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Weed management in isabgol (*Plantago ovata* Forsk)

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Abstract

A field experiment was conducted during 2013-14 to 2015-16 at Seed Spice Research Station, S.D. Agricultural University, Jagudan on “Integrated weed management in isabgol (*Plantago ovata* Forsk)”. The soil was loamy sand in texture, neutral in soil reaction, with low in organic carbon, medium in available phosphorus and potash. There were ten treatments consisting physical and chemical weed control as well as their integration. Weed control treatments affected considerably on growth and yield attributes of isabgol. Whereas, there was no positive impact on test weight. The maximum and minimum values of all the growth and yield attributes were achieved under treatment when crop was facilitate with two inter-culturing fb hand weeding at 25 and 40 DAS and unweeded control treatments, respectively. Similarly, Physical method of weed control *i.e.* Two inter-culturing fb hand weeding at 25 and 40 DAS recorded significantly higher seed yield over rest of the treatments. The weeds were controlled efficiently resulted in higher seed yield under physical method. Effective removal of weeds throughout the crop growth period better space and resources utilization *i.e.*, moisture, nutrients, solar radiation *etc.* The adoption of a purely physical method of weed control *i.e.* treatment T₆: two inter-culturing fb hand weeding at 25 and 40 DAS recorded significantly lower sedges, monocot, dicot and total weed count and dry weight of weeds during investigation. Thus, performing two inter-culturing followed by hand weedings at 20 and 40 DAS produced sustainable and quality seed yield and maintained the soil health.

Keywords : Isabgol, interculturing, integrated weed management, weed control, soil health,

Introduction

Isabgol (*Plantago ovata* Forsk) is one of the important medicinal plant belongs to family Plantaginaceae. It is a medicinal plant, valued for its mucilaginous rosy white husk (epicarp of seed). Economic value of this species is related to mucilage content of the seed mainly used in medicine and industry (Galindo *et al.*, 2000). In India, isabgol is cultivated commercially in Gujarat, Rajasthan, Haryana, Punjab, Uttar Pradesh, Madhya Pradesh and Bihar. Isabgol is a late *rabi* cash crop. Due to lower production cost and higher market price, it is known as low volume but high value crop. In Gujarat, isabgol is cultivated on commercial scale in the

region of North Gujarat and Saurashtra region. In modern agriculture, now a days farmers are practicing line sowing rather than broadcasting. Due to initial slow growth rate may increase severe weed problem during early stage, responsible up to 50 per cent in yield loss. Hand weeding is a common and effective weed control method to eliminate the weeds in isabgol crop. Herbicidal uses to reduce the cost with an increase in yields. However, herbicides are one of the sources of soil, air and water pollution and reduced export potential of isabgol.

Materials and Methods

A field experiment was conducted during *rabi* season of three consecutive years 2013-14, 2014-15 and 2015-16 at Seed Spice Research Station, S.D. Agricultural University, Jagudan on "Integrated weed management in isabgol (*Plantago ovata* Forsk)". The soil was loamy sand in texture, neutral in soil reaction, with low in organic carbon, medium in available phosphorus and potash. There were ten treatments consisting T_1 : Oxyfluorfen @ 75 g ha⁻¹ post emergence (PoE) at 20 DAS, T_2 : Oxyfluorfen @ 75 g ha⁻¹ PoE at 20 DAS + I.C. followed by (*fb*) hand weeding (H.W.) at 35 DAS, T_3 : Oxadiargyl @ 100 g ha⁻¹ as PoE at 20 DAS, T_4 : Oxadiargyl @ 100 g ha⁻¹ as PoE at 20 DAS + I.C. *fb* H.W. at 35 DAS, T_5 : Isoproturon @ 500 g ha⁻¹ as pre-emergence, T_6 : Isoproturon @ 500 g ha⁻¹ as pre-emergence + I.C. *fb* H.W. at 35 DAS, T_7 : T_5 + Oxyfluorfen @ 75 g ha⁻¹ PoE at 20 DAS, T_8 : T_5 + Oxadiargyl @ 100 g ha⁻¹ PoE at 20 DAS, T_9 : Two inter-culturing *fb* hand weeding at 25 and 40 DAS and T_{10} : Unweeded control. The treatments were replicated thrice in a randomized block design. The seeds of isabgol variety GI 3 were sown at 30 cm apart in line sowing with an application of irrigation. Hand weeding and inter-culturing operation at 25 and 40 DAS were carried out manually. Pre-emergence application of isoproturon with required quantity was sprayed by knapsack sprayer with flat fan nozzle using 500 liters of water per hectare after 3 to 4 DAS under sufficient moisture for better effect. Another light irrigation at 10 DAS was given to ensure uniform germination. A basal dose of half of nitrogen and full dose of phosphorus was applied uniformly in furrow just before sowing. The remaining half dose of nitrogen was top dressed at the time of irrigation *i.e.* 30 DAS. Different

