

Efficacy and Selectivity of Pre-Emergence Herbicide S-Metolachlor Against Annual Grass and Broad Leaved Weeds in Faba Bean

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Abstract: A field trial was conducted at Holetta research center and farmers' fields during 2016/17 and 2017/18 to determine the effectiveness of S-metolachlor herbicide application on annual grasses and broad leaved weeds in faba bean. The experiment consisted of six treatments; S-metolachlor (1.0, 1.5 Lha⁻¹ alone and S-metolachlor 1.0, 1.5 Lha⁻¹ supplemented one hand weeding (25-30 days after crop emergence), farmers' practice twice hand weeding (25-30 and 55-60 days after crop emergence) and weedy checks arranged in randomized complete block design. The faba bean variety used was Dosha and the recommended fertilizer rate was applied. The herbicide was applied single pre emergence (1-3) days after planting using manual knapsack sprayer with a water volume of 200 Lha⁻¹ rates for each plot. The result exhibited that pre emergence application of S-metolachlor @1.0 and 1.5 Lha⁻¹ had a significant ($P<0.05$) effect on broad leaved and grass weeds; *Polygonum nepalensis*, *Corrigiola capensis*, *Plantago lanceolata*, *Caylusea abyssinica*, *Spergula arvensis*, *Raphanus raphanistrum*, *Bidens pilosa*, *Galinsoga parviflora*, *Oxalis latifolia*, and *Guizotia scabra*, *Snowdenia polystachya*, *Setaria pumilia*, *Phalaris paradoxa* and *Avena fatua* for a prolonged time after application and their density was significantly reduced. Between treatments significant differences of yield, plant height and seeds per plant was attained. The highest grain yield (2770 kg ha⁻¹) was achieved from twice hand weeding followed by S-metolachlor 1.0 and 1.5 Lha⁻¹ supplemented one hand weeding (2540, 2502 kg ha⁻¹). The yield advantages were 64.8, 61.6 and 61.0% over the unweeded check.

Keywords: S-metolachlor, effectiveness, faba bean, weeds

Abbreviations: CSA: Central Statistical Authority, SAS: Statistical Analysis System

1. INTRODUCTION

In Ethiopia, faba bean is the major food legumes grown for human consumption, as green pods or dry seeds, as well as for animal feed and use for soil fertility replenishment. Faba bean (*Vicia faba* L.) is the most important and widely grown among pulse crop in Ethiopia it covers about 459000 ha of land with a total production of 0.58 million tons every year (CSA, 2017). It is the most important and widely grown pulse crop, accounting for about 58 % of the area covered by food legumes in southern Ethiopia [1]. However the yields remain very low due to several constraints, one of the major constraints to faba bean production are weeds. Faba bean is very sensitive to weed competition particularly at its early growing stage to early flowering stage; yield loss of 20-95 % was recorded in Ethiopia [2, 3]. This is mainly because of farmers' belief that weeds have no influence on legumes [4]. Twice hand-weeding (four and seven weeks after planting) are recommended to control the weeds in faba bean [2]. But these operations were found laborious, time and energy consuming and least preferred by farmers due to labor resource limitations. So far, little information is available on the response of faba bean to alternative herbicides. Therefore, the purpose of this study was to examine the effect of S-metolachlor efficiency on performance against commonly problematic annual grasses and broad leaf weeds in faba bean.

2. MATERIAL AND METHODS

2.1. Site Description

The experiment was conducted at Holetta Research center and farmers field during the main cropping season of 2016/17 and 2017/ 2018. At both locations, the average monthly mean minimum

temperature during the crop growing season are 6.4°C and 11.5°C the corresponding average monthly mean maximum temperature are 21.3°C and 23.8°C with total rainfall of 924.5 and 580mm, respectively. All locations had been under conventional management practices of plowing, disking and harrowing for last many years.

2.2. Treatments, Experimental Design and Procedure

The experiment consisted of five treatments in three sites (HRC and on two different farmers’ fields). The trial was laid out in a randomized complete block design (RCBD) with three replications for each site in a plot size of 4m x 5m².

