed indices and yield of fenugreek under the influence of various weed management practices and vermicompost application.

Materials and Methods

A field experiment was conducted at Instructional farm, Rajasthan College of Agriculture, MPUAT, Udaipur during rabi 2016-17 and 2017-18. Thirteen weed management treatments comprising imazethapyr (70 g ha⁻¹, 70 g ha⁻¹ fb hoeing at 40 DAS), imazethapyr 50 g ha⁻¹ at 2-4 leaf stage of weeds, imazethapyr + imazamox 50 and 60 g ha⁻¹ at 2-4 leaf stage of weeds, pendimethalin 750 g ha⁻¹ PE, oxyfluorfen (120, 150 g ha⁻¹ and 120 g ha⁻¹ fb hoeing at 40 DAS), oxadiargyl (100 g ha⁻¹ and 100 g ha⁻¹ fb hoeing at 40 DAS) including weed free and weedy check in main plot treatments and levels of vermicompost viz; control and 5 t ha⁻¹ in sub plot treatments. The experiment is laid out in split plot design with three replications. The soils of experimental field was clay loam in texture slightly alkaline in reaction with pH 8.1 medium in organic carbon (0.71%), available nitrogen (285 kg ha⁻¹), available phosphorus (19.42 kg ha⁻¹) and high in available potassium (344.16 kg ha⁻¹). Fenugreek variety RMT-305 was sown at 30 cm distance with 25 kg ha⁻¹ seed rate and recommended dose of fertilizers (40 kg N and 40 kg P₂O₅ ha⁻¹) was applied as basal dose through urea and DAP.

As per treatment, pre-emergence application of herbicide was sprayed one day after sowing, while post-emergence application of herbicide was sprayed at 2-3 leaf stage of weeds (21 DAS). The herbicides were sprayed with knapsack sprayer fitted with flat fan nozzle using 500 litres of water per hectare.

The crop was harvested at physiological maturity when plants turned golden yellow. The harvested bundles were brought to the threshing floor and left for sun drying for a period of 7 days. The dried bundles were weighed to record total biological yield. After threshing, winnowing and cleaning was done and seeds were weighed separately to record seed yield kg plot⁻¹ and yield expressed in terms of kg ha⁻¹.

Total weed density at 60 DAS was recorded m⁻² with the help of 0.25 m² quadrat. In each treatment weeds were counted and the mean data were converted to per square metre and subjected to square root transformation $\sqrt{X + 0.5}$ to normalize their distribution (Gomez and Gomez, 1984) [5]. The weeds were dried at 65 °C temperature in oven till a constant weight was obtained which was expressed as weed dry matter. Weed indices were computed using standard procedures detailed as follow

Weed control efficiency (Mani *et al.*, 1968)

To judge the effect of different treatments in controlling weeds on the basis of weed dry weight. Weed control efficiency (WCE) was calculated by using the formula given by Mani *et al.*, 1968 as follow:

$$WCE = \frac{X - Y}{X} \times 100$$

Where,

WCE = Weed control efficiency

X = Weed dry matter in weedy check
Weed dry matter in treated plot

Weed persistence index (WPI)

It indicates the resistance in weeds against the tested treatments and confirms the effectiveness of the selected herbicide and it was computed by using the formula given by Mishra and Mishra, 1997 [12]:

$$WPI = \frac{\text{Dry matter of weed in treated plot}}{\text{Dry matter of weeds in control plot}} \times \frac{\text{Weed count in control plot}}{\text{Weed count in treated plot}}$$

Crop resistance index (CRI) (Mishra and Mishra, 1997) [12]

It gives the relationship between a proportionate increase in crop biomass and a proportionate decrease in weed biomass in the treated plots. It was computed by using the formula as given below:

$$CRI = \frac{\text{Dry matter production by the crop in treated plot}}{\text{Dry matter production by the crop in control plot}} \times \frac{\text{Dry matter production of weed in control plot}}{\text{Dry matter production of weeds in treated plot}}$$

