

EFFICACY OF PRE AND POST EMERGENCE HERBICIDES ON WEED CONTROL AND GROWTH OF LINSEED (*Linum usitatissimum* L.)

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ABSTRACT

The field experiment was carried out to study the relative efficacy of pre and post emergence herbicides on weed control in linseed as well as to study its effect on growth and yield of linseed during *rabi* season of 2022-23 at Agronomy Farm, College of Agriculture, Nagpur. The experiment was laid out in randomized block design (RBD) with eight treatments and replicated thrice. The treatments comprised of T₁- Weedy check, T₂- Weed free check, T₃- PE Metribuzin @ 250 g a.i. ha⁻¹fb Imazethapyr @ 100 g a.i. ha⁻¹ at 25 DAS, T₄- PE Metribuzin @ 250 g a.i. ha⁻¹fb (Propaquizafop 2.5% + Imazethapyr 3.75%) @ 50 + 75 g a.i. ha⁻¹ at 25 DAS, T₅- PE Metribuzin @ 250 g a.i. ha⁻¹fb (Quizalofop 7.5% + Imazethapyr 15%) EC @ 32.81 g a.i. ha⁻¹ + 65.625 g a.i. ha⁻¹ at 25 DAS, T₆-PE Oxyflurofen @ 125 g a.i. ha⁻¹fb Imazethapyr @ 100 g a.i. ha⁻¹ at 25 DAS, T₇- PE Oxyflurofen @ 125 g a.i. ha⁻¹fb (Propaquizafop 2.5% + Imazethapyr 3.75%) @ 50 + 75 g a.i. ha⁻¹ at 25 DAS and T₈- PE Oxyflurofen @ 125 g a.i. ha⁻¹fb (Quizalofop 7.5% + Imazethapyr 15%) EC @ 32.81 g a.i. ha⁻¹ + 65.625 g a.i. ha⁻¹ at 25 DAS. Results revealed that, the weed infestation throughout the growth period of crop was significantly controlled with weed free treatment (T₂). Maximum weed control efficiency and lowest weed index was observed under weed free check (T₂). Amongst the herbicidal weed management practices, application of PE Oxyflurofen @ 125 g a.i. ha⁻¹fb (Quizalofop 7.5% + Imazethapyr 15%) EC @ 32.81 + 65.625 g a.i. ha⁻¹ at 25 DAS (T₆) was found to be most effective treatment in controlling weed population across the crop growth period which resulted in maximum weed control efficiency and lowest weed index followed by treatment PE Metribuzin @ 250 g a.i. ha⁻¹fb (Quizalofop 7.5% + Imazethapyr 15%) EC @ 32.81 + 65.625 g a.i. ha⁻¹ at 25 DAS (T₅). Amongst the herbicidal weed management practices, application of PE Oxyflurofen @ 125 g a.i. ha⁻¹fb (Quizalofop 7.5% + Imazethapyr 15%) EC @ 32.81 + 65.625 g a.i. ha⁻¹ at 25 DAS (T₈) recorded significantly highest yield attributes *viz.*, plant height (cm), number of branches plant⁻¹, dry matter accumulation plant⁻¹, test weight (g), seed yield and straw yield (kg ha⁻¹) followed by application of PE Metribuzin @ 250 g a.i. ha⁻¹fb (Quizalofop 7.5% + Imazethapyr 15%) EC @ 32.81 + 65.625 g a.i. ha⁻¹ at 25 DAS (T₅). Hence, these two treatments can be effective in controlling the weeds. The shortage of labourers, when really on demand, makes it imperative to opt for herbicidal control. The relative preference of the farmers was towards a post-emergence herbicide for managing weeds.