Treatment code	Detail
1	S-metolachlor 1.0 Lha ⁻¹
2	S-metolachlor 1.0 Lha ⁻¹ + HW
3	S-metolachlor 1.5 Lha ⁻¹
4	S-metolachlor 1.5 Lha ⁻¹ + HW
5	HW X 2 (25-30, 55-60)
6	Untreated control

HW= Hand Weeding

The experimental field was ploughed twice using tractor mounted plough and the plots were leveled manually. Planting of Faba bean was done by drilling the seeds at 40 cm wide rows at a rate of 200kg ha⁻¹. The Faba bean variety used was Dosha. Recommended fertilizer rate was drilled in furrows at planting. The herbicides were applied single pre emergence application immediately after sowing or before emergence using manual knapsack sprayer with a water volume of 200 L ha⁻¹ rate for each plot.

2.3. Data Collection

Weed density was taken twice (at the time of first and second hand weeding) for each individual weed species from each plot using 0.25m² quadrats four times. The weed species found within the sample quadrat were identified, counted and expressed in m². Individual and general weed control scores were also taken four weeks after herbicide application, first and second hand weeding and at the time of harvest. At harvest the weeds were cut near the soil surface and placed in an oven at 65°C temperature till constant weight and their dry weight was measured. The dry weight was expressed in gm². The data on weed density and dry matter were subjected to $\sqrt{x+0.5}$ transformations before analysis.

Weed control efficiency: $WCE = \frac{(WDC - WDT)}{WDC} \times 100$

Where: WCE=Weed Control Efficiency, WDC= Weed Dry mater in weedy check,

WDT=Weed Dry Matter in particular treatment

Plant height was measured from 4 randomly selected plants in each plot. **Hundred seeds** were counted randomly and their weight was measured at 10 % grain moisture content. Grain yield was also measured after threshing the sun dried plants harvested from each plot and adjusted at 10% grain moisture content.

Partial budget analysis was calculated by taking in to account the additional input cost (the labor cost for hand weeding, harvesting, threshing and winnowing) and gross returns obtained from different weed control treatments.

Statistical analysis

Finally, all data were subjected to analysis of variance following a procedure appropriate to the design of the experiment using SAS statistical software [5]. The treatment means that were significantly different at 5% levels of significance were separated using Duncan Multiple Range Test (DMRT).

3. RESULTS AND DISCUATION

The experimental field was found to be infested with different types of grasses and broad leaved weeds (Table 1). The most dominant broad leaved weeds include Polygonum nepalensis, Corrigiola

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capensis, Plantago lanceolata, Caylusea abyssinica, Spargula arvensis, Raphanus raphanistrum, Bidens pilosa, Galinsoga parviflora, Oxalis latifolia, and Guizotia scabra. Among the grass weeds Snowdenia polystachya, Setaria pumilia, Phalaris paradoxa and Avena fatua were dominant.

Table1. The major problematic weeds in the experimental fields during 2016/17 and 2017/18 cropping season.

Botanical name	Family
<i>Bidens pilosa</i> L., <i>Galinsoga parviflora</i> , <i>Guzotia scabra</i>	Composite Composite Composite
<i>Raphanus raphanistrum</i>	Brassicaceae
<i>Corrigiola capensis</i> , <i>Spargula arvensis</i>	Caryophyllaceae Caryophyllaceae
<i>Oxalis latifolia</i>	Oxalidaceae
<i>Plantago lanceolata</i> L.	Plantaginaceae
<i>Snowdenia polystachya</i> , <i>Setaria pumilia</i> , <i>Phalaris paradoxa</i> L., <i>Avena fatua</i>	Poaceae Poaceae Poaceae Poaceae
<i>Polygonum nepalensis</i>	Polygonaceae
<i>Caylusea abyssinica</i> (Fressen.)Fisch. & May	Resedaceae

Weeds density (m^{-2}) was significantly affected by S-metolachlor herbicide which reduced the weed population from 88 - 97% (Table-2). The highest number ($1250m^{-2}$) was recorded in weedy check; while the lowest (30, 50 and 65) m^{-2} was detected with twice hand weeding followed by application of S-metolachlor 1.0 and 1.5 Lha^{-1} + hand weeding.

