Short communication

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Integrated weed management for increased yield and quality of isabgol

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Isabgol (*Plantago ovata* Forsk) is one of the important medicinal plants grown during *rabi* season and introduced into India during Muslim settlement in middle ages. The name is derived from two Persian words "Isab" and "Ghol" meaning horse's ear. This derivation fits well with the shape of the seed which resembles the ear of horse. Seeds of isabgol are mainly valued for their mucilaginous rosy white husk. In addition to medicinal uses, it has a place in dyeing, printing, ice-cream, confectionary and cosmetic industries.

In India, isabgol is cultivated commercially in Gujarat, Rajasthan, Haryana, Punjab, Uttar Pradesh, Madhya Pradesh and Bihar. It is a late *rabi* season cash crop. Due to lower production cost and higher market price, it is known as a low volume but high value crop. Initial slow growth rate of isabgol invites severe weed problem during early stages which is responsible up to 50% yield loss. Managing the weeds by hand weeding, a costly affair, has also reduced yield and quality of produce. Integrated weed management approaches involving physical and chemical weed control techniques can help achieve complete, long-term and effective control of weeds during crop season. Keeping this in view, the present experiment was planned as per the methods below.

The field experiment was conducted at Agronomy Instructional Farm, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushi nagar during *rabi* 2012-13. Twelve treatments of weed control *i.e*. oxyfluorfen 50 g/ha post-emergence at 20 DAS, oxyfluorfen 50 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS, oxyfluorfen 75 g/ha post-emergence at 20 DAS, oxyfluorfen 75 g/ha post-emergence at 15 DAS + interculturing followed by hand weeding at 30 DAS, isoproturon 500 g/ha as pre-emergence, oxadiargyl 80 g/ha at 20 DAS, oxadiargyl 80 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS, oxadiargyl 100 g/ha at 20 DAS, oxadiargyl 100 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS, interculturing followed by hand weeding at 20 and 40 DAS, unweeded and weed-free were evaluated in randomized block design with three replications. The soil was loamy-sand low organic carbon (0.27 %) and available nitrogen (149 kg/ha), medium in available phosphorus (38.9 kg/ha) and high in available potash (287.0 kg/ha) with 7.7 pH. The crop was fertilized with recommended dose of fertilizer *i.e.* 40 kg N and 20 kg P_2O_5/ha in the form of Urea and DAP, respectively in manually opened furrows at 30 cm distance. Half nitrogen in the form of urea was applied at the time of sowing and remaining half N was top-dressed at 30 DAS. Isabgol (variety - *GI 3*) was sown in first week of December, 2012 and crop was harvested in last week of March, 2013. Weeding and interculturing were carried out during crop season for weed management as per treatments. The observations were recorded on growth and yield determinates and yields of isabgol during the crop period. The protein content was evaluated by estimation of nitrogen content in seed by adopting Kjeldhal's method (Jackson 1973) multiplying the nitrogen content to 6.25. The swelling factor was determined as per the method suggested by (Kalyansundram *et al.* 1982). The economics of different treatments was worked out in terms of net returns/ha and benefit cost ratio. Simple correlation coefficient (r) of each character was also calculated.

Effect on growth and yield attributes

It is evident from the data presented in Table 1 that all the growth parameters, yield attributes and yields differed significantly due to integrated weed management treatments. Statistically the higher plant height (36.3 cm) at harvest, number of total (22.4) and effective (15.6) tillers per plant, length of spike (5 cm) and 1000-seed weight (1.88 g) of isabgol were recorded when crop was kept weed free. Weed free

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treatment did not differ significantly with treatments interculturing followed by hand weeding at 20 and 40 DAS, oxadiargyl 100 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS and oxadiargyl 80 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS, but was significantly superior over rest of the treatments. The minimum plant height was recorded when no weed management practices were adopted, which may be responsible for severe competition between weeds and crop plants for space and resources *i.e*. light, nutrient, moisture *etc*. Effective control of weeds improved crop growth, checked nutrient depletion by weeds and accelerated more absorption of nutrients by isabgol crop that resulted in taller plants with more number of tillers. Similar results were reported by Patel *et al.* (1996) and Sharma and Jain (2002).