weed flora *viz.*, sedges, monocot and dicot weeds were counted at 60 DAS. The weed count was taken from the tagged spot of 0.25 m² in the randomly selected each net plot were calculated and converted into square meter basis for convenience. In order to draw a valid conclusion, the weed count data are subjected to square root transformation ($\sqrt{x + 0.5}$) as suggested by Gomez and Gomez (1984) before statistical analysis. For dry weight of weeds, the weeds were air dried completely till they reached to constant and finally weight recorded for each treatment after harvest and converted in to kg ha⁻¹. Weed control efficiency and weed index were calculated by the formulae suggested by Kondap and Upadhyaya (1985) and Gill and Kumar (1969), respectively. Weed control efficiency (%) and Weed Index (%) were worked out by using formulae given below. respectively. Statistical analysis was done as per by Panse and Sukhatme (1985).

$$\text{Weed control efficiency (\%)} = [(DWC - DWT)/DWC] \times 100$$

Where, WCE = Weed control efficiency (%).

DWT = Dry weight of weeds in treated plot.

DWC = Dry weight of weeds in unweeded control plot.

$$\text{Weed Index (\%)} = [(X - Y)/X] \times 100 \text{ where,}$$

Where, X is the yield from weed-free plot and Y is the yield from treated plot.

Results and discussion

Growth and yield attributes

Weed control treatments affected considerably on growth and yield attributes of isabgol. Whereas, there was no positive impact on test weight (Table 1) based on pooled data. The maximum and minimum values of all the growth and yield attributes were achieved under treatment when crop was facilitated with two inter-culturing *fb* hand weeding at 25 and 40 DAS and unweeded control treatments, respectively except plant height where it was the highest under the treatments when isoproturon applied @ 500 g ha⁻¹ as pre-emergence and application of isoproturon @ 500 g ha⁻¹ as pre-emergence + I.C. *fb* H.W. at 35 DAS. Treatments T_5 (Isoproturon @ 500 g ha⁻¹ as pre-emergence) and T_6 (Isoproturon @ 500 g ha⁻¹ as pre-emergence + Two inter-

culturing *fb* hand weeding at 25 and 40 DAS) were at par and recorded significantly higher plant height over rest of the treatments, except treatments T_9 : Two inter-culturing *fb* hand weeding at 25 and 40 DAS T_4 : Oxadiargyl @ 100 g ha⁻¹ as PoE at 20 DAS + I.C. *fb* H.W. at 35 DAS, T_8 : T_5 + Oxadiargyl @ 100 g ha⁻¹ PoE at 20 DAS and T_7 : T_5 + Oxyfluorfen @ 75 g ha⁻¹ PoE at 20 DAS. The maximum number of tillers per plant, spike per plant, length of spike and seeds per spike were recorded under treatment T_9 : Two inter-culturing *fb* hand weeding at 25 and 40 DAS was remained at par with the treatments T_4 : Oxadiargyl @ 100 g ha⁻¹ as PoE at 20 DAS + I.C. *fb* H.W. at 35 DAS, T_5 : Isoproturon @ 500 g ha⁻¹ as pre-emergence, T_6 : Isoproturon @ 500 g ha⁻¹ as pre-emergence + I.C. *fb* H.W. at 35 DAS, T_8 : T_5 + Oxadiargyl @ 100 g ha⁻¹ PoE at 20 except T_2 : Oxyfluorfen @ 75 g ha⁻¹ PoE at 20 DAS + I.C. *fb* H.W. at 35 DAS for numbers of tillers per plant. However, all the growth and yield attributes were the minimum under unweeded plot (T_{10}). The findings have been reported by Sagarka *et al.* (2005) and Salvi *et al.* (2015) in isabgol, several scientist in seed spices by Mehriya *et al.* (2007) in fenugreek as well as Patel *et al.* (2019 a) in dill seed and Patel *et al.* (2019 b) in ajwain.