Table2. Effect of weed control treatments on weed density m^{-2}

Treatments	Broad leaved weeds	Grasses	Total
S-metolachlor 1.0 Lha^{-1}	138	11	149
S-metolachlor 1.0 Lha^{-1} + HW	47	3	50
S-metolachlor 1.5 Lha^{-1}	122	9	131
S-metolachlor 1.5 Lha^{-1} + HW	51	14	65
HW X2 (25-30, 55-60)	26	4	30
Untreated control	1124	126	1250

Dry weight of weeds biomass: The data on above ground dry weight biomass of weeds showed significant difference among the treatments at $p \leq 0.05$. At harvest the highest total weeds biomass ($560.3 g m^{-2}$) was recorded in weedy check, while, the lowest weeds biomass (57.9 and $64.6 g m^{-2}$) was observed with application S- metolachlor 1.0 $L ha^{-1}$ + one hand weeding and twice hand weeding treatments. All the weed control treatments significantly reduced the weed infestation (weed dry matter) and increased the yield of faba bean when compared with the control (unweeded check) (Table 3).

Table3. Effect of weed control treatments on weed dry weight at harvest (gms).

Treatments	Dry weight of weeds (gm^{-2}) at Harvest		
	Broad leaved	Grass	Total
S-metolachlor 1.0 $L ha^{-1}$	17.7 (214.3)b	6.2 (38.3)c	23.9(252.6)b
S-metolachlor 1.0 Lha^{-1} + HW	8.4(40.3)e	4.9 (24.3)c	13.3(64.6) e
S-metolachlor 1.5 $L ha^{-1}$	15.2(138.2)c	6.0 (39.1)c	21.2(177.3)c
S-metolachlor 1.5 $L ha^{-1}$ + HW	5.8(68.2)d	5.9 (24.0)c	11.7(92.2)d
HW X2 (25-30, 55-60)	11.9(33.3)d	4.4 (24.6)b	16.3(57.9)e
Untreated control	21 (442.3)a	6.9(118.0)a	27.9(560.3)a
CV%	16.50	13.99	22.72

3.1. Weed Control Efficiency

Weed control efficiency (%) was affected significantly by different rates of S-metolachlor herbicide. The maximum weed control efficiency was recorded in twice hand weeding plot (98%) followed by s-metolachlor at 1.5 $kgha^{-1}$ plus one hand weeding (95%) and s-metolachlor at 1.0 $kgha^{-1}$ plus one hand weeding (92%). While, the lowest weed control efficiency was recorded in weedy check (0). The

result is in agreement with the findings of [6] who reported that pre-emergent herbicides gave higher weed control efficiency by reducing the weed density and dry weight significantly as compared to weedy check (Figure 1).

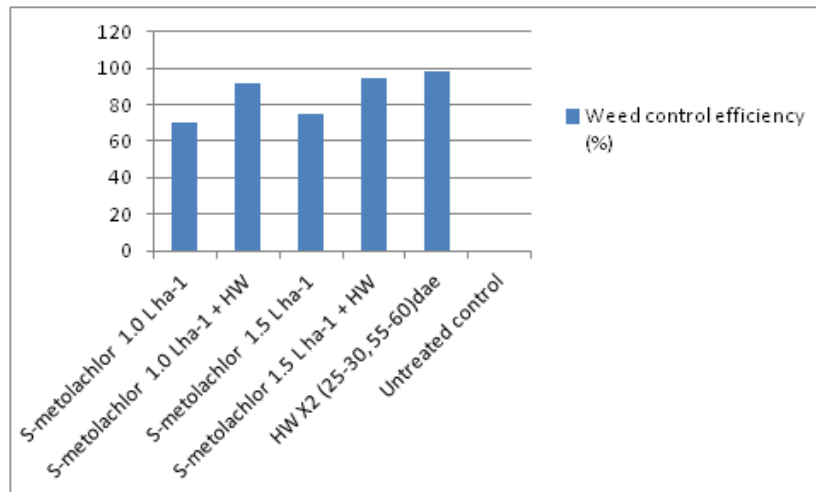


Figure1. Effect of weed control treatments on weed control efficiency

3.2. Yield Components and Yield

Plant height: The maximum height (146.7 cm) was recorded from two hand weeding treatment which did not significantly vary with plots treated S-metolachlor. The weedy check plot had plants with lowest height (127.1 cm) that was due to the impact of weeds on the growth and development of faba bean.

Hundred seed weight the data showed that the highest and lowest hundred seed weight was attained in two hand weeding and weedy check treatments respectively which were statistically insignificant among treatments.

