Int.J.Curr.Microbiol.App.Sci (2018) *7*(2): 2711-2717

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 02 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.702.329

Efficacy of Cultural Method of Weed Control on Growth, Yield and Quality of Linseed (*Linum usitatissimum* L.)

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Keywords

Linseed, Oxyfluorfen, Isoproturon, Quizalofop ethyl, Weed management

Article Info

Accepted:
24 January 2018
Available Online:
10 February 2018

A B S T R A C T

A field experiment was conducted during *rabi* season of 2014-2015 at the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari to study the effect of weed management practices on growth, yield and quality of linseed (*Linum usitatissimum* L.). Growth parameters, yield attributes, oil yield and seed yield were higher with lower weed count and weed dry weight in treatment (T_{11}) weed free (interculturing followed by hand weeding at 20 and 40 DAS).

Introduction

Linseed or flax is among the oldest crop plants cultivated for the purpose of oil and fiber. It belongs to the genus *Linum* and family Linaceae. The botanical name, *Linum usitatissimum* was given by Linnaeus in his book "Species Plantarum" (Linnaeus, C., 1857). It is an annual herbaceous plant with shallow root system. The common names flax and linseed are used in North America and Asia, respectively, for *L. usitatissimum*. Oilseed varieties and fiber varieties are specialized development of this species (Millam *et al.*, 2005). The cultivars grown primarily for seed/oil purpose are relatively short in height and possess more secondary branches and seed bolls (seed capsule). The cultivars grown for fiber purpose are tall growing with straight culms and have fewer secondary branches.

The present weed control practices are characterized by intensive use of manual labour and animal power. Both of them are in short supply and increasingly became uneconomical. Adverse soil and climatic conditions prevent timely removal of weeds through manual and mechanical means. Linseed having less branching habit, small leaf area and show growth during initial growth period, it complete poorly with weeds and often suffers from severe weed competition. Unchecked weed growth has

been reported to reduce grain yield of linseed to the tune of 34.2 per cent (Mani *et al.*, 1968).

Every part of linseed plant is utilized commercially, either directly or after processing. Seed contains 33 to 47 per cent oil. A small quantity is directly used for edible purposes. About 20 per cent of the total oil produced is used at farmer level and the rest 80 per cent oil goes to industries in various forms, such as boiled oil, borated oil, eposidized oil, aluminated oil, urethane oil, isomerized oil *etc*. Seeds of linseed contain high levels of dietary fibers as well as lignans, an abundance of micronutrients and omega-3 fatty acids. The oil (>66%) is rich in linolenic acid and is a perfect drying oil. The seed of linseed content nutrient value per 100 g is carbohydrates 28.88 g, sugars 1.55 g, fat 42.16 g, protein 18.29 g and dietary fibers 27.39 g (Anonymous, 2013).

Materials and Methods

Experiment was conducted on the farm of college of Agriculture, Navsari during *rabi* season of 2014-2015. The linseed crop local variety was sown on alkaline soil having (pH 7.8). The experiment was conducted in Randomized Block Design with twelve treatments replicated three times. The treatment comprises of four herbicides *viz*., Pendimethalin and Oxyfluorfen as pre-emergence and Isoproturon and Quizalofop ethyl as a post-emergence with or without cultural practices. There was conventional method of weed control like manual weeding and interculturing for comparison of effect.

The treatment details are (T_1) Pendimethalin @ 750 g/ha as pre-emergence, (T_2) Oxyfluorfen @ 60 g/ha as pre-emergence, (T_3) Isoproturon @ 750 g/ha as post-emergence, (T_4) Quizalofop ethyl @ 75 g/ha as post-emergence, (T_5) T_1fb IC and HW at 30 DAS, (T_6) T_2fb IC and HW at 30 DAS, (T_7) T_3fb IC and HW at 30 DAS, (T_8) T_4fb IC and HW at 30 DAS, (T_9) Pendimethalin (T_1) + Quizalofop ethyl (T_4), (T_{10}) 1 HW at 20 DAS, (T_{11}) Weed free (IC fb by HW at 20 and 40 DAS) and (T_{12}) Weedy check. Linseed local variety was sown on 20 November 2014 at 30 x 10 cm spacing. Observation regarding growth study i.e. plant height and number of branches per plant were carried out at 30, 60, 90 DAS and at harvest. Weed study i.e. weed count (No. per m^2) at 25, 50 DAS and at harvest. Dry weight of weeds (kg/ha) were determined at harvest. While yield attributing characters i.e. number of capsules $plant^{-1}$, number of seeds capsules $plant^{-1}$ and seed yield and stover yield were noted at harvest.