Effect on yield

Isabgol yield is an output of sequential metamorphosis from source to sink. Marked effect on yields of isabgol was recorded due to various integrated weed management practices (Table 2). The maximum seed yield/plant, seed and straw yields/ha was recorded 1.74 g, 1225 and 2930 kg/ha, respectively under weed-free crop condition, which was significantly superior over rest of the treatments except treatment oxadiargyl 80 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS oxadiargyl 80 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS, oxadiargyl 100 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS and interculturing followed by hand weeding at 20 and 40 DAS. Performance of interculturing and hand weeding at 20 and 40 DAS did not differ significantly with treatments oxadiargyl 100 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS oxadiargyl 80 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS, oxyfluorfen 75 g/ha post-emergence at 15 DAS + interculturing followed by hand weeding at 30 DAS and isoproturon 500 g/ha as pre-emergence. Per cent increase in yield due to treatment interculturing followed by hand weeding at 20 and 40 DAS over unweeded, oxyfluorfen 50 g/ha post-emergence at 20 DAS and oxyfluorfen 75 g/ha post-emergence at 20 DAS was 185.6, 114.2 and 98.9% whereas, it was 151.2, 88.4 and 75.0% due to treatment oxadiargyl 100 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS, respectively. Effective removal of weeds throughout the crop growth period by physical and integrated weed control practices provided better space and resources *i.e.*, moisture, nutrients, solar radiation etc., for crop plant which led to higher yields. These findings corroborate the results reported by Patel and Mehta (1986), Patel *et al.* (1996), Sharma and Jain (2002), Kumawat *et al.* (2002) and Sagarka *et al.* (2005) as well as Yadav *et al.* (2005) and Mehariya *et al.* (2007) in case of cumin.

The unweeded crop condition recorded the significantly highest, whereas use of oxyfluorfen 75 g/ha alone as post-emergence recorded the least harvest index. The per cent increase in harvest index due to treatment unweeded was 21.3, 23.5, 29.0, 30.2 and 35.2 with treatments isoproturon 500 g/ha as pre-emergence, oxyfluorfen 75 g/ha post-emergence at 15 DAS + interculturing followed by

Table 1. Effect of different integrated weed management treatments on growth and yield attributes of isabgol

Treatment	Plant height (cm)			Total tillers/ plant	Effective tillers/ plant	Length of spike (cm)	1000-grain weight (g)
	30 DAS	60 DAS	Harvest				
T_1 : Oxyfluorfen 50 g/ha post-emergence at 20 DAS	10.8	25.0	32.1	12.3	10.1	3.4	1.50
T_2 : Oxyfluorfen 50 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS	11.7	26.8	34.0	16.0	12.2	4.4	1.60
T_3 : Oxyfluorfen 75 g/ha post-emergence at 20 DAS	11.0	25.6	32.6	13.0	10.7	3.7	1.55
T_4 : Oxyfluorfen 75 g/ha post-emergence at 15 DAS + interculturing followed by hand weeding at 30 DAS	12.6	28.0	34.7	17.6	13.1	4.5	1.65
T_5 : Isoproturon 500 g/ha as pre-emergence	12.0	27.6	34.3	16.8	13.0	4.4	1.62
T_6 : Oxadiargyl 80 g/ha at 20 DAS	11.2	26.0	33.6	14.3	11.4	4.1	1.58
T_7 : Oxadiargyl 80 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS	12.8	28.5	35.0	18.9	14.0	4.6	1.75
T_8 : Oxadiargyl 100 g/ha at 20 DAS	11.6	26.4	34.3	15.8	12.1	4.2	1.60
T_9 : Oxadiargyl 100 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS	13.2	29.0	35.3	20.4	14.3	4.7	1.80
T_{10} : Interculturing followed by hand weeding at 20 and 40 DAS	13.4	29.9	35.7	21.4	14.9	4.8	1.85
T_{11} : Un weeded	10.7	24.6	27.9	8.67	6.6	2.9	1.00
T_{12} : Weed-free	13.8	30.6	36.3	22.4	15.6	5.0	1.88
LSD (P=0.05)	1.30	2.64	3.17	3.15	2.63	0.83	0.30

