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FLAME WEEDING METHOD TO CONTROL WEEDS IN FABA BEAN IN RIVER NILE STATE IN SUDAN

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Abstract: A flame apparatus was designed and its performance in terms of weeding efficiency and economic feasibility was compared with hand weeding and herbicides application. Weeding was carried out at 4 and 4 plus 6 weeks after sowing for flaming and hand weeding. A pre-emergence herbicide Pursuit plus Stomp, was mixed in a tank and applied before one day of first irrigation at the recommended rate. The mean number of weeds over two seasons revealed that flaming at 4 weeks after sowing reduced weed density by 77.3% and 71.3% respectively, whereas for hand weeding at the same period was 80.8% and 70.3% respectively. Grain yield of the plots subjected to flame weeding was comparable to that from pre-emergence herbicides and hand weeding treated plots for both growing seasons. However, economic analysis showed that flame weeding at 4 weeks after sowing gave the highest value of marginal rate of return for both seasons.

Key words: *weeding, faba bean, flame, River Nile State, Sudan.*

INTRODUCTION

Faba bean (*Vicia faba*) is one of the main cash and food crops in northern Sudan where 98% of the crop is produced. One of the major factors limiting the production of faba bean in the Sudan is the high weed infestation. Sudan is classified as a class C country (least developed), in which losses of yield in the large-acreage food crops

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attributed to weeds are estimated at 25% [1]. For faba bean Kukula *et al.* [2] found that without weed control practice, a crop loss of up to 54% was recorded. Hand weeding is common around the world, and an estimate up to 50-70% of the world's farmers control weeds by this methods [3,4]. In the River Nile State, it is the most common method adopted by the farmers and represents 85% of weed control [5], however other practices such as the use of herbicides are also used.

Faba bean crop is very sensitive to competition with both broad-leaved and grassy weeds [6, 7, 8, 9]. Intensive studies were carried out to determine most prevalent weeds, weed competition critical period and chemical weed control methods in faba bean crop in the River Nile State [10, 11]. From these studies, the critical period has been found to be between 2 and 6 weeks from sowing and a mixture of pre-emergence herbicides are recommended for legume crops, and hand weeding which is tedious and time consuming is usually performed after 6 weeks to use weeds as animal fodder.

There has been a dramatic increase in cases of herbicide-resistant weeds worldwide. For the ALS herbicide group (Glean, Accent, Pursuit) 95 species are now resistant, and for Dinitroanilines herbicide group (Treflan, Prowl, Stomp) 10 species [12]. Developing countries contribute 22 percent of the herbicide resistance incidences worldwide [13], thus emphasis continues on all possible alternatives of cultural and biological weeds control. This study analyzes the flaming technique for weed control to alleviate the tedious human power use and to improve efficacy of weeding, as also flame can suppress any weeds.

MATERIAL AND METHODS

A flame apparatus using liquefied petroleum gas (LPG) was designed, the apparatus consisting of a LPG cylinder with 10.5 liter capacity, equipped with a valve, a pressure regulator, a high pressure hose, a round burner with valve, shield, ground wheel and a frame with handle (Photo 1). Its performance in terms of weeding efficiency; work rate and economic feasibility was compared with hand-weeding using a hand-held tool (toryia) and the recommended pre-emergence herbicides, namely, Pursuit and Stomp (in tank mixture) as sprayed at the rate of 0.05 and 1.2 kg a.i./ha respectively. Flaming and hand weeding were carried out at four and 4+6 weeks after sowing.

Herbicide efficiency has been based on the average weeds/m² four weeks after sowing in herbicides treated plots. Weeding efficiency for flaming and hand weeding was assessed from a specific area, as a percentage of total weeds before weeding to the eradicated weeds from the same area, with labels fixed till weeds counted 3 days after weeding operation for complete desiccation, with the purpose to study the effect of flaming on already emerged weeds before treatment rather than weeds emerging after treatment. The mean weeding efficiency was calculated as the average of weeding efficiency to control grasses and broad-leaved weeds. For the work rate calculation, as the different weeding treatments depended on one man power, and herbicides and flaming were applied at a man walking speed and pre-emergence herbicides sprayed with a 1.2 m boom width, hand weeding and flaming carried out within 0.6m width, therefore time to cover a unit of area was taken.

A test carried out for evaluating the effect of flaming soil surface on micro flora content, one gram of 3 soil samples from the field dissolved in 10 ml of sterile distilled water.



Figure 1. Flame emission apparatus

Nutrient agar and Malt extract agar media for the isolation of bacteria, fungi respectively were prepared and poured into Petri dishes under sterile conditions, and they inoculated with 1ml of soil samples dissolve, plates were incubated at 35°C for 24 hours for bacteria and at 27°C for 28 hours for fungi, then counted under microscope. Data on weeds/m²; yield; application time; herbicides and LPG consumed and their cost for each plot were collected. The experiment was executed in randomized block design with four replications, for two consecutive seasons 2006/07 and 2007/08. The results were analyzed statistically using Mstat C computer software.