Seed yield

Seed yield of isabgol was significantly influenced due to different chemical, physical as well as their integrated treatments during the course of investigation as well as on pooled basis (Table 2). Physical method of weed control *i.e.* two inter culturing *fb* hand weeding at 25 and 40 DAS (T_9) recorded significantly higher seed yield over rest of the treatments and remained at par with the treatments T_6 : Isoproturon @ 500 g ha⁻¹ as pre-emergence + I.C. *fb* H.W. at 35 DAS, T_5 : Isoproturon @ 500 g ha⁻¹ as pre-emergence, T_8 : T_5 + Oxadiargyl @ 100 g ha⁻¹ PoE at 20 DAS, T_4 : Oxadiargyl @ 100 g ha⁻¹ as PoE at 20 DAS + I.C. *fb* H.W. at 35 DAS, T_2 : Oxyfluorfen @ 75 g ha⁻¹ PoE at 20 DAS + I.C. *fb* H.W. at 35 DAS, and T_7 : T_5 + Oxyfluorfen @ 75 g ha⁻¹ PoE at 20 DAS, in the year 2012-13 and 2013-14 except treatment T_7 (T_5 + Oxyfluorfen @ 75 g ha⁻¹ PoE at 20 DAS) in the year 2013-14. Whereas, in the year 2014-15 and in pooled data, it was remained at par only with treatments T_8 : T_5 + Oxadiargyl @ 100 g ha⁻¹ PoE at 20 DAS, T_6 : Isoproturon @ 500 g ha⁻¹ as pre-emergence + I.C. *fb* H.W. at 35 DAS,

T_5 : Isoproturon @ 500 g ha⁻¹ as pre-emergence and T_4 : Oxadiargyl @ 100 g ha⁻¹ as PoE at 20 DAS + I.C. *fb* H.W. at 35 DAS. The weeds under these treatments were controlled efficiently resulted in higher seed yield. Effective removal of weeds throughout the crop growth period by physical and integrated weed control practices provided and better space and resources *i.e.*, moisture, nutrients, solar radiation *etc.*, for crop plant which could be improved ultimately to higher yields. These findings corroborate the results reported by Salvi *et al.* (2015) in isabgol, Patel *et al.* (2016) in cumin, Patel *et al.* (2017) in fennel, Patel *et al.* (2019 a) in dill seed and Patel *et al.* (2019 b) in ajwain. Treatment unweeded control (T_{10}) recorded significantly lowest seed yield during course of investigation and on pooled basis. This might be due to sever competition between crop and weed resulted into poor quality yield.

Weed study

Weed flora

The major weed species appeared in the experimental plot during the crop growth period were *Cynodon dactylon* L. and *Cyperus rotundus* L. as sedges in the weedy check treatment. In case of monocot weed species, *Asphodelus tenuifolius* L., *Melilotus indica* L. and *Digitaria sanguinalis* L. were appeared. However, dicot weed species are concerned, majority population of *Chenopodium album* L., *Amaranthus spinosus* L., *Amaranthus viridis* L., *Spergula arvensis* L., *Boerhavia diffusa* L., *Launaea nudicaulis* L., *Phyllanthus niruri* L. and *Portulaca oleracea* L. were observed during three years of study.

