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Weed dynamics, growth pattern, yield and economics of linseed under different weed management practices

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ABSTRACT

A field experiment was conducted during *Rabi* season of 2016-17 and 2017-18 at Research cum Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh to study weed dynamics, growth pattern, yield and economics of Linseed (*Linum usitatissimum* L.) under weed management practices. The experiment consisted ten treatments replicated thrice using the linseed variety '*RLC-92*'.The plant population, plant height and number of branches varied significantly among different weed management treatments. Linseed seed yield was significantly higher (1.94 t/ha) with hand weeding twice, which was statistically at par with isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) post-emergence treatment (PoE), metsulfuron-methyl (4 g/ha) PoE and pendimethalin (1 kg/ha) pre-emergence treatment (PE) followed by (*fb)* metsulfuron-methyl (4 g/ha) PoE. Density and biomass of weed was the lowest and weed control efficiency was higher with hand weeding twice 21 and 45 days after seeding (DAS) followed by isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) PoE and metsulfuron-methyl (4 g/ha) PoE. The gross return was maximum with hand weeding twice 21 and 45 DAS while net return was maximum with isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) PoE. The highest benefit: cost ratio (3.91) was recorded with metsulfuron-methyl (4 g/ha) PoE due to higher seed yield coupled with lower cost of chemical treatment.

INTRODUCTION

India is an important linseed growing country in the world and it contributes 7% to the world linseed pool (Devendra *et al.* 2016). Among the oilseeds, linseed or flax (*Linum usitatissimum* L.) is one of the oldest crop, grown in almost all countries of world for oil, fibre and seed purpose. Linseed is unique among oilseeds for its technical grade vegetable oil producing ability and fibre (good quality having high strength and durability) production. Linseed contains 35-45% oil with high content of omega-3 fatty acid and alpha lenolenic acid (ALA). Omega-3 fatty acid lowers levels of triglycerides in the blood, thereby reducing heart disease and also promise in the battle against rheumatoid arthritis (Amin and Thakur 2014, ISOR 2015). Linseed oil contains three times as much omega-3 fatty acid than omega-6 fatty acid (Singh *et al.* 2013). Its seed has 36% protein out of which 85% is digestible. Its oil cake is used to feed milch and fattening animals for milk and meat production. Its oil has a lot of uses apart from human consumption *viz.* Oil paint, varnishes, printing ink, oil cloth, soap, patent leather and waterproof fabrics due to its fast volatility feature (Sharma *et al*. 2015). Round the globe linseed crop occupies an area of 2.764 million ha yielding out 2.925 million tons having an average productivity of 1.06 t/ha (Anonymous 2018). Our national production of 0.18 million tons is realized from an area of 0.32 million/ha with low productivity of 567 kg/ha in world arena (Anonymous 2017a).

Linseed is mainly cultivated in the states like Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Maharashtra, Rajasthan, West Bengal, Karnataka, Odisha and Bihar. The average productivity of this crop is very low as compared to other oilseed crops, which can be attributed to several reasons. The major causes behind low production of linseed mainly in sub-marginal and input starved coupled with poor weed management (Anonymous 2017b). Hence appropriate herbicides for managing weeds in linseed are needed for enhancing linseed yield. Pre-mixed application of pre-emergence and post-emergence herbicides was found effective elsewhere for weed control in linseed and other oilseed crops (Siddesh *et al.* 2016) but region specific information is needed. Therefore the study was carried out to evaluate herbicides for weed dynamics, growth pattern, yield and economic in linseed.

MATERIALS AND METHODS

Experiment was conducted at Research cum Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.) during *Rabi* season of 2016-17 and 2017-18. The experiment was conducted in a randomized block design with ten treatments replicated thrice. The treatment details were: metribuzin + oxyflurofen (250 g + 125 g/ha) pre-emergence treatment (PE), oxyflurofen (25 g/ha) PE, oxadiargyl (80 g/ha) PE, imazethapyr (75 g/ha) post-emergence treatment (PoE), metsulfuron-methyl (4 g/ha) PoE, isoproturon (1 kg/ha) PoE, isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) PoE, pendimethalin (1 kg/ha) PE *fb* metsulfuron-methyl (4 g/ha) PoE, hand weeding twice 21 and 45 days after seeding (DAS) and weedy check. Linseed variety '*RLC-92*'was sown on 19th November 2016 and 15th November 2017, first year and second year respectively at 30 cm row to row spacing. Observations for crop and weed were determined as per standard procedure. The computation of weed control efficiency and economics study *i.e.* cost of cultivation, gross return, net return and B:C ratio were computed as per standard formulas. Pooled data of 2 years has been presented in this paper. Transformation ($\sqrt{x + 0.5}$) of weed data and statistical analysis was fallowed as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect on growth and yield of linseed