Results and Discussion

Weeds

Weed flora identified in experiment plot were monocot, Dicot and Sedges weeds. In monocot weeds *Cynodon dactylon*, *Digitaria sanguinalist*, *Bracharia spp*, *Sorghum halepense*, *Echinochloa crusgallis* and in dicot weeds *Alternanthera sessillis*, *Physalis minima*, *Euphorbia hirta*, *Vernonia cinerea*, *Amaranthus viridis*, *Digera arvensis* were observed while under sedges weed *Cyperus rotundus* were observed.

Effect of weed management practices on weed count and dry weight of weed of weeds

At 25, 50 DAS and at harvest stage weed count (monocot + dicot + sedges) and dry weight of weeds at harvest were recorded and are presented in Table 1. All weed control treatments recorded significant reduction in weed count of weeds and dry weight of weeds. The treatments T_{11} Weed free (IC followed by hand weeding at 20 and 40 DAS) recorded significantly the lowest number of monocot, dicot and sedges weeds at 25, 50 DAS and at

harvest but remained at par with T_{10} (1 HW at 20 DAS), T_5 (T_1fb IC and HW at 30 DAS) and T_1pendimethalin @ 750 g ha^{-1} as pre-emergence at 25 DAS. The treatment T_{10} (1 HW at 20 DAS) recorded significantly the lowest number of monocot, dicot and sedges weeds next to T_{11} (1.46, 1.33 and 1.46 per cent m^2). It clearly indicated that IC followed by 1 HW significantly reduced the weed population during initial period of crop growth.

At 50 DAS and at harvest, besides treatment T_{11} weed free (interculturing followed by hand weeding at 20 and 40 DAS), T_5, T_8 and T_6 recorded significantly lower number of monocot, dicot and sedge weeds as compare to the treatment weedy check (T_{12}). The removal of weed at regular interval through hand weeding at 20 and 40 DAS accounted for less count of monocot, dicot and sedge weeds under treatment T_{11}. Similarly, effective control of monocot, dicot and sedge weeds by integration of herbicides with hand weeding was responsible for lower number of monocot, dicot and sedge weeds under treatments T_5, T_8 and T_6. At harvest treatment T_5, T_8 and T_6 was at par with treatment T_{11} weed free (interculturing followed by hand weeding at 20 and 40 DAS) for monocot, dicot and sedge weeds.

The treatment weedy check (T_{12}) recorded the high population of monocot, dicot and sedge weeds owing to uncontrolled condition. Tomar *et al.,* (1990) reported significant reduction in grassy and broad leaved weeds which causes 37.9 per cent reduction in yield of linseed. The lower dry weight of weeds were recorded and presented in (Table 2) at harvest (248.85 kg/ha) with treatment T_{11} weed free (interculturing followed by hand weeding at 20 and 40 DAS) due to hand weeding. Owing to fact that hand weeding cause a substantial reduction in weed density hence, recorded the lowest dry weight of weeds. It was statistically at par with treatments T_5, T_8 and T_6 at harvest.

Weed control efficiency and weed index

Reduction in dry weight of weed accumulation leads to maximization of weed control efficiency. With the application of treatment T_{11} Weed free (interculturing followed by hand weeding at 20 and 40 DAS) recorded highest weed control efficiency 84.09 per cent was clearly recorded in (Table 2) which was followed by treatment T_5 and T_8 having weed control efficiency of 81.60 and 80.90 per cent at harvest respectively. While, minimum weed index (0.00 %) was recorded under treatment T_{11} Weed free (interculturing followed by hand weeding at 20 and 40 DAS). Frisen and freer (1991) reported that only pre emergence herbicides application was less effective and allow weed competition in later stages, therefore along with cultural practices (hoeing or weeding) or post emergence herbicides gave maximum weed control efficiency.