Weed index (%)

Weed index is defined as the per cent reduction in seed yield under the particular treatment due to the presence of weeds in comparison to the seed yield obtained in weed free plot as suggested by Gill and Kumar (1969) [4]. It is expressed in percentage and can be computed by using following formula as given below

$$\text{Weed index} = \frac{X - Y}{X} \times 100$$

X - Yield from weed free

Y - Yield from particular treatment

Results and Discussion

Weed flora

The experimental field was full of monocot and dicot weeds. Among the total weeds dicot weeds were more prominent (89.75%) compared to monocots (11.25%) during rabi 2016-17 and 2017-18. The weed flora under dicots includes *Chenopodium album*, *Chenopodium murale*, *Fumaria parviflora*, *Malva parviflora*, *Melilotus indica* and *Convolvulus arvensis* whereas; *Phalaris minor* was only monocots weed.

Weed density and weed dry matter

A significant reduction was observed in weed density at 60 DAS in fenugreek (Table 1). Among weed management treatments oxadiargyl 100 g ha⁻¹ PE fb hoeing at 40 DAS recorded lower total weed density and dry matter (15.00 m⁻² and 54.20 g m⁻²) of weeds which was significantly superior over other treatments and weedy check (231.42 m⁻² and 395.99 g m⁻²). However, oxyfluorfen 120 g ha⁻¹ fb hoeing at 40 DAS (21.45 m⁻² and 79.69 g m⁻²) and imazethapyr 70 g ha⁻¹ fb hoeing at 40 DAS (21.50 m⁻² and 69.73 g m⁻²) were remained at par with each other in minimizing the density and dry matter of weeds at 60 DAS.

This might be due to the fact that broad spectrum contact herbicide used mainly as a pre-emergence controlled early flushes of weeds as well as late flushes of weeds up to the most critical stage of crop-weed competition due to the persistence and prolonged activity in the soil and later hoeing at 40 DAS controlled late flushes of weeds resulting in

excellent performance compared to herbicides specially applied alone or as pre or post-emergence. Higher efficacy of herbicides at early growth stage and hoeing at later stage (at 40 DAS) was effective to control weeds emerged during vegetative stage of crop (30 to 60 DAS), thereby, reducing the weed density and dry matter in these treatments. The superiority of herbicide in integration with hoeing or weeding at 40 DAS was also been reported by Singh *et al.* (2013), Singh *et al.* (2014) [16], Fageria *et al.* (2014) [3], Kumar *et al.* (2016) [6], Punia and Tehlan (2017) [14].

Application of vermicompost to fenugreek crop did not produce any significant effect on weed density but it had significant effect on weed dry matter. A uniform trend was emerged out for dry matter production of total weeds in relation to application of vermicompost over control during both the years as well as on pooled basis. Application of vermicompost significantly increases the dry matter of total weeds (128.93 g m⁻²) over control (113.95 g m⁻²) which was 24.65 percent higher over control on pooled basis.

Interaction effect: The interaction effect of weed management and vermicompost was found significant over the years and on pooled basis. At each level of weed management, the effect of vermicompost varied significantly in most of the weed management treatments consistently and resulted into increased dry matter of total weeds. On pooled basis, the application of vermicompost 5 t ha⁻¹ gave significantly higher dry matter of total weeds at each level of weed management except oxadiargyl 100 g ha⁻¹ PE fb IC at 40 DAS.