Weed count

The weed count at 60 DAS (Table 3) significantly influenced due to different weed control practices on pooled basis. The adoption of purely physical method of weed control *i.e.* treatment T_9 : two inter-culturing *fb* hand weeding at 25 and 40 DAS recorded significantly lower sedges, monocot, dicot and total weed count during the course of investigation. Significantly the highest weed counts of sedges, monocot, dicot and their total were registered by treatment unweeded control on pooled basis. The findings have been reported by Sagarka *et al.* (2005) and Salvi *et al.* (2015) in isabgol.

Dry weight of weeds

Similar trend was observed for dry weight of weeds as observed in different weed count of weeds during course

of study. The dry weight of sedges, monocot, dicot as well as their total was significantly affected by different weed management practices (Table 3). The minimum sedges, monocot, dicot and their total dry weight of weeds was registered with T_9 : Two inter-culturing *fb* hand weeding at 25 and 40 DAS. The dry weight of sedges, monocot, dicot and their total was recorded significantly the highest over rest of the treatments by unweeded control during course of investigation. Numerically higher weed control efficiency (Table 3) was registered with the treatment T_9 : Two inter-culturing *fb* hand weeding at 25 and 40 DAS (92 %) *fb* treatments T_4 : Oxadiargyl @ 100 g ha⁻¹ as PoE at 20 DAS + I.C. *fb* H.W. at 35 DAS (91%) and T_6 :

Isoproturon @ 500 g ha⁻¹ as pre-emergence + I.C. *fb* H.W. at 35 DAS (91 %). Researchers have reported similar observations on dry weed weight for fenugreek (Mehriya *et al.*, 2007), dill seed (Patel *et al.*, 2019 a) and ajwain (Patel *et al.*, 2019 b).

Weed control efficiency and Weed Index (%)

The data pertaining to weed control efficiency (%) and weed index (%) are tabulated in Table 3. The results revealed that higher weed control efficiency was recorded when two inter-culturing *fb* hand weeding at 25 and 40 DAS was made followed by application of oxadiargyl @ 100 g ha⁻¹ as PoE or isoproturon @ 500 g ha⁻¹ as pre-emergence *fb* at 20 DAS + I.C. *fb* H.W. at 35

Table 1 : Growth and yield attributes of Isabgol as influenced by different weed control treatments (Pooled data).

Treatments	Plant height (cm)	No. of tillers plant ⁻¹	No. of spike plant ⁻¹	Length of spike (cm)	No. of seeds spike ⁻¹	Test weight (g)
T_1 : Oxyfluorfen @ 75 g ha ⁻¹ PoE at 20 DAS	22.9	3.1	17.9	2.8	31.6	1.50
T_2 : Oxyfluorfen @ 75 g ha ⁻¹ PoE at 20 DAS + I.C. <i>fb</i> H.W. at 35 DAS	27.1	3.6	19.3	3.1	34.7	1.52
T_3 : Oxadiargyl @ 100 g ha ⁻¹ as PoE at 20 DAS	26.7	3.2	18.1	2.9	32.3	1.51
T_4 : Oxadiargyl @ 100 g ha ⁻¹ as PoE at 20 DAS + I. C. <i>fb</i> H.W. at 35 DAS	29.0	3.9	20.8	3.3	36.8	1.53
T_5 : Isoproturon @ 500 g ha ⁻¹ as pre-emergence	29.7	3.9	21.1	3.4	37.0	1.54
T_6 : Isoproturon @ 500 g ha ⁻¹ as pre-emergence + I.C. <i>fb</i> H.W. at 35 DAS	29.7	3.9	22.1	3.4	38.1	1.53
T_7 : T_5 + Oxyfluorfen @ 75 g ha ⁻¹ PoE at 20 DAS	28.2	3.5	17.9	3.1	31.4	1.51
T_8 : T_5 + Oxadiargyl @ 100 g ha ⁻¹ PoE at 20 DAS	28.3	3.6	20.6	3.3	37.2	1.53
T_9 : Two interculturing <i>fb</i> hand weeding at 25 and 40 DAS	29.5	4.0	22.0	3.4	39.0	1.54
T_{10} : Unweeded control	20.0	2.7	16.9	2.2	29.0	1.44
S.Em(±)	0.91	0.13	0.62	0.1	1.14	0.03
CD at 5 %	2.6	0.4	1.8	0.3	3.3	NS
Y x T	NS	NS	NS	NS	NS	NS
S.Em(±)	-	-	-	-	-	-
CD at 5 %	-	-	-	-	-	-
CV %	10	12	9	10	10	6