RESULTS AND DISCUSSION

The flame weeding shows a promising efficiency to control grasses and broad-leaved weeds (Tab. 1), analysis shows that there was significant difference in mean weeding efficiency, and efficiencies to control grasses and broad-leaved weeds in both seasons. Comparison of means of flaming and hand weeding efficiency at four weeks after sowing show no differences except on grasses in the last season. The means of flaming efficiency to control weeds at four weeks after sowing were 77.3% and 71.3% respectively at the two seasons, whereas for hand weeding at the same period they were 80.8% and 70.3% respectively, and the efficiencies of a mixture of Pursuit + Stomp as a pre-emergence herbicides were 89.3% and 88.1% respectively. As shown in Fig. 1, with the means of the two seasons, which shows that flaming at four weeks after sowing was comparable to hand weeding at the same period.

Table 1. Efficiency of flaming compare to hand weeding and pre-emergence herbicides application in faba bean in RNS

Season 2005-06					
Treatments	Number of weeds		Weeding efficiency (%)		Mean
	Grass/m ²	Brd*/m ²	on grass	on Brd.	
4WAS [†] flaming	42	99	74.6	80.0	77.3
4WAS HW [*]	63	87	85.5	76.2	80.8
4+6WAS HW	68	73	89.4	76.1	82.7
4+6WAS flaming	67	65	68.5	87.0	77.8
Pre-em.herbicides	80	61	86.8	91.8	89.3
SE	10.1 ^{ns}	12.2 ^{ns}	4.5 [*]	3.4 [*]	2.9 ^{ns}
C.V. (%)	31.6	31.7	11.2	8.2	7
LSD (5%)			13.9	10.4	
Weedy	63	77			
Season 2006-07					
4WAS [†] flaming	85	38	69.2	73.3	71.3
4WAS HW [*]	97	37	76.7	63.8	70.3
4+6WAS HW	89	34	77.1	72.9	75.0
4+6WAS flaming	99	39	68.2	73.9	71.0
Pre-em.herbicides	96	41	98.2	77.9	88.1
SE	13.6 ^{ns}	4 ^{ns}	1.9 ^{**}	3.8 ^{ns}	2.2 ^{**}
C.V. (%)	29.3	21.4	4.9	10.6	5.9
LSD (5%)			5.9	6.9	
Weedy	95	40			

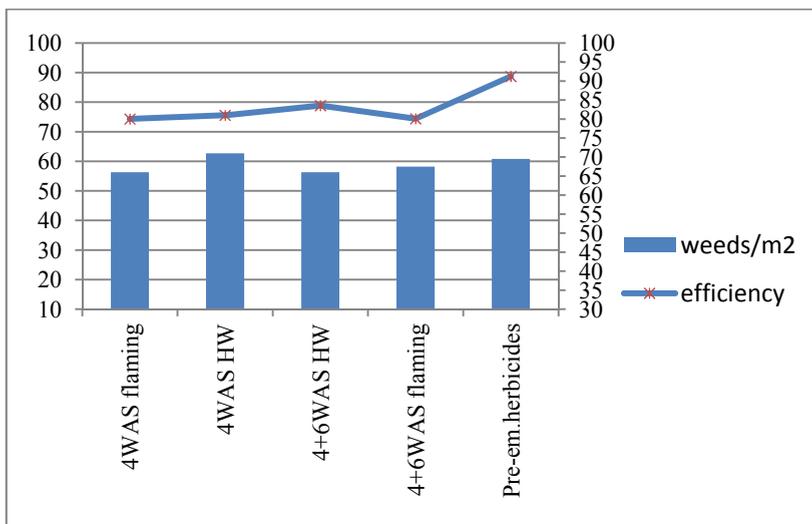
WAS[†] = weeks after sowingHW^{*} = hand weedingBrd.^{*} = broad leaved

Figure 1. Means of weeding efficiencies for the two seasons

As shown in Tab. 2. there was no significant difference in the yield of faba bean of the different weeding treatments tested in both seasons of the experiment, but there was a significant difference in faba bean yield between treated plots and weedy control plot.

Table 2. Effect of the three weeds control methods in faba bean yield in River Nile State

Season	2005-06			2006-07		
	Plants /m ²	Weeds /m ²	Yield (t/ha)	Plants /m ²	Weeds /m ²	Yield (t/ha)
4WAS ^f flaming	31	141	1.5	27	123	5.8
4WAS HW	30	150	1.5	28	135	5.0
4+6WAS HW	28	141	1.8	26	123	6.0
4+6WAS flaming	24	132	1.6	33	138	5.3
Pre-eme. Herbicides	28	141	1.9	20	137	6.1
SE ±	3.7 ^{ns}	15.2 ^{ns}	0.14 ^{ns}	3.3 ^{ns}	15.1 ^{ns}	0.39 ^{ns}
C.V. (%)	26.5	21.6	17.2	24.5	23	13.8
Weedy	22	140	1.04	27	135	4.3

The bacteria and fungi in the soil in 0-5 mm depth were decreased by 9% and 13.6% respectively, when the soil was flamed using a flaming dose of 55.5 kg·ha⁻¹ in this study at walking speed (Tab. 3). As the soil is a very good insulator with little increase in temperature at the crops roots zone.