Conversely, on pooled basis, at each level of vermicompost, all the weed management treatments resulting into significant reduction in dry matter of total weeds in comparison to weedy check. Oxadiargyl 100 g ha⁻¹ PE fb hoeing at 40 DAS accounting for significantly lower dry matter than other treatments on pooled basis

Seed yield

The data on seed yield of fenugreek was significantly increased due to different weed management treatments. On pooled basis significant increase in seed yield was recorded by weed free check (2908 kg ha⁻¹) which was closely followed by oxadiargyl 100 g ha⁻¹ PE fb hoeing at 40 DAS (2820 kg ha⁻¹) were 175.71 and 167.45 percent higher over weedy check (1055 kg ha⁻¹), respectively. While, yield increased under the application of imazethapyr fb hoeing at 40 DAS and oxadiargyl alone by 114.26 and 110.11 percent in comparison to weedy check (1055 kg ha⁻¹) were remained next in order of superiority. The yield increased due to weed

management practices have also been reported by Mehta *et al.* (2010) [10], Meena *et al.* (2013) [11] and Singh *et al.* (2014) [16], Fageria *et al.* (2014) [3].

The data (Table 1) revealed that application of vermicompost significantly improve the seed yield (2308 kg ha⁻¹) over control (1849 kg ha⁻¹). The enhancement in seed yield due to application of vermicompost over control was 24.93 percent. The results are closely confirmity with the findings of Choudhari *et al.* (2011) [2], Kumawat and Yadav, (2011) [7], Shivran *et al.* (2016), Sharma *et al.* (2016) [15], Karmarkar *et al.* (2017).

Interaction effect: The interaction effect of weed management and vermicompost on seed yield was found significant on pooled basis (Table 3). It was noted that each level of weed management, addition of vermicompost 5 t ha⁻¹ appreciably increased the yield over control with highest increment (37.13%) under pre-emergence application of imazethapyr 70 g ha⁻¹. A further insight of data revealed that in comparison to weedy check application of all weed management treatment resulted in appreciably higher seed yield irrespective of vermicompost application. However, the yield obtained under weed free check was at par with oxadiargyl 100 g ha⁻¹ PE fb IC at 40 DAS which was in turn appreciably superior over rest of the treatments at each level of vermicompost.

Effect of weed management practices on various weed indices in fenugreek

The values of various weed indices like weed control efficiency (WCE), weed persistence index (WPI), crop resistance index (CRI) and weed index (WI) were inferior in treatments indicate the no weed control measures or unsatisfactory weed control by the particular treatment adopted for weed management (Table 4). Among the herbicidal treatments pre-emergence application of oxadiargyl 100 g ha⁻¹ fb hoeing at 40 DAS showing superior values of these indices and proved better than the other weed management options in fenugreek. Also integration of herbicide followed by hoeing at 40 DAS recorded higher values of weed indices over the alone application of herbicides. Pre-emergence application of oxadiargyl 100 g ha⁻¹ followed by hoeing at 40 DAS recorded significantly higher weed control efficiency (86.29%), crop resistance index (10.20), weed persistence index (1.79%) and lowest weed index (3.03%) among the herbicidal treatments. Similar results have also been reported by Mishra *et al.*, 2016 [13]; Lal *et al.*, 2017 [8].

Table 1: Effect of weed management and vermicompost on category wise weed density and weed dry matter in fenugreek at 60 DAS

Treatments	Weed density (m ⁻²)			Weed dry matter (g m ⁻²)			Seed yield (kg ha ⁻¹)		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
Weed management									
Imazethapyr 70 g ha ⁻¹ PE	6.75 (45.08)	7.16 (50.83)	6.96 (47.95)	117.19	129.82	123.51	1873	1920	1897
Imazethapyr 70 g ha ⁻¹ PE fb hoeing at 40 DAS	4.58 (20.50)	4.79 (22.49)	4.69 (21.50)	66.05	73.40	69.73	2230	2289	2260
Imazethapyr 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	6.25 (38.62)	6.62 (43.34)	6.43 (40.98)	92.23	104.01	98.12	2112	2151	2132
Imazethapyr + Imazamox (RM) 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	6.82 (46.08)	7.20 (51.58)	7.01 (48.78)	121.86	143.67	132.76	2065	2139	2102
Imazethapyr + Imazamox (RM) 60 g ha ⁻¹ PoE 2-4 leaf stage of weed	6.28 (39.00)	7.08 (49.67)	6.68 (44.33)	105.23	138.57	121.90	2125	2198	2162
Pendimethalin 750 g ha ⁻¹ PE	7.22 (51.58)	7.58 (57.00)	7.40 (54.29)	105.75	128.31	117.03	1948	2059	2004
Oxyfluorfen 120 g ha ⁻¹ PE	6.93 (47.50)	7.04 (49.17)	6.98 (48.33)	160.14	176.10	168.12	1786	1889	1837
Oxyfluorfen 150 g ha ⁻¹ PE	5.88 (34.16)	6.18 (37.78)	6.03 (35.97)	117.60	137.69	127.65	1906	2046	1976