Effect of weed management practices on growth and development of linseed

Plant height (cm) and Number of branches per plant were recorded at 30, 60, 90 DAS and at harvest presented in Table 3. Treatment (T_{11}) Weed free (IC followed by HW at 20 and 40 DAS) was observed highest plant height (19.46 cm) which was statistically at par with T_5, T_6 and T_8 at 30 DAS. The highest plant height (42.30, 55.49 and 63.06 cm) was observed under treatment (T_{11}) Weed free (IC followed by HW at 20 and 40 DAS) and was statistically at par with T_5, T_8, and T_6 at 60, 90 and at harvest. While more number of branches per plant (8.01 and 8.43) was recorded with treatment (T_{11}) Weed free (IC followed by HW at 20 and 40 DAS) at 90 (DAS) and at harvest, but it was found statistically at par with treatments T_5, T_6, and T_8 (90 DAS) and T_5, T_6, and T_8 at harvest. It is established fact that weed compete for light, space, nutrient and water with the crop and hamper overall growth of the same.

Table.1 Effect of weed management practices on monocot, dicot and sedges weed density at 25, 50 DAS and at harvest

	Monocot weed (m^{-2})			Dicot weed (m^{-2})			Sedge weed (m^{-2})		
Treatments	**25 DAS**	**50 DAS**	**At Harvest**	**25 DAS**	**50 DAS**	**At Harvest**	**25 DAS**	**50 DAS**	**At harvest**
T_1: Pendimethalin @ 750 g/ha as PE	1.68 (2.33)	3.67 (13)	5.46 (29.33)	1.68 (2.33)	4.84 (23)	6.16 (37.66)	1.53 (1.88)	6.16 (37.66)	7.15 (51)
T_2: Oxyfluorfen @ 60 g/ha as PE	2.11 (4)	3.85 (14.33)	5.72 (32.33)	2.20 (4.33)	5.23 (27)	6.40 (40.66)	2.34 (5)	6.27 (39)	7.48 (56.66)
T_3: Isoproturon @ 750 g/ha as PoE	3.89 (14.66)	4.40 (19)	6.25 (38.66)	4.12 (16.66)	5.51 (30)	6.96 (48.33)	4.44 (19.33)	6.48 (41.66)	7.83 (61)
T_4: Quizalofopethyl @ 75 g/ha as PoE	3.84 (14.33)	3.62 (12.66)	5.60 (31)	4.00 (15.66)	4.25 (17.66)	6.21 (38.33)	3.92 (15)	5.86 (34)	7.31 (53.33)
T_5: T_1 fb IC and HW at 30 DAS	1.56 (2.66)	2.03 (3.66)	3.43 (11.33)	1.52 (2)	1.95 (3.33)	3.26 (10.33)	1.52 (1.81)	3.07 (9)	5.17 (26.33)
T_6: T_2 fb IC and HW at 30 DAS	1.95 (3.33)	2.19 (4.33)	3.62 (12.66)	2.48 (5.66)	2.10 (4)	3.37 (11)	2.96 (8.33)	3.23 (10)	5.32 (28)
T_7: T_3 fb IC and HW at 30 DAS	4.02 (15.66)	2.79 (7.33)	4.33 (17)	4.18 (17)	2.60 (6.33)	4.54 (20)	3.58 (12.33)	4.12 (16.66)	6.16 (37.66)
T_8: T_4 fb IC and HW at 30 DAS	3.76 (13.33)	2.11 (4)	3.57 (12.33)	4.04 (16)	2.03 (3.33)	3.32 (10.66)	3.48 (11.66)	3.17 (9.66)	5.22 (27)
T_9: Pendimethalin (T_1) + Quizalofopethyl (T_4)	1.54 (2.33)	2.91 (8)	5.78 (33.33)	1.77 (2.66)	2.73 (6)	4.65 (21.33)	1.53 (1.90)	5.66 (31.66)	7.27 (52..66)
T_{10}: 1 HW at 20 DAS	1.46 (1.66)	5.46 (29.33)	7.32 (53.33)	1.34 (1.33)	4.87 (23.33)	7.24 (52.33)	1.46 (1.66)	7.98 (63.33)	8.47 (71.66)
T_{11}: Weed free (IC follow by HW at 20 and 40 DAS)	1.34 (1.33)	1.85 (3)	3.38 (11)	1.22 (1)	1.76 (2.66)	2.90 (8)	1.34 (1.33)	2.85 (7.66)	4.80 (22.66)
T_{12}: Weedy check	5.27 (27.33)	6.94 (47.66)	8.96 (80)	5.11 (25.66)	7.63 (58)	8.54 (72.66)	6.31 (39.33)	9.23 (80)	10.41 (108.33)
S. Em. ±	0.13	0.19	0.31	0.20	0.28	0.40	0.16	0.31	0.44
C.D. at 5%	0.39	0.55	0.91	0.59	0.82	1.17	0.48	0.92	1.30
C. V. %	8.56	9.45	10.21	12.44	12.85	13.10	9.96	10.18	11.23