(Key words: Linseed, herbicides, efficacy, weed management, weed flora)

INTRODUCTION

Linseed (*Linum usitatissimum* L.) is one of the important *rabi* oilseed crop of India belongs to linaceae family and genus *Linum*. Linseed contains high level of lignin, Omega-3 and Omega-6 fatty acid possesses anti-cancer properties and studies found reduced growth in specific types of tumors. Initial studies suggest benefit with certain types of breast and prostate cancer. In linseed some herbicides are used as pre-emergence herbicide and some herbicides are post-emergence for weed management in linseed field, but the efficacy of herbicides fluctuates according the soil type, moisture regime, and types of weed flora. Therefore, for effective control of weeds in linseed,

selected herbicide is needed with the integration of inter-culturing and hand weeding (Angiras *et al.*, 1991). Out of several factors affecting the production of linseed, weed is one of the most important factors responsible for causing tremendous loss in yield.

Weeds are unwanted plants competing for water, light, space and nutrients and affect the growth of crop. Owing to poor initial growth and lower canopy spread with small sized leaves, weed infestation imposes serious constraints in realizing higher yields causing 30-40% loss in seed yield. (Mahere *et al.*, 2000). Heavy infestation may even cause compete crop failures depending on the type and intensity of weed flora. Pre-mixed application of pre-emergence and early post-emergence herbicides was found

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effective for weed control. The weeds contribute not only to reduction of yield of linseed but also substantially reduce suitability for processing and potential to obtain good quality fibers (Bilalis *et al.*, 2012; Heller *et al.*, 2012). The shortage of labourers, when really on demand, makes it imperative to opt for herbicidal control. The relative preference of the farmers was towards a post-emergence herbicide for managing weeds.

MATERIALS AND METHODS

The present field investigation was carried out during *rabi*, 2022-2023 to study the weed management in linseed (*Linum usitatissimum* L.) during *rabi* season at Agronomy farm, College of Agriculture, Nagpur, Maharashtra State, India. The experiment was laid out in randomized block design (RBD) with three replications with 8 treatments. The experiment included treatments T₁ - Weedy check, T₂ - Weed free check, T₃ - PE Metribuzin @ 250 g a.i. ha⁻¹fb Imazethapyr @ 100 g a.i. ha⁻¹ at 25 DAS, T₄ - PE Metribuzin @ 250 g a.i. ha⁻¹fb (Propaquizafop 2.5% + Imazethapyr 3.75%) @ 50 + 75 g a.i. ha⁻¹ at 25 DAS, T₅ - PE Metribuzin @ 250 g a.i. ha⁻¹fb (Quizalofop 7.5% + Imazethapyr 15%) EC @ 32.81 g a.i. ha⁻¹ + 65.625 g a.i. ha⁻¹ at 25 DAS, T₆ - PE Oxyflurofen @ 125 g a.i. ha⁻¹fb Imazethapyr @ 100 g a.i. ha⁻¹ at 25 DAS, T₇ - PE Oxyflurofen @ 125 g a.i. ha⁻¹fb (Propaquizafop 2.5% + Imazethapyr 3.75%) @ 50 + 75 g a.i. ha⁻¹ at 25 DAS and T₈ - PE Oxyflurofen @ 125 g a.i. ha⁻¹fb (Quizalofop 7.5% + Imazethapyr 15%) EC @ 32.81 g a.i. ha⁻¹ + 65.625 g a.i. ha⁻¹ at 25 DAS. Further data on weed count (at 60 DAS), number of branches plant⁻¹, test weight, seed yield, straw yield were recorded and analysed statistically (Panse and Sukhatme, 1967). Weed index was calculated by formula given by Gill and Kumar (1969).

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

Where,

X = Yield from weed free plot

Y = Yield from treatment plot, for which WI is to be calculated

RESULTS AND DISCUSSION

Weed flora

Major weed flora observed on weedy plot comprised of *Convolvulus arvensis*, *Alternanthera triandra*, *Euphorbia hirta*, *Trigonella foenumgraecum*, *Parthenium hysterophorus*, *Euphorbia geniculate*, *Celosia argentea* and *Diger aarvensis* among the dicot weeds and *Cyperus rotundus*, *Cynadon dactylon*, *Dinebra arabica*, *Cynotis axillaris* and *Poa annua* among the monocot weeds. Herbicides treatment showed differential influence on weed control in linseed during the year of experimentation.