Oxyfluorfen 120 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	4.57 (20.42)	4.79 (22.49)	4.68 (21.45)	75.74	83.64	79.69	2087	2141	2114
Oxadiargyl 100 g ha ⁻¹ PE	5.57 (30.48)	6.02 (35.72)	5.79 (33.10)	82.43	97.63	90.03	2200	2232	2216
Oxadiargyl 100 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	3.79 (13.83)	4.08 (16.17)	3.93 (15.00)	45.89	62.51	54.20	2779	2862	2820
Weed free check	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.00	0.00	0.00	2894	2921	2908
Weedy check	15.10 (227.50)	15.36 (235.33)	15.23 (231.42)	382.77	409.22	395.99	1013	1096	1055
SEm ±	0.08	0.12	0.03	5.80	5.59	1.87	95	92	31
CD (P=0.05)	0.25	0.36	0.08	16.93	16.33	5.76	279	268	95
Levels of vermicompost									
Control	6.20 (47.44)	6.51 (51.60)	6.35 (49.52)	105.93	121.97	113.95	1849	1911	1880
Vermicompost 5 t ha ⁻¹	6.20 (47.27)	6.51 (51.71)	6.35 (49.49)	120.67	137.19	128.93	2308	2388	2348
SEm ±	0.01	0.02	0.01	0.70	0.97	0.66	19	23	18
CD (P=0.05)	NS	NS	NS	2.04	2.83	1.85	56	67	50

Values are $\sqrt{X} + 0.5$ transformed and actual values are in parentheses

Table 2: Interaction effect of weed management and vermicompost on total weed dry matter at 60 DAS of fenugreek (Pooled)

Weed management	Weed dry matter (g m ⁻²)	
	Vermicompost	
	Control	5 t ha ⁻¹
Imazethapyr 70 g ha ⁻¹ PE	115.25	131.77
Imazethapyr 70 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	62.76	76.69
Imazethapyr 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	95.73	100.51
Imazethapyr + Imazamox (RM) 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	123.83	141.69
Imazethapyr + Imazamox (RM) 60 g ha ⁻¹ PoE 2-4 leaf stage of weed	112.95	130.85
Pendimethalin 750 g ha ⁻¹ PE	108.53	125.53
Oxyfluorfen 120 g ha ⁻¹ PE	159.38	176.86
Oxyfluorfen 150 g ha ⁻¹ PE	118.15	137.14
Oxyfluorfen 120 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	74.22	85.17
Oxadiargyl 100 g ha ⁻¹ PE	83.05	97.00
Oxadiargyl 100 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	50.11	58.29
Weed free check	0.00	0.00
Weedy check	377.40	414.59
	SEm ±	CD (P=0.05)
Weed management at the same level of vermicompost	1.31	3.71
Vermicompost at the same or different levels of weed management	3.23	9.14

Table 3: Interaction effect of weed management and vermicompost on yield (kg ha⁻¹) of fenugreek (Pooled)