Note: Transformation √X+0.5 (Figures in parenthesis are original values)

Table.3 Effect of integrated weed management practices on plant height (cm) and number of branches per plant of linseed

Treatments	Plant height (cm)				Number of branches plant^{-1}			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1:Pendimethalin @ 750 g/ha as PE	17.37	37.36	48.07	55.59	2.23	4.57	5.67	6.66
T_2:Oxyfluorfen @ 60 g/ha as PE	17.27	36.13	47.56	55.15	1.85	4.51	5.34	6.56
T_3:Isoproturon @ 750 g/ha as PoE	16.80	36.54	45.76	52.54	1.71	4.45	4.67	6.33
T_4:Quizalofopethyl @ 75 g/ha as PoE	16.98	37.66	46.25	53.65	1.73	4.34	5.01	6.59
T_5: T_1 fb IC and HW at 30 DAS	18.30	39.66	53.68	61.59	2.11	5.31	7.67	7.89
T_6: T_2 fb IC and HW at 30 DAS	18.13	38.82	51.63	60.90	1.98	4.92	7.34	7.65
T_7: T_3 fb IC and HW at 30 DAS	17.14	37.45	49.53	55.98	2.14	4.73	6.34	6.86
T_8: T_4 fb IC and HW at 30 DAS	17.80	39.60	52.18	61.19	1.87	5.12	7.01	7.53
T_9:Pendimethalin (T_1) + Quizalofopethyl (T_4)	17.33	37.26	48.32	55.78	1.85	4.54	6.01	6.84
T_{10}: 1 HW at 20 DAS	17.41	32.05	43.73	51.41	1.77	4.60	4.34	5.50
T_{11}: Weed free (IC follow by HW at 20 and 40 DAS)	19.46	42.30	55.49	63.06	2.25	5.40	8.01	8.43
T_{12}: Weedy check	15.63	31.35	41.11	49.65	1.84	3.64	4.01	5.00
S. Em. ±	0.69	1.50	1.99	2.36	0.12	0.33	0.45	0.52
C.D. at 5%	2.02	4.40	5.86	6.95	NS	NS	1.33	1.55
C. V. %	6.85	7.00	7.12	7.28	11.49	12.53	13.25	13.45

Table.4 Effect of different treatments on yield attributing characters, quality and yield of linseed

Treatments	Yield attributing characters			Yield		Quality parameters	
	Number of capsules per plant	Number of seeds per capsule	1000 Seed weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Oil content (%)	Oil yield (kg/ha)
T_1:Pendimethalin @ 750 g/ha as PE	47.54	7.13	6.33	668	2056	37.00	248
T_2:Oxyfluorfen @ 60 g/ha as PE	46.08	7.10	6.25	642	2039	37.00	238
T_3:Isoproturon @ 750 g/ha as PoE	44.43	6.97	6.14	631	2024	36.93	234
T_4:Quizalofopethyl @ 75 g/ha as PoE	45.84	7.03	6.14	657	2053	36.90	243
T_5: T_1 fb IC and HW at 30DAS	52.54	8.07	6.65	801	2358	38.03	305
T_6: T_2 fb IC and HW at 30 AS	50.44	7.83	6.53	720	2220	37.73	272
T_7: T_3 fb IC and HW at 30DAS	49.75	7.37	6.37	711	2206	37.33	265
T_8: T_4 fb IC and HW at 30DAS	50.32	7.60	6.37	798	2351	37.00	296
T_9:Pendimethalin (T_1) + Quizalofopethyl (T_4)	48.68	7.15	6.41	688	2061	37.50	258
T_{10}: 1 HW at 20 DAS	41.28	6.63	6.02	635	2045	36.33	230
T_{11}: Weed free (IC follow by HW at 20 and 40 DAS)	56.01	8.40	6.76	810	2391	38.40	310
T_{12}: Weedy check	36.71	5.33	6.26	510	1982	35.60	183
S. Em. ±	2.20	0.41	0.22	33.74	111.68	2.17	16.81
C.D. at 5%	6.46	1.23	NS	98.97	327.57	NS	49.32
C. V. %	8.04	10.06	6.24	8.47	9.00	10.14	11.32

