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Efficacy of pre and post emergence herbicides on yield and economics of linseed (*Linum usitatissimum* L.)

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Abstract
A field experiment was conducted at Agronomy Farm, College of Agriculture, Nagpur during Rabi season 2022-23 to study the efficacy of pre and post emergence herbicides on yield and economics of linseed. The experiment was laid out in randomized block design (RBD) with eight treatments and three replications. Result revealed that among all the treatments weed free check treatment (T_2) showed higher seed yield and highest B:C ratio. However, in the herbicidal treatments, application of PE Oxyflurofen @ 125 g a.i. ha^{-1} fb (Quizalofop 7.5% + Imazethapyr 15%) EC @ 32.81 g a.i. ha^{-1} + 65.625 g a.i. ha^{-1} at 25 DAS (T_8) was found to be effective in higher number of capsules plant^{-1} (75.77), seed yield plant^{-1} (4.18g), test weight (7.83g), seed yield (1035 kg ha^{-1}) and straw yield (2115 kg ha^{-1}) of linseed which resulted in maximum net monetary returns (30340 Rs ha^{-1}) and B:C ratio (2.24) which is at par with application of PE Metribuzin @ 250 g a.i. ha^{-1} fb (Quizalofop 7.5% + Imazethapyr 15%) EC @ 32.81 g a. i. ha^{-1} + 65.625 g a.i. ha^{-1} at 25 DAS (T_5) with (28044 Rs ha^{-1}) net monetary returns and 2.13 B: C ratio.

Keywords: Linseed, yield, metribuzin, imazethapyr and oxyflurofen

Introduction
Linseed or flax is among the oldest crop plants cultivated for the purpose of oil and fibre. It belongs to the genus Linum and family. The botanical name, *Linum usitatissimum* was given by Linnaeus in his book "Species Plantarum" (Linnaeus, 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) [3]. 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. 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. 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) [1].
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 compete 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) [2]. Weeds the essential component of agro-ecosystems, interfere with crops and lead to enormous crop losses (*Vaid et al.*, 2010) [6].

Materials and Methods
A field experiment entitled efficacy of pre and post emergence herbicides on weed flora in linseed was conducted at Agronomy Section Farm, College of Agriculture, Nagpur

(Maharashtra) during Rabi season of 2022-23. The experiment was laid out in randomized block design with eight treatments and replicated thrice *viz*., Weedy check (T_1), Weed free check (T_2), PE Metribuzin @ 250 g a.i. ha^{-1} fb Imazethapyr @ 100 g a.i. ha^{-1} at 25 DAS (T_3), 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 (T_4), PE Metribuzin @ 250 g a.i. ha^{-1} fb (Quizalofop 7.5% + Imazethapyr 15%) EC @ 32.81 g a.i. ha^{-1} + 65.625 g a.i. ha^{-1} at 25 DAS (T_5), PE Oxyflurofen @ 125 g a.i. ha^{-1} fb Imazethapyr @ 100 g a.i. ha^{-1} at 25 DAS (T_6), 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(T_7) and PE Oxyflurofen @ 125 g a.i. ha^{-1} fb (Quizalofop 7.5% + Imazethapyr 15%) EC @ 32.81 g a.i. ha^{-1} + 65.625 g a.i. ha^{-1} at 25 DAS (T_8). The economics was carried out by estimating the cost of cultivation, monetary returns and BC ratio. The data were statistically analysed by using statistical procedures and comparisons were made at 5% level of significance.

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 *Digera arvensis* 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 yield attributes

The number of capsules plant^{-1} (81.21), seed yield plant^{-1} (4.64 g) and test weight (7.94 g) were significantly higher with weed free check treatment (T_2), Among herbicidal treatments, application of 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 (T_8) recorded higher yield attributing characters and at pat with treatment 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_5). The increase in yield attributing characters might be due to better suppression of weeds by herbicidal treatments which might have maintained greater availability of nutrients and moisture due to less removal by weeds. This might have increased nutrient and water uptake by crops leading to increase rate of various sinks. Similar findings have also been reported by Singh *et al*. (2019) [5].

Effect on yield

Weed free check treatment (T_2) produces significantly higher seed yield (1173 kg ha^{-1}) and straw yield (2295 kg ha^{-1}). Among herbicidal treatments application of 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 (T_8) recorded higher seed and straw yield. Lowest seed yield and straw was recorded in control treatment i.e. weedy check (T_1) which was found at par with T_3 and T_6. This might due to more dry matter plant^{-1} in linseed and lesser dry matter accumulation in weeds, in all the treatments, facilitating better crop growth, development and production of more seed and straw yields.

Table 1: Yield attributes of linseed as influenced by different weed management practices

Treatments		No. of capsules plant^{-1}	Seed yield plant^{-1} (g)	Test weight (g)
T_1	Weedy check	49.59	2.68	7.13
T_2	Weed free check	81.21	4.64	7.94
T_3	PE Metribuzin @ 250 g a.i.ha^{-1} fb Imazethapyr @ 100 g a.i.ha^{-1} at 25 DAS	60.11	3.26	7.47
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	65.78	3.42	7.58
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	72.03	3.96	7.79
T_6	PE Oxyflurofen @ 125 g.a.i.ha^{-1} fb Imazethapyr @ 100 g a.i.ha^{-1} at 25 DAS	64.50	3.31	7.57
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	69.77	3.78	7.71
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	75.77	4.18	7.83
	SE (m) ±	1.91	0.08	0.13
	C.D.5%	5.08	0.24	NS
	G.M.	67.34	3.65	7.62

Effect on economics

As regards economics, weed free check (T_2) recorded the highest GMR (60945 Rs ha^{-1}), NMR (39043 Rs ha^{-1}) and B:C ratio (2.78) followed by treatment application of (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 (2.24). Similar result was reported by Prachand *et al*. (2015) [4], who observed that application of imazethapyr 0.100 kg ha^{-1} + quizalofop-ethyl 0.075 kg ha^{-1} as post emergence recorded maximum gross return (Rs. 81,500) net return (Rs. 56,269) and highest B:C ratio (3.23).

Table 2: Yield and economics of linseed as influenced by different weed management practices

Treatments		Yield		Economics		
		Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	GMR (Rs ha^{-1})	NMR (Rs ha^{-1})	B:C ratio
T_1	Weedy check	729	1920	38370	18568	1.93
T_2	Weed free check	1173	2295	60945	39043	2.78
T_3	PE Metribuzin @ 250 g a.i.ha^{-1} fb Imazethapyr @ 100 g a.i.ha^{-1} at 25 DAS	805	1630	41880	21718	2.07
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	936	1836	48636	23574	1.94
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	1013	2056	52706	28044	2.13
T_6	PE Oxyflurofen @ 125 g.a.i.ha^{-1} fb Imazethapyr @ 100 g a.i.ha^{-1} at 25 DAS	845	1775	44025	21000	1.98
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	965	1940	50190	25365	2.02
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	1053	2115	54765	30340	2.24
	SE (m) ±	22	26	2453	2453	-
	C.D.5%	66	72	6167	6167	-
	G.M.	940	1946	48939	25956	2.13

Conclusion

Based on experimental findings, it can be concluded that among herbicidal treatments, application of 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 (T_8) recorded number of capsules plant^{-1}, seed yield plant^{-1}, test weight (g), seed yield and straw yield kg ha^{-1} and also maximum net monetary returns, B:C ratio of linseed crop followed by treatment 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_5).

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