Effect on weeds

Data pertaining to number of monocots, dicots and total weeds are presented in Table 1 showed that the number of monocots, dicot and total weeds were influenced significantly due to the different treatments. Monocot and dicot weed population was reduced significantly due to various weed control treatments. The lowest density of weed was recorded with treatment weed free check (T₂) and was significantly superior amongst all other treatments. Amongst herbicidal treatments, application of PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₈) recorded significantly lowest weeds m⁻² than all other treatments might be due to keeping the weed free environment and application of post-emergence herbicides that have continued effect on controlling both monocot and dicot population. At all stages of crop, weed population were reduced significantly due to various weed management practices which were effective in timely reducing weed population. However, it was found at par with treatment PE Metribuzin @ 250 g a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₅) and PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb (Propaquizafop 2.5 % + Imazethapyr 3.75 %) @ 50 + 75 g a.i.ha⁻¹ at 25 DAS (T₇). The treatment weedy check (T₁) recorded the highest monocot and dicot weed count m⁻². These results support findings by Singh *et al.* (2014). They reported that imazethapyr at 75 g ha⁻¹ sprayed at 15 or 25 DAS and 100 g ha⁻¹ at 25 DAS found significantly superior in reducing the population of all the predominant weeds.

Effect on DMW, WEC (%) and WI (%)

At 60 DAS, the treatment T₂ - weed free check produce significantly lowered weed dry matter over rest of the treatments due to keeping the weed free environment. Regarding herbicidal treatments, application of PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₈) recorded significantly less dry matter over all other treatments except treatments T₅ - PE Metribuzin @ 250 g a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS and T₇ - PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb (Propaquizafop 2.5 % + Imazethapyr 3.75 %) @ 50 + 75 g a.i.ha⁻¹ at 25 DAS which were at par with treatment of PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₈). This might be due to effective control of weeds.

The highest weed control efficiency was recorded in treatment weed free check (T₂) because of keeping weed free environment, very less crop-weed competition occurred that produces less weed biomass and found superior over rest of all treatments. Amongst various herbicidal treatments application of PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₈) recorded maximum weed control efficiency, followed by PE Metribuzin @ 250 g a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₅) and PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb

(Propanil 2.5 % + Imazethapyr 3.75 %) @ 50 + 75 g a.i.ha⁻¹ at 25 DAS (T₇). This might be due to combination of both pre and post emergence herbicides that have longer effect on controlling the monocot as well as dicot weed population producing less weed biomass and thereby increasing weed control efficiency. Similar results were reported by Thakare *et al.* (2015) that the highest weed control efficiency was recorded under treatment imazethapyr @ 0.100 kg a.i. ha⁻¹ + quizalofop ethyl @ 0.075 kg a.i. ha⁻¹. The lowest weed control efficiency was found in treatment (T₁) i.e. weedy check.

Weed index was computed as the yield reduction comparatively to highest yielding treatment i.e. weed free check (T₂). Among the weed management practices, application of PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₈) showed minimum weed index (10.23) over all other treatments followed by treatment PE Metribuzin @ 250 g a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₅) (13.64). Weedy check treatment (T₁) recorded maximum weed index (37.85) indicating the reduction in linseed yield due to presence of weed throughout crop growth period. These results support to findings by Prachand *et al.* (2015), they observed that application of imazethapyr 0.100 kg ha⁻¹ + quizalofop ethyl 0.075 kg ha⁻¹ as PoE recorded lowest weed dry matter, weed index and highest weed control efficiency.

Effect on crop

The periodical data on mean plant height (cm), number of branches plant⁻¹ and dry matter accumulation plant⁻¹ (g) and test weight (g) of linseed as influenced by different treatments are presented in Table 2. The general mean plant height at harvest was 41.26 cm. The rate of increase in plant height was gradually increased with advancement in crop age up to harvest. The rate of increase in plant height was rapid during vegetative growth stage. The treatment weed free check (T₂) recorded significantly maximum plant height, number of branches plant⁻¹ and dry matter accumulation over all other treatments. Amongst various herbicidal treatments PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₈) recorded significantly higher plant height, number of branches plant⁻¹ and dry matter accumulation over all other herbicidal treatments and weedy check (T₁) treatment at all growth stages.