Table 2 : Seed yield of isabgol as influenced by different weed control treatments (Pooled data).

Treatments	Isabgol seed yield (kg ha ⁻¹)			
	2013-14	2014-15	2015-16	Pooled
T ₁ :Oxyfluorfen @ 75 g ha ⁻¹ PoE at 20 DAS	355	361	441	386
T ₂ :Oxyfluorfen @ 75 g ha ⁻¹ PoE at 20 DAS + I.C. fb H.W. at 35 DAS	716	678	667	687
T ₃ :Oxadiargyl @ 100 g ha ⁻¹ as PoE at 20 DAS	367	306	509	394
T ₄ :Oxadiargyl @ 100 g ha ⁻¹ as PoE at 20 DAS + I.C. fb H.W. at 35 DAS	727	704	714	715
T ₅ :Isoproturon @500 g ha ⁻¹ as pre-emergence	766	715	751	744
T ₆ :Isoproturon @500 g ha ⁻¹ as pre-emergence + I.C. fb H.W. at 35 DAS	780	751	792	774
T ₇ :T ₅ + Oxyfluorfen @ 75 g ha ⁻¹ PoE at 20 DAS	710	540	571	607
T ₈ :T ₅ + Oxadiargyl @ 100 g ha ⁻¹ PoE at 20 DAS	753	694	728	725
T ₉ : Two interculturing fb hand weeding at 25 and 40 DAS	783	743	820	782
T ₁₀ : Unweeded control	253	194	278	242
S.Em(±)	52	38.69	44.61	26.35
CD at 5 %	156	115	132	75
Y x T	NS	NS	NS	NS
CV %	15	12	12	13

DAS. The higher weed index value was recorded in unweeded control followed by application of oxyfluorfen @ 75 g ha⁻¹ PoE at 20 DAS. The lowest value was recorded with two inter-culturing fb hand weeding at 25 and 40 DAS and application of Isoproturon @ 500 g ha⁻¹ as pre-emergence + I.C. fb H.W. at 35 DAS.

Economics

Isoproturon @ 500 g ha⁻¹ as pre-emergence + I.C. fb H.W. at 35 DAS recorded higher net return of Rs. 34664/- which was closely fb the treatment T₉: Two inter-culturing fb hand weeding at 25 and 40 DAS (Rs.32901/-). Similarly maximum BCR value of 1.20 (Table 4) was recorded with the treatment isoproturon @ 500 g ha⁻¹ as

pre-emergence + I.C. fb H.W. at 35 DAS fb T₈ (1.11), T₉ (1.05) and T₅ (1.02).

Conclusion

In conclusion, physical weed control methods are the most efficient and effective weed management strategy for getting higher and residue-free produce and to effectively control weed growth in isabgol. A two-step inter-culturing process followed by hand weeding at 20 and 40 DAS produced sustainable and quality seed yields, as well as maintaining soil health

Conflicts of Interest : The authors declare no conflicts of interest.

Table 3 : Weed count (numbers / m²) in Isabgol crop at 60 DAS, dry weight of weed (kg ha⁻¹), weed control efficiency (WCE) and Weed intensity (WI) as influenced by different weed management practices (Pooled data).