Treatment	Seed yield (kg ha ⁻¹)	
	Vermicompost	
	Control	5 t ha ⁻¹
Weed management		
Imazethapyr 70 g ha ⁻¹ PE	1600	2194
Imazethapyr 70 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	1999	2520
Imazethapyr 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	1877	2386
Imazethapyr + Imazamox (RM) 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	1827	2378
Imazethapyr + Imazamox (RM) 60 g ha ⁻¹ PoE 2-4 leaf stage of weed	1899	2424
Pendimethalin 750 g ha ⁻¹ PE	1788	2220
Oxyfluorfen 120 g ha ⁻¹ PE	1625	2050
Oxyfluorfen 150 g ha ⁻¹ PE	1777	2175
Oxyfluorfen 120 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	1906	2321
Oxadiargyl 100 g ha ⁻¹ PE	1971	2461
Oxadiargyl 100 g ha ⁻¹ PE <i>fb</i> hoeing at 40 DAS	2556	3085
Weed free check	2636	3179
Weedy check	976	1134
	SEm ±	CD (P=0.05)
Weed management at the same level of vermicompost	35	100
Vermicompost at the same or different levels of weed management	60	170

Table 4: Effect of weed management and vermicompost on weed indices in fenugreek at 60 DAS and at harvest

Treatments	Weed control efficiency (%) at 60 DAS			Weed persistence index (WPI)			Crop resistance index (CRI) at harvest			Weed index (%)		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
Weed Management												
Imazethapyr 70 g ha ⁻¹ PE	69.33	68.16	68.72	1.55	1.47	1.51	2.94	2.95	2.94	35.28	34.27	34.77
Imazethapyr 70 g ha ⁻¹ PE <i>fb</i> hoeing at	82.66	81.93	82.28	1.92	1.89	1.91	6.29	6.20	6.25	22.94	21.64	22.28

40 DAS												
Imazethapyr 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	75.84	72.01	73.86	1.42	1.52	1.48	5.02	4.27	4.61	27.02	26.36	26.69
Imazethapyr + Imazamox (RM) 50 g ha ⁻¹ PoE 2-4 leaf stage of weed	67.98	65.43	66.66	1.56	1.58	1.57	3.97	3.65	3.80	28.65	26.77	27.72
Imazethapyr + Imazamox (RM) 60 g ha ⁻¹ PoE 2-4 leaf stage of weed	72.43	66.68	69.46	1.61	1.58	1.59	3.98	3.78	3.87	26.57	24.75	25.65
Pendimethalin 750 g ha ⁻¹ PE	72.89	69.29	71.03	1.20	1.27	1.23	4.21	3.74	3.95	32.69	29.51	31.09
Oxyfluorfen 120 g ha ⁻¹ PE	57.90	56.18	57.01	2.00	2.10	2.05	2.81	2.95	2.88	38.29	35.33	36.83
Oxyfluorfen 150 g ha ⁻¹ PE	69.24	66.04	67.59	2.07	2.12	2.09	3.55	3.36	3.45	34.14	29.96	32.05
Oxyfluorfen 120 g ha ⁻¹ PE,fb hoeing at 40 DAS	80.16	79.66	79.90	2.21	2.13	2.17	4.52	4.70	4.61	27.89	26.70	27.30
Oxadiargyl 100 g ha ⁻¹ PE	78.44	76.24	77.30	1.61	1.57	1.59	5.66	5.17	5.40	23.98	23.59	23.80
Oxadiargyl 100 g ha ⁻¹ PE,fb hoeing at 40 DAS	88.00	84.69	86.29	1.95	2.23	2.10	11.31	9.32	10.20	3.97	2.02	3.03
Weed free check	100.00	100.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weedy check	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	65.00	62.48	63.72

Conclusion

On the basis of two years study pre-emergence application of oxadiargyl 100 g ha⁻¹ followed by hoeing at 40 DAS was superior in curbing weed density, reducing weed dry matter, higher weed control efficiency, weed persistence index, crop resistance index, lowest weed index and higher seed yield of fenugreek.

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