Seed yield is highly dependent upon the growth and yield attributes of linseed crop. The significantly higher plant population was observed with isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) PoE, which was found at par with the treatment of metsulfuron-methyl (4 g/ha) POE, pendimethalin (1 kg/ha) PE *fb* metsulfuron-methyl (4 g/ha) PoE and hand weeding twice at 21 and 45 DAS and lower plant population recorded under weedy check treatment at both stages of observations, as reported earlier (Bali *et al*. 2015). The maximum plant height was observed with hand weeding twice at 21 and 45 DAS at all growth stages of linseed (**Table 1)**. Maximum number of branches was found with hand weeding twice at 21 and 45 DAS at harvest stage and statistically at par with the application of isoproturon + metsulfuron-methyl (1 kg/ha + 4 g/ha) PoE, metsulfuron-methyl (4 g/ha) PoE and pendimethalin (1 kg/ha) PE *fb* metsulfuron-methyl (4 g/ha) PoE. At 30 DAS differences were not significant among weed management practices as reported by Mankar (2015). Significantly higher seed yield (1.94 t/ha) was observed with hand weeding twice and it was statistically at par with isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) PoE, metsulfuron-methyl (4 g/ ha) PoE and pendimethalin (1 kg/ha) PE *fb* metsulfuron-methyl (4 g/ha) PoE. Minimum seed yield was recorded under weedy check due to unhindered weed growth. Similar findings were also reported by Dange *et al.* **(**2007**)** and Jain and Agarwal (1998).

Effect on weeds

The weed density and biomass of *Medicago denticulata*, *Convolvulus arvensis*, *Parthenium hysterophorus* and others were recorded at 30 and 60 DAS (**Table 2**). The weed density and biomass were significantly influenced by different weed

Table 1. Effect of weed management treatments on linseed growth parameters and yield

Treatment	Plant population (no./m^2)		Plant height (cm)				No. of branches/plant		Yield (t/ha)
	Initial	At harvest	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	At harvest	
Metribuzin + oxyfluorfen (250 g + 125 g/ha) 1 DAS	173	165	14.2	62.6	68.6	69.6	2.5	3.6	1.71
Oxyflurofen (125 g/ha) 1 DAS	171	164	13.9	62.3	68.2	69.3	2.4	3.5	1.65
Oxadiargyl (80 g/ha) 1 DAS	168	161	13.6	61.7	67.9	69.2	2.3	3.6	1.61
Imazethapyr (75 g/ha) 22 DAS	163	155	13.8	61.4	67.7	68.8	2.5	3.5	1.49
Metsulfuron-methyl (4 g/ha) 22 DAS	205	196	15.3	64.7	70.8	71.8	2.8	3.9	1.87
Isoproturon (1 kg/ha) 22 DAS	195	187	14.9	63.7	69.8	70.4	2.6	3.7	1.81
Isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) 22 DAS	207	199	15.9	66.3	72.7	74.1	2.8	4.0	1.92
Pendimethalin (1 kg/ha) 1 DAS *fb* metsulfuron-methyl (4 g/ha) 22 DAS	201	192	15.0	64.4	70.4	71.3	2.6	3.8	1.83
Hand weeding twice 21 and 45 DAS	207	199	16.4	67.5	74.7	75.7	2.6	4.2	1.94
Weedy check	162	155	14.2	61.3	67.8	68.7	2.6	3.4	1.37
LSD (p=0.05)	8.03	8.63	1.49	3.62	4.22	4.36	NS	0.40	0.12

DAS = Days after seeding; *fb* = followed by management treatments. At 30 and 60 DAS minimum weed density and biomass were observed with hand weeding twice, and it was on par with pendimethalin (1 kg/ha) PE *fb* metsulfuron-methyl (4 g/ha) PoE and metribuzin + oxyflurofen (250 g + 125 g/ha) PE at 30 DAS except *Parthenium hysterophorus*. However, at 60 DAS application of isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) PoE and metsulfuron-methyl (4 g/ha) PoE was found at par value of weed density and biomass. Maximum weed density and biomass were recorded in weedy check.These results are corroborative with the findings of Malligwad *et al.* (2000) and Madhu *et al. (*2006).