The increased in plant height, number of branches plant⁻¹ and dry matter accumulation of linseed under weed free check treatment (T₂) and application of treatments PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₈) followed by treatment PE Metribuzin @ 250 g a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₅), might due to good aeration of soil and least weed population observed in these treatments which reduces the crop-weed competition for soil moisture,

plant nutrients, solar radiation and space during active growth period. These results are in conformity with those reported by Sasikala *et al.* (2004) and Chaitanya *et al.* (2013) i.e. application of quizalofop-p-ethyl 5 % EC @ 50 g ha⁻¹ at 20-30 DAS and pendimethalin 30 % EC @ 1.5 kg ha⁻¹ fbimazethapyr 10 % SL @ 75 g ha⁻¹ at 20-30 DAS reduced weed competition, improved growth parameters and these improved growth parameters and the yield attributes which in turn increased pod yield.

There was no significance difference observed in test weight among all weed treatments. However, weed free check (T₂) recorded higher test weight (7.94 g) amongst all other treatments, while lower test weight (7.13 g) was observed under weedy check treatment (T₁). This could be because of elimination of crop weed competition during early growth as well as later part of the crop growth and development in this treatments and consequently greater dry matter accumulation by plants causing improvement in yield attributes.

The weed free check (T₂) recorded significantly highest seed yield ha⁻¹ (1173 kg ha⁻¹) amongst all other treatments, whereas minimum seed yield ha⁻¹ (729 kg ha⁻¹) was observed under weedy check treatment (T₁). Amongst herbicidal weed management practices, application of PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₈) recorded significantly higher seed yield ha⁻¹ (1035 kg ha⁻¹) followed by PE Metribuzin @ 250 g a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₅), over all other herbicidal weed management practices and weedy check. Different weed management practices significantly improved the crop yield as compared to weedy check might be due to efficiency and broad spectrum weed control of sedges and broad leaf weeds as well as better suppression of grassy weeds achieved with herbicides. The favourable conditions created through the efficient weed management resulted in lesser weed competition between crop and weeds during the critical period of crop growth. This favoured the crop to produce more leaf area plant⁻¹ and dry matter production.

The weed free check (T₂) recorded significantly highest straw yield ha⁻¹ (2295kg ha⁻¹) amongst all other treatments, whereas minimum straw yield ha⁻¹ (1920kg ha⁻¹) was observed under weedy check treatment (T₁). Amongst herbicidal weed management practices, application of PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₈) recorded significantly higher straw yield ha⁻¹ (2115 kg ha⁻¹) followed by PE Metribuzin @ 250 g a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T₅) over all other herbicidal weed management practices. Increase in straw yield might be due to luxurious crop growth, increase in dry matter accumulation in crop and decrease in dry matter accumulation in weeds, less crop weed competition in weed free and herbicidal treated plots.

Table 1. Weed density (no./m²), dry matter of weed (g/m²), WCE (%) at 60 DAS, weed index at harvest as affected by different treatments