Table 2. Effect of different integrated weed management treatments on yield and quality of isabgol

Treatments	Seed yield/ plant (g)	Yields (t/ha)		Harvest index (%)	Swelling factor (ml/g)	Protein content (%)
		Seed	Straw			
T_1: Oxyfluorfen 50 g/ha post-emergence at 20 DAS	0.68	0.51	1.30	28.1	9.3	16.9
T_2: Oxyfluorfen 50 g/ha at 15 DAS + interculturing *fb* hand weeding at 30 DAS	1.02	0.81	1.96	29.2	10.3	17.5
T_3: Oxyfluorfen 75 g/ha post-emergence at 20 DAS	0.73	0.55	1.69	24.5	9.7	17.0
T_4: Oxyfluorfen 75 g/ha post-emergence at 15 DAS + interculturing *fb* hand weeding at 30 DAS	1.41	0.90	2.03	30.8	11.8	17.7
T_5: Isoproturon 500 g/ha as pre-emergence	1.18	0.90	1.96	31.3	10.7	17.6
T_6: Oxadiargyl 80 g/ha at 20 DAS	0.85	0.60	1.82	24.9	10.2	17.3
T_7: Oxadiargyl 80 g/ha at 15 DAS + interculturing *fb* hand weeding at 30 DAS	1.46	0.92	2.64	25.9	12.0	17.8
T_8: Oxadiargyl 100 g/ha at 20 DAS	0.97	0.64	1.92	24.5	10.3	17.4
T_9: Oxadiargyl 100 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS	1.62	0.96	2.73	26.0	12.0	17.9
T_{10}: Interculturing *fb* hand weeding at 20 and 40 DAS	1.65	1.09	2.83	27.8	13.1	18.1
T_{11}: Unweeded	0.30	0.38	0.62	38.0	9.0	16.5
T_{12}: Weed-free	1.74	1.22	2.93	29.5	14.0	18.3
LSD (P=0.05)	0.29	0.19	0.38	3.94	1.00	NS

hand weeding at 30 DAS weede free, oxyfluorfen 50 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS and oxyfluorfen 50 g/ha post-emergence at 20 DAS, respectively. Similar results were also reported by Singh *et al.* (2005), Kulmi and Dubey (2006), Kulmi (2007) in case of isabgol and Yadav *et al.* (2005) in case of cumin.

Effect on quality parameters

Weed free treatment secured maximum swelling factor (14.0 ml/g), which was at par with interculturing followed by hand weeding at 20 and 40 DAS, interculturings and hand weedings at 20 and 40 DAS. It was minimum under unweeded crop condition. On the contrary, various integrated weed control treatments did not exert any significant influence on protein content of seed though the higher value of protein content (18.3%) was recorded under weed free plot. These findings corroborate the results reported by Sagarka *et al.* (2005) and Mehariya *et al.* (2007).

Table 3. Correlation coefficient (r) between seed yield (kg/ha) and other characters

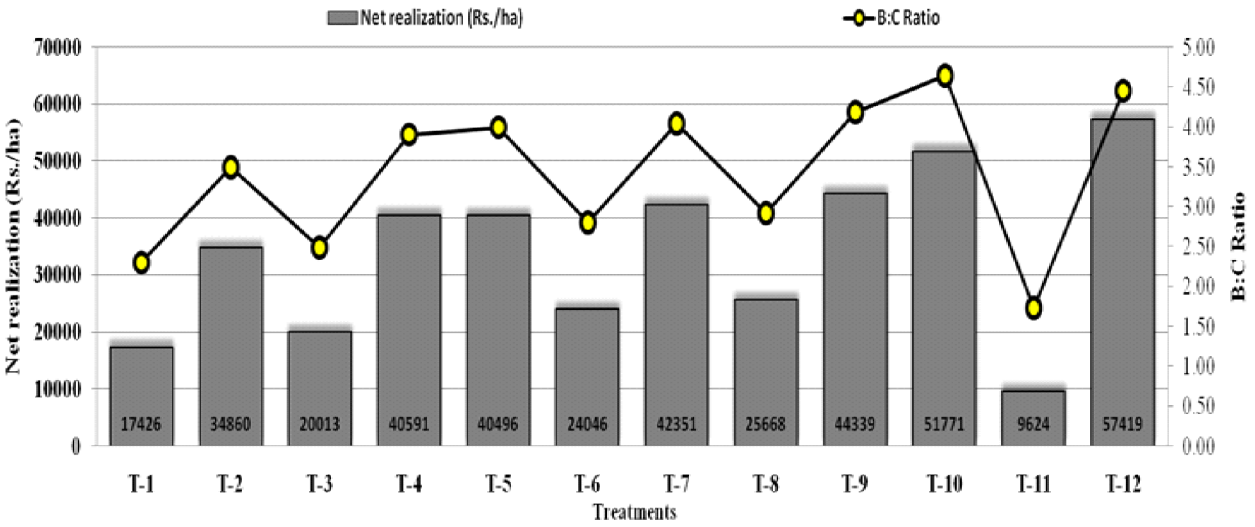
Characters	(r)
Plant height (cm)	0.744
Number of total tillers per plant	0.837
Number of effective tillers per plant	0.788
Length of spike (cm)	0.714
Number of seed per spike	0.532
1000-seed weight (g)	0.425
Seed yield per plant (g)	0.855
Straw yield (kg/ha)	0.808