Treatments	Weed count (No./m ²) at 60 DAS					Dry weight of weed(Kg ha ⁻¹)			WCE (%)	WI (%)
	Sedges	Monocot	Dicot	Total		Sedges	Monocot	Dicot		
T ₁ :Oxyfluorfen @ 75 g ha ⁻¹ PoE at 20 DAS	1.42	1.34	3.32	3.73		105	45	577	56	50.7
T ₂ :Oxyfluorfen @ 75 g ha ⁻¹ PoE at 20 DAS + I.C. fb H.W. at 35 DAS	1.21	1.35	2.95	3.27		56	43	124	87	12.1
T ₃ :Oxadiargyl @ 100 g ha ⁻¹ as PoE at 20 DAS	1.30	2.21	3.15	3.94		120	255	427	51	49.6
T ₄ :Oxadiargyl @ 100 g ha ⁻¹ as PoE at 20 DAS + I.C. fb H.W. at 35 DAS	1.22	1.38	1.49	2.03		34	47	72	91	8.6
T ₅ :Isoproturon @500 g ha ⁻¹ as pre-emergence	1.30	1.42	1.38	2.09		79	100	33	86	4.9
T ₆ :Isoproturon @500 g ha ⁻¹ as pre-emergence + I.C. fb H.W. at 35 DAS	1.15	1.32	1.42	1.94		33	59	64	91	1.0
T ₇ :T ₅ + Oxyfluorfen @ 75 g ha ⁻¹ PoE at 20 DAS	1.70	1.30	2.83	3.40		109	44	109	84	22.4
T ₈ :T ₅ + Oxadiargyl @ 100 g ha ⁻¹ PoE at 20 DAS	1.64	2.26	1.50	2.83		110	151	69	80	7.2
T ₉ : Two i nterculturing fb hand weeding at 25 and 40 DAS	1.05	1.26	1.30	1.91		26	35	73	92	0.0
T ₁₀ : Unweeded control	1.94	2.79	4.25	5.36		140	296	1216	0	69.1
SEM+	0.06	0.06	0.07	0.07		2.02	2.36	12.5	-	-
CD at 5 %	0.18	0.18	0.20	0.20		6	7	36	-	-
Y x T	NS	NS	NS	NS		S	S	S	-	-
SEM+	-	-	-	-		4.80	3.63	25	-	-
CD at 5 %	-	-	-	-		14	11	75	-	-
CV %	14.0	12.0	9.0	7.0		7	7	14	-	-

Table 4 : Economics of isabgol crop as influenced by different weed control treatments

Treatments	Seed yield (Kg ha ⁻¹)	Gross realization (Rs ha ⁻¹)	Gross expenditure (Rs ha ⁻¹)	Net return (Rs ha ⁻¹)	BCR
T ₁ :Oxyfluorfen @ 75 g ha ⁻¹ PoE at 20 DAS	386	31616	25639	5977	0.23
T ₂ :Oxyfluorfen @ 75 g ha ⁻¹ PoE at 20 DAS + I.C. fb H.W. at 35 DAS	687	56319	28815	27504	0.95
T ₃ :Oxadiargyl @ 100 g ha ⁻¹ as PoE at 20 DAS	394	32295	28180	4115	0.15
T ₄ :Oxadiargyl @ 100 g ha ⁻¹ as PoE at 20 DAS + I.C. fb H.W. at 35 DAS	715	58613	31356	27257	0.87
T ₅ :Isoproturon @500 g ha ⁻¹ as pre-emergence	744	60994	26005	34989	1.35
T ₆ :Isoproturon @500 g ha ⁻¹ as pre-emergence + I.C. fb H.W. at 35 DAS	774	63479	29181	34298	1.18
T ₇ :T ₅ + Oxyfluorfen @ 75 g ha ⁻¹ PoE at 20 DAS	607	49770	25639	24131	0.94
T ₈ :T ₅ + Oxadiargyl @ 100 g ha ⁻¹ PoE at 20 DAS	725	59460	28180	31280	1.11
T ₉ :Two interculturing fb hand weeding at 25 and 40 DAS	782	64104	31202	32901	1.05
T ₁₀ : Unweeded control	242	19832	24850	-5018	-0.20

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