At 30 and 60 DAS, highest weed control efficiency (**Table 4**) was found with hand weeding twice at 21 and 45 DAS and it was at par with pendimethalin (1 kg/ha) PE *fb* metsulfuron-methyl (4 g/ha) PoE and isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) PoE at 30 and 60 DAS respectively and minimum was observed with the application of imazethapyr (75 g/ha) PoE. These results were in close conformity with Kapur and Singh (1992).

Effect on economics

The highest cost of cultivation and gross return was recorded with hand weeding twice at 21 and 45 DAS due to higher cost involved in labour wages, followed by the treatment of isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) PoE (**Table 4**). The highest net return was noted under isoproturon +

Table 2. Effect of weed management treatments on individual weed density in linseed

Treatment	Weeds density (no./m^2)							
	M.denticulata		*C.arvensis*		*P.hysterophorus*		Other weeds	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Metribuzin + oxyfluorfen (250 g + 125 g/ha) 1 DAS	3.71(13.4)	3.85(14.3)	1.72(2.5)	1.91(3.2)	1.47(1.7)	1.62(2.2)	2.24(4.5)	2.67(6.7)
Oxyflurofen (125 g/ha) 1 DAS	4.28(17.8)	5.45(29.3)	1.82(2.8)	2.07(3.8)	1.53(1.8)	1.78(2.7)	2.34(5.2)	2.84(7.7)
Oxadiargyl (80 g/ha) 1 DAS	4.58(20.8)	6.13(37.2)	1.90(3.2)	2.15(4.2)	1.69(2.5)	1.91(3.2)	2.53(6.0)	2.99(8.5)
Imazethapyr (75 g/ha) 22 DAS	7.16(51.0)	7.56(56.8)	2.35(5.0)	2.24(4.7)	2.07(4.0)	2.00(3.5)	3.08(9.2)	3.13(9.3)
Metsulfuron-methyl (4 g/ha) 22 DAS	6.92(47.4)	1.85(3.0)	2.19(4.3)	1.38(1.5)	2.08(3.4)	1.28(1.2)	2.92(8.3)	1.99(3.5)
Isoproturon (1 kg/ha) 22 DAS	5.44(29.2)	2.79(7.3)	2.04(3.7)	1.67(2.3)	1.77(2.7)	1.53(2.0)	2.81(7.5)	2.54(6.0)
Isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) 22 DAS	6.47(41.3)	1.63(2.2)	2.12(4.0)	1.35(1.3)	2.04(3.7)	1.07(0.7)	2.91(8.0)	1.72(2.7)
Pendimethalin (1 kg/ha) 1 DAS *fb* metsulfuron-methyl (4 g/ha) 22 DAS	3.35(10.7)	2.51(5.8)	1.73(2.5)	1.46(1.7)	1.28(1.3)	1.44(1.7)	1.89(3.2)	2.13(4.5)
Hand weeding twice 21 and 45 DAS	1.46(1.7)	1.41(1.5)	0.90(0.3)	0.90(0.3)	0.90(0.3)	0.80(0.2)	0.98(0.5)	0.80(0.2)
Weedy check	8.17(66.3)	7.93(62.3)	2.45(5.5)	2.37(5.3)	2.33(5.0)	2.08(3.8)	3.40(11.2	3.58(12.3
LSD (p=0.05)	0.55	0.52	0.34	0.39	0.48	0.40	0.50	0.64

Figures in parentheses are original, transformed to values $\sqrt{x+0.5}$; *DAS = Days after seeding; *fb* = followed by

Table 3. Effect of weed management treatments on individual weeds biomass in linseed