Note: r value significant at 5 per cent level of probability in all cases.

Effect on economics

Weed free treatment gave the maximum net realization (` 57,419/ha) and was followed by treatments interculturing followed by hand weeding at 20 and 40 DAS (Fig. 1), interculturing and hand weeding at 20 and 40 DAS and oxadiargyl 100 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS and oxadiargyl 100 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS. The highest value of benefit cost ratio, *i.e.* 4.65 was obtained under interculturing and hand weeding at 20 and 40 DAS interculturing followed by hand weeding at 20 and 40 DAS which was closely followed by treatments weed free, oxadiargyl 100 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS and Oxadiargyl 80 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS with BCR values of 4.46, 4.19 and 4.05, respectively. Thus, adoption of interculturing and hand weeding at 20 and 40 DAS was more effective for getting remunerative higher yield.

Yield is a complex quantitative character, which depends on different interrelated characters. These components may show varying degree of association, either favourable or unfavorable. Hence, in order to attain rational improvement in yield, the extent of relationship between the seed yield (kg/ha) and other growth characters as well as yield attributes were studied. It was noticed that growth parameters, yield attributes and straw yield (kg/ha) showed positive significant correlation with seed yield (Table 3).



It can be concluded that effective weed control with higher yields of isabgol under loamy-sand soil of North Gujarat Agro-climatic condition was obtained by performing two interculturings followed by hand weeding at 20 and 40 DAS. During labor scarcity, economically viable production of isabgol can be achieved by adopting integrated weed management practices *i.e.* post-emergence application of oxadiargyl 100 g/ha at 15 DAS with interculturing followed by hand weeding at 30 DAS.

SUMMARY

A field experiment was carried out during *rabi* 2012-13 to study the effect of integrated weed management in isabgol (*Plantago ovata* Forsk). Twelve treatments of weed control *i.e.*, oxyfluorfen 50 g/ha post-emergence at 20 DAS, oxyfluorfen 50 g/haat 15 DAS + interculturing followed by hand weeding at 30 DAS,oxyfluorfen 75 g/ha post-emergence at 20 DAS, oxyfluorfen 75 g/ha post-emergence at 15 DAS + interculturing followed by hand weeding at 30 DAS, isoproturon 500 g/ha as pre-emergence, oxadiargyl 80 g/ha at 20 DAS, oxadiargyl 80 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS, oxadiargyl 100 g/ha at 20 DAS, oxadiargyl 100 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS, interculturing followed by hand weeding at 20 and 40 DAS, unweeded and weed free were evaluated in randomized block design with three replications. Results revealed that, crop in weed free condition recorded significantly higher growth parameters, yield attributes, swelling factor (14.0 ml/g), seed (1.22 t/ha) and straw (2.93 t/ha) yields, which were statistically at par to the physical method *i.e.* interculturing followed by two hand weedings at 20 and 40 DAS and integrated weed management practices *i.e.* oxadiargyl 100 g/ha at 15 DAS + interculturing followed by hand weeding at 30 DAS.

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