Grain yield data revealed that significance difference among weed control treatments. The analysis of variance indicated that the highest grain yield (2770kg ha⁻¹) was resulted from two hand weeding treatments that performed best and significantly vary from the weedy check plot but not statistically differ with S-metolachlor 1.5 L ha⁻¹ + one hand weeding and S-metolachlor 1.0 L ha⁻¹ + one hand weeding. Statistically in significant yield differences (2540 and 2502 kg ha⁻¹) was perceived from S-metolachlor 1.0 L ha⁻¹ and 1.5 L ha⁻¹ alone applied plots. Two hand weeding treatment has a yield advantage (9 and 8%) over S-metolachlor 1.0 L ha⁻¹ and 1.5 L ha⁻¹ supplemented with one hand weeding respectively [8,9]. Comparable result obtained in plant height, pods per plant, number of seeds per pod, 100 seed weight between treatments. Treatments effect was highly significant for the grain yield increased by 64.8% over the unweeded control plot. It was found that the results agreed with the study of many researchers (Table 5) [7, 8, 9, 10].

Table5. Effect of weed control treatments on yield and yield attributes of faba bean

Treatments	PH(cm)	100 SW (gms)	NPPP	NSPP	NSPP	GY (kg ha ⁻¹)
S-metolachlor 1.0 Lha ⁻¹	143.0	80.2	10.2	22.2	2.4	2170b
S-metolachlor 1.0 Lha ⁻¹ + HW	144.1	82.0	10.4	24.6	2.6	2502ab
S-metolachlor 1.5 Lha ⁻¹	145.2	80.1	9.8	24.1	2.2	2080 b
S-metolachlor 1.5 Lha ⁻¹ + HW	141.3	81.7	12.3	26.2	2.5	2540ab
HW X2 (25-30, 55-60)	146.7	84.0	12.1	26.6	2.7	2770a
Unweeded (control)	127.1	74.9	9.7	18.6	2.3	975c

HW= Hand weeding ; PH= Plant Height ; NSPP=no of seeds per pod ; NPPP= number of pods per plant; 100SW= 100 seed weight; NSPP= number of seeds per plant ; GY=grain weight; Values followed by the same letter are not significantly different at the 5% level of the LSD test.

3.3. Partial Budget Analysis

The result of the partial budget analysis showed that the highest total variable coast was recorded from two hand weeding (42174.00 Birr ha⁻¹) followed by S-metolachlor 1.0 L ha⁻¹ plus one hand

weeding and S-metolachlor 1.5 L ha⁻¹ supplemented with one hand weeding four weeks after planting resulted in the highest grain yield and economic benefit. This finding has an agreement with the result; most studies [7] showed that, applying herbicide or herbicide plus manual weeding was more economical than manual or hand weeding alone.

Table4. Cost benefit analysis

No.	Treatment	Grain yield (Kg ha ⁻¹)	Gross return (Birr ha ⁻¹)	Variable Cost (Birr ha ⁻¹)	Net returns (Birr ha ⁻¹)
1	S-metolachlor 1.0 L ha ⁻¹	2170	34720.00	2300.00	32420.00
2	S-metolachlor 1.0 L ha ⁻¹ + HW	2502	40032.00	3915.00	36117.00
3	S-metolachlor 1.5 L ha ⁻¹	2080	33280.00	3450.00	29830.00
4	S-metolachlor 1.5 L ha ⁻¹ + HW	2540	40640.00	5065.00	35575.00
5	HW X2 (25-30, 55-60)	2770	44320.00	2145.40	42174.00
6	Untreated control	975	15600.00	—	15600.00

Local market price of Faba bean= 16.00 birr/kg grain, HW= hand weeding

Coast of 1 litre S-metolachlor = (2300 Birr/kg,

Coast of one man days= 30.00 Birr

4. CONCLUSION AND RECOMMENDATIONS

Results of these study revealed that two hand weeding can be recommended in faba bean farms where labor power is not a problem. But under labor scarce conditions, pre-emergence application of lower rate of S-metolachlor 1.0 L ha⁻¹ supplemented with one hand weeding 4 to 5 weeks after crop emergence was found to be most effective in reducing the weed infestation and enhancing the seed yield of faba bean benefit cost ratio.

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