Table.2 Dry weight of weed, weed control efficiency and weed index as influenced by different weed management treatments

Treatments	Dry weight of weeds at harvest (kg/ha)	Weed control efficiency (%)	Weed index (%)
T_1:Pendimethalin @ 750 g/ha as PE	883.85	43.51	17.47
T_2:Oxyfluorfen @ 60 g/ha as PE	976.72	37.58	20.65
T_3:Isoproturon @ 750 g/ha as PoE	1034.85	33.86	22.01
T_4:Quizalofopethyl @ 75 g/ha asPoE	857.52	45.20	18.84
T_5: T_1 fb IC and HW at 30 DAS	286.85	81.66	1.03
T_6: T_2 fb IC and HW at 30DAS	360.52	76.96	11.11
T_7: T_3 fb IC and HW at 30 DAS	578.99	63.00	12.22
T_8: T_4 fb IC and HW at 30 DAS	298.85	80.90	1.44
T_9:Pendimethalin (T_1) + Quizalofopethyl (T_4)	696.52	55.48	15.02
T_{10}: 1 HW at 20 DAS	1240.19	20.74	21.60
T_{11}: Weed free (IC follow by HW at20 and 40 DAS)	248.85	84.09	0.00
T_{12}: Weedy check	1564.85	0.00	58.80
S. Em. ±	46.65	-	-
C.D. at 5%	136.83	-	-
C. V. %	10.74	-	-

If weeds are removed by weed control methods, the trend was reversed and crop gain height as well as more number of branches per plant.

Effect of weed management practices on yield attributing characters and yield

Yield attributes as number of capsules plant^{-1} and number of seeds capsules^{-1} noted significant increase under treatment T_{11} weed free (IC follow by HW at 20 and 40 DAS) being at par with T_5, T_6, T_8 and T_7. But in case of test weight did not significant due to different weed management treatments. While Seed and Stover yield (Table 4) were found significantly higher under treatment T_{11} weed free (interculturing followed by hand weeding at 20 and 40 DAS) but was remained at par with treatments T_5 (T_1fb IC and HW at 30 DAS), T_8 (T_4fb IC and HW at 30 DAS), T_6 (T_2fb IC and HW at 30 DAS) and T_7 (T_3fb IC and HW at 30 DAS). All weed control methods established their superiority over weedy check in respect of seed yield, stover yield and yield attributing characters by virtue of reduced weed competition. Angiras *et al*., (1991) also reported that herbicidal treatments produce significantly higher seed yield over unweeded check in linseed.

Effect of weed management practices on quality of linseed

The highest oil yield (310 kg/ha) was recorded with the treatment T_{11} weed free (IC fb HW at 20 and 40 DAS). The higher oil yield received under this treatment was due to the higher seed yield recorded under this treatment which directly responsible for higher oil yields. There was no significant effect on oil content due to various weed

management treatments (Table 4). The maximum oil content was observed in T_{11} weed free (IC fb HW at 20 and 40 DAS). This might be due to oil content is mainly a genetic character which cannot be manipulated by agronomic practices. The higher oil yield recorded with two hand weeding may be due to deleterious effect of Weedicides on crop development as well as nutrient supply from soil to plant reported by Husain *et al.*, (2015).

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How to cite this article:

Chhaganiya, H.J., A.P. Pate and Patel, V. D. 2018. Efficacy of Cultural Method of Weed Control on Growth, Yield and Quality of Linseed (*Linum usitatissimum* L.). *Int.J.Curr.Microbiol.App.Sci.* 7(02): 2711-2717. doi: https://doi.org/10.20546/ijcmas.2018.702.329