Treatments	Monocot weed (no./m ²)	Dicot weed (no./m ²)	Total weed (no./m ²)	DMW (g/m ²)	WCE (%)	WI (%)
T ₁ Weedy check	6.67(44.00)	7.58(57.00)	10.07(101.00)	6.57(42.65)	-	37.85
T ₂ Weed free check	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	100	-
T ₃ PE Metribuzin @ 250 g a.i.ha ⁻¹ fb Imazethapyr @ 100 g a.i.ha ⁻¹ at 25 DAS	3.29(10.33)	4.63(21.00)	5.64(31.33)	4.09(16.23)	61.94	31.37
T ₄ PE Metribuzin @ 250 g a.i.ha ⁻¹ fb (Propaquizafop 2.5 % + Imazethapyr 3.75 %) @ 50 + 75 g a.i.ha ⁻¹ at 25 DAS	2.91(8.00)	3.53(12.00)	4.52(20.00)	3.88(14.56)	65.86	20.20
T ₅ PE Metribuzin @ 250 g a.i.ha ⁻¹ fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g a.i.ha ⁻¹ at 25 DAS	2.68(6.67)	3.29(10.33)	4.18(17.00)	3.37(10.88)	74.49	13.64
T ₆ PE Oxyflurofen @ 125 g a.i.ha ⁻¹ fb Imazethapyr @ 100 g a.i.ha ⁻¹ at 25 DAS	2.80(8.33)	3.77(13.76)	4.75(22.09)	4.05(15.95)	62.60	27.96
T ₇ PE Oxyflurofen @ 125 g a.i.ha ⁻¹ fb (Propaquizafop 2.5 % + Imazethapyr 3.75 %) @ 50 + 75 g a.i.ha ⁻¹ at 25 DAS	2.48(5.67)	3.49(11.67)	4.22(17.34)	3.43(11.30)	73.50	17.73
T ₈ PE Oxyflurofen @ 125 g a.i.ha ⁻¹ fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g a.i.ha ⁻¹ at 25 DAS	2.27(4.67)	2.97(8.33)	3.67(13.00)	2.93(8.12)	80.96	10.23
SE(m)±	0.17	0.16	0.19	0.18	-	-
CD at 5%	0.51	0.48	0.57	0.54	-	-

Table 2. Plant height (cm), number of branches plant⁻¹ and dry matter accumulation plant⁻¹ (g), test weight (g), seed yield and straw yield (kg ha⁻¹) as affected by different treatments

Treatments	Plant height (cm)	No. of branches plant ⁻¹	Dry matter accumulation plant ⁻¹ (g)	Test weight (g)	Seed yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)
T ₁ Weedy check	38.27	3.33	4.28	7.13	729	1920
T ₂ Weed free check	46.45	4.53	7.86	7.94	1173	2295
T ₃ PE Metribuzin @ 250 g a.i.ha ⁻¹ fb Imazethapyr @ 100 g a.i.ha ⁻¹ at 25 DAS	38.68	3.42	5.21	7.47	805	1630
T ₄ PE Metribuzin @ 250 g a.i.ha ⁻¹ fb (Propaquizafop 2.5 % + Imazethapyr 3.75 %) @ 50 + 75 g a.i.ha ⁻¹ at 25 DAS	40.38	3.53	5.58	7.58	936	1836
T ₅ PE Metribuzin @ 250 g a.i.ha ⁻¹ fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g a.i.ha ⁻¹ at 25 DAS	42.27	3.90	6.05	7.79	1013	2056
T ₆ PE Oxyfluorfen @ 125 g a.i.ha ⁻¹ fb Imazethapyr @ 100 g a.i.ha ⁻¹ at 25 DAS	39.17	3.48	5.42	7.57	845	1775
T ₇ PE Oxyfluorfen @ 125 g a.i.ha ⁻¹ fb (Propaquizafop 2.5 % + Imazethapyr 3.75 %) @ 50 + 75 g a.i.ha ⁻¹ at 25 DAS	41.27	3.77	5.75	7.71	965	1940
T ₈ PE Oxyfluorfen @ 125 g a.i.ha ⁻¹ fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g a.i.ha ⁻¹ at 25 DAS	43.66	4.11	6.33	7.83	1035	2115
SE(m)±	0.65	0.13	0.19	0.13	22	26
CD at 5%	1.95	0.39	0.57	-	66	72

Based on experimental findings, it can be inferred that application of PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T) recorded significantly lowest weed population and dry matter of grassy and broad-leaved weeds. This treatment was at par with PE Metribuzin @ 250 g a.i.ha⁻¹ fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T). Similarly, highest weed control efficiency and lower weed index was recorded by these treatments. Application of PE Oxyflurofen @ 125 g.a.i.ha⁻¹fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T) recorded significantly maximum plant height, number of branches and dry matter plant¹ of linseed which was at par with the application of PE Metribuzin @ 250 g a.i.ha⁻¹ fb (Quizalofop 7.5 % + Imazethapyr 15 %) EC @ 32.81 + 65.625 g.a.i.ha⁻¹ at 25 DAS (T). Based on results, it can be concluded that herbicides base management provides effective and viable alternative to the farmer's practice for weed management in linseed.

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