Table 3. Effect of flaming on soil micro flora biomass

Season	Sample	Number of bacteria/ml			Number of fungi/ml		
		Before flaming	After flaming	Reduction (%)	Before flaming	After flaming	Reduction (%)
2005-06	1	75	70				
	2	70	68				
	3	50	39				
Mean		65	59	9.2			
2006-07	1	24	22		15	14	
	2	30	29		21	19	
	3	34	29		30	24	
Mean		29.3	26.7	8.8	22	19	13.6

As there were different treatments widths of application, and at pre-emergence application of herbicides no faba bean plants were grown on soil surface, where flaming and hand weeding were carried out when the ridges were covered with faba bean plants, therefore a variation on work rate was obtained as presented in Tab. 5. Flame weeding reduced work rate by 46% compared to hand weeding, which means enhancing of using human power.

For economic analysis as presented in Tab. 5. the marginal rate of return of flaming at 4 weeks after sowing and pre-emergence herbicides in both seasons, they exceeded targeted rate of return. The flaming at 4 weeks after sowing had the highest value of marginal rate of return, which indicates that farmer can gain 5.62 and 10.94 Sudanese Pound for each 1SP invested as compared to 0.9 and 3.14 for using herbicides in the two seasons. In spite of the low yield of faba bean in season 2005-06, due to unsuitable weather compared to yield of the next season, marginal rate of return from flaming at 4 weeks after sowing gave better values.

Table 4. Work-rate of different weeding treatments

Season	2005-06		2006-07	
	Weeds/m ²	Work rate (m-hr/ha)	Weeds/m ²	Work rate (m-hr/ha)
4WAS flaming	141	41.3	123	36
4WAS HW	150	85.5	135	62
4+6WAS HW	142	118.6	123	139.2
4+6WAS flaming	132	67.2	138	62.7
Pre-em.herbicides	141	5.1	137	3.7

Table 5. Marginal analysis for the flame weeding compare to prevailing weeds control treatments

2005-06								
Treatment	Value of output (SP/ha)	Weeding cost (SP/ha)	Threshing cost (SP/ha)	Net benefit (SP/ha)	MNB* (SP/ha)	MVC [†] (SP/ha)	MRR ^ψ (%)	IOV* (%)
Herbicides	2182.8	204.7	54.6	1923.5	109.15	121.25	90*	7.2
4+6 HW	2139.6	296.5	53.5	1789.6				
4 WASF	1952.4	89.25	48.8	1814.3	601.05	106.95	562*	5.3
4 WASHW	1917.0	209.15	47.9	1659.9				
4+6 F	1944.0	125.7	48.6	1769.7				
Weedy	1244.4	0	31.1	1213.3	0.0	0.0	0.0	
2006-07								
Herbicides	7338.6	204.7	183.5	6950.4	455.3	144.67	314.7*	1.1
4+6 HW	7209.6	348.0	180.2	6681.4				
4 WASF	6738.6	75.03	168.5	6495.0	1171.5	107.03	1094*	4.6
4 WASHW	6671.4	172.5	166.8	6332.1				
4+6 F	6160.0	117.2	159.0	5883.8				
Weedy	5460.0	0	136.5	5323.5	0.0	0.0	0.0	

* marginal net benefit † marginal variable cost ψ marginal rate of return

♦ index of variability * meet or exceed target rate of re

CONCLUSIONS

Regards to the low work rate of hand weeding linked to the critical period of weeds competition, and considering the recommended herbicides to control weeds in faba bean in River Nile state is pre-emergence herbicides, the flaming apparatus shows promising results in terms of weeding efficiency and economic feasibility.

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UKLANJANJE KOROVA PLAMENOM KAO METOD ZA SUZBIJANJE KOROVA U BOBU U OBLASTI REKE NIL U SUDANU

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Sažetak: Plamenik je bio konstruisan i ispitivan tako da su njegove karakteristike efikasnosti uništavanja korova i ekonomske isplativosti poređene sa suzbijanjem korova primenom herbicida. Tretman je izvođen 4 i 4 plus 6 nedelja posle setve, paljenjem i ručnim plevljenjem. Herbicid Pursuit plus Stomp je mešan u rezervoaru i primenjen u

preporučenoj dozi jedan dan pre prvog navodnjavanja. Prosečan broj korova tokom dve sezone pokazao je da je paljenje na 4 nedelje posle setve smanjilo gustinu korova za 77.3% i 71.3% redom, dok je ručnim plevljenjem u istim periodima postignuto 80.8% i 70.3%, redom. Prinos zrna sa parcela tretiranih plamenom bio je uporediv sa prinosom sa parcela tretiranih herbicidom i ručnim plevljenjem, u obe sezone. Ipak, ekonomska analiza je pokazala da je tretiranje plamenom 4 medelje posle setve u obe sezone dalo najveću vrednost jedinične stope prinosa.

Ključne reči: *suzbijanje korova, bob, plamen, oblast reke Nil, Sudan*

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