Treatment	Weeds biomass (g/m^2)							
	M.denticulata		*C. arvensis*		*P.hysterophorus*		Other weeds	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Metribuzin + oxyfluorfen (250 g + 125 g/ha) 1 DAS	2.46(2.2)	3.07(9.0)	1.08(0.7)	1.57(2.0)	1.00(0.5)	2.16(4.2)	1.25(1.1)	3.57(12.4)
Oxyflurofen (125 g/ha) 1 DAS	2.66(2.7)	4.13(16.7)	1.11(0.7)	1.92(3.2)	1.05(0.6)	2.17(4.2)	1.34(1.3)	3.98(15.3)
Oxadiargyl (80 g/ha) 1 DAS	2.70(3.9)	4.54(20.1)	1.15(0.8)	2.06(3.8)	1.02(0.6)	2.43(5.4)	1.30(1.2)	4.12(16.5)
Imazethapyr (75 g/ha) 22 DAS	3.37(7.0)	5.06(25.3)	1.35(1.3)	2.11(4.0)	1.14(0.8)	2.62(6.4)	1.47(1.7)	4.26(17.6)
Metsulfuron-methyl (4 g/ha) 22 DAS	3.35(6.6)	2.05(3.7)	1.27(1.1)	1.18(0.9)	1.15(0.8)	1.69(2.4)	1.45(1.6)	2.65(6.6)
Isoproturon (1 kg/ha) 22 DAS	2.97(4.9)	2.34(5.0)	1.22(1.0)	1.41(1.5)	1.07(0.7)	2.15(4.1)	1.44(1.6)	3.34(10.8)
Isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) 22 DAS	3.25(5.3)	1.72(2.0)	1.26(1.1)	1.24(1.1)	1.23(1.0)	1.06(0.7)	1.53(1.9)	2.29(5.2)
Pendimethalin (1 kg/ha) 1 DAS *fb* metsulfuron-methyl (4 g/ha) 22 DAS	2.40(1.7)	2.24(4.5)	1.06(0.6)	1.29(1.2)	0.96(0.5)	1.99(3.7)	1.11(0.8)	2.69(7.4)
Hand weeding twice 21 and 45 DAS	1.64(0.1)	1.51(1.8)	0.77(0.1)	1.03(0.6)	0.76(0.1)	0.80(0.1)	0.76(0.1)	1.00(0.7)
Weedy check	3.62(8.9)	5.37(28.4)	1.42(1.5)	2.21(4.5)	1.27(1.1)	2.78(7.2)	1.67(2.4)	4.60(20.7)
LSD (p=0.05)	0.37	0.37	0.16	0.35	0.20	0.51	0.29	0.88

Figures in parentheses are original, transformed to values $\sqrt{x+0.5}$; *DAS = Days after seeding; *fb* = followed by

Table 4. Effect of weed management treatments on cost of cultivation and weed control efficiency of linseed

Treatment	Cost of Cultivation (x10^3 `/ha)	Gross returns (x10^3 `/ha)	NMR (x10^3 `/ha)	B:C ratio	Weed control efficiency (%)	
					30 DAS	60 DAS
Metribuzin + oxyfluorfen (250 g + 125 g/ha) 1 DAS	20.03	77.50	57.46	3.37	68.69	54.52
Oxyflurofen (125 g/ha) 1 DAS	19.60	74.70	55.10	3.31	61.82	35.13
Oxadiargyl (80 g/ha) 1 DAS	19.80	73.17	53.38	3.20	53.75	24.64
Imazethapyr (75 g/ha) 22 DAS	19.67	67.56	47.89	2.94	22.58	12.55
Metsulfuron-methyl (4 g/ha) 22 DAS	19.27	84.96	65.69	3.91	27.28	77.58
Isoproturon (1 kg/ha) 22 DAS	20.36	82.34	61.98	3.55	41.94	64.70
Isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) 22 DAS	20.63	87.31	66.68	3.73	33.27	84.59
Pendimethalin (1 kg/ha) 1 DAS *fb* metsulfuron-methyl (4 g/ha) 22 DAS	20.33	82.97	62.64	3.58	74.59	72.37
Hand weeding twice 21 and 45 DAS	22.80	88.17	65.37	3.37	97.28	94.71
Weedy check	18.80	62.25	43.45	2.82	0	0

*DAS = Days after seeding; *fb* = followed by; NMR = Net monetary return

metsulfuron-methyl (1 kg + 4 g/ha) PoE, followed by metsulfuron-methyl (4 g/ha) PoE and hand weeding twice at 21 and 45 DAS. The highest benefit: cost ratio (3.91) was recorded with metsulfuron-methyl (4 g/ha) PoE followed by isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) PoE and pendimethalin (1 kg/ha) PE *fb* metsulfuron-methyl (4 g/ha) PoE. The higher B:C ratio in above treatments might be due to higher seed yield coupled with lower cost of the treatment. Similar finding was reported by Mishra *et al.* (2003).

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