Weeding Initiation Time and Frequency: Their Effect on Performance and the Economics of Weed Control in Cotton

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ABSTRACT

Experiments were conducted at Serere Agricultural and Animal Production Research Institute (SAARI) in 1996 and 1997 to determine the time of initiation and number of cultivations to optimise returns and the cost of weed control. Weeding was started either early (30 days after planting, (dap)) or late (45 dap). In both cases, plots were cultivated four times at fortnightly intervals but where cultivation was initiated early, some treatments were cultivated five or six times. The herbicide (Tomen) was also tested. Reduced weeding from both late initiation and reduced number of cultivations reduced plant height, numbers of branches, fruiting positions, number of bolls and seed cotton yields. Weeding costs increased with higher number of cultivations but was optimized with early initiation and five cultivations. Non-weeded controls gave no yield while Tomen was ineffective against some dicotyledonous weeds species.

Introduction

Weeding is a must in growing cotton and is one of the most expensive factors, making it prohibitive to many farmers. Weed infestation reduces yields by 12-41 % (Jalias and Shash, 1982), but the reduction can reach 100 %. Cotton grows for 4-6 months, so is exposed to weed infestation by several weed species. Close row spacing of 51 cm reportedly reduced weed infestation and increased cotton yields by 15 % compared to wide row spacing of 102 cm (Miller *et al.*, 1983). Such spacing is not applicable in Uganda because of high fertility that leads to vegetative growth, so spacing range from 75 - 90 cm (Elobu *et al.*, 1994). The diversity of weed species in Uganda, coupled with the low knowledge about use of, and lack of herbicides, makes hand weeding the most widely used option (Jameson, 1970). Ox-drawn cultivators are not popular because of lack of oxen, cultivators, and farmer ignorance on their use.

Two aspects of weeding by hand i.e. time of initiation and frequency of weeding, are critical because they affect the overall effectiveness and costs of the operation. When weeded early, cotton is given an opportunity to compete effectively with late season weeds. However, weeding has to be frequent, particularly on poorly prepared seedbeds, under high rainfall conditions and when there are many weed species. Late weeding gives cotton a poor initial growth pattern although it might reduce the frequency of weeding. Regularly weeded cotton can be kept weed-free but weeding is expensive and as a tillage practice, loosens the soil and may make it more vulnerable to erosion.

The commencement and frequency of weeding is not properly documented in Uganda but this information is required to improve the economics of cotton growing and alleviate rural household poverty. The objective of this experiment was to understand how early cotton weeding can be started economically and how regularly it should be done to optimize returns and weeding costs.

Material and Methods

Cotton (SATU 85) was planted at SAARI on 12th April 1996 and 14th April 1997. One month later, hand cultivation treatments and one herbicide application treatment commenced. In the hand cultivated treatments, weeding started either early (EW) at 30 days after planting (dap) or late (LW) at 45 dap. In the early weeded treatments, there were five times of cultivation while in the late weeded treatments there were four. The interval between cultivations was two weeks so weeding was done on 13th May, 28th May, 12th June, 27th June and 12th July in 1996. In 1997 the weeding dates were 28th April, 12th May, 26th May, 9th June and 23rd June. Tomen (Select) herbicide was applied post-emergence at a rate of 100 gm a.i./ha, only in 1996. This rate was achieved by mixing 80 mls of Tomen in 20 lt. of water at each application, made at 30, 45 and 60 dap. There were two controls, weed-free and unweeded (in 1996 only). Weed freeness was achieved by hand weeding the plots starting 30 dap six times at two weeks intervals until the canopy development totally suppressed weeds. At 150 dap when the cotton had opened, monopodia, sympodia, bolls and all fruiting positions were counted from four sample plants in each plot and plant heights were measured. Abortion of fruiting bodies was calculated as the percentage of all fruiting points (Fps) that did not form good bolls. All seed cotton from plants in the middle four rows was picked, sorted and weighed.

The treatments studied were:

EW1 = Early weeding once starting 30 dap
EW2 = Early weeding twice starting 30 dap
EW3 = Early weeding thrice starting 30 dap

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EW4 = Early weeding four times starting 30 dap
EW5 = Early weeding five times starting 30 dap
EW6 = (Weed free) Early weed six times starting 30 dap
LW1 = Late weeding once starting 45 dap
LW2 = Late weeding twice starting 45 dap
LW3 = Late weeding thrice starting 45 dap
LW4 = Late weeding four times starting 45 dap
NW = Not weeded
H = 100 gm a.i./ha (80 mls/20 L. of water) of Tomen herbicide at 30, 45 and 60 dap.

Cotton was grown at 75x15 cm and thinned to one plant per hill at first weeding. All plots measured 4 x 4 m in a randomized complete block design with four replications. Weeding costs were estimated at Shs. 33750/ha for each cultivation, based on wages of 250/= per 100 m row, spaced at 75 cm. At this spacing, one hectare has 13,500 metres of row. Herbicide application cost was estimated at Sh. 14000/= for each of the three applications. It was applied at 1 lt./ha/application. One litre cost 12000/= and the labour cost per application was sh. 2000/=. Revenue obtained was divided into two. Revenue from clean "safi" (A grade) cotton was obtained by multiplying "safi" seed cotton yield by the government indicative cotton price of 350/=/kg for the 1995/96 cotton season. Revenue for "fifi"' cotton was a product of "fifi" (B grade) yield and the government "fifi" indicative price of 150/=/ kg. Revenue reduction (margin) due to weeding alone was computed as the difference between weeding cost and total revenue, calculated over treatments and therefore not statistically analyzed. All other data were analyzed by the MSTATC computer programme and mean separation done by DMRT.

Results and Discussion

Branches and Height. All treatments significantly reduced the numbers of both monopodia and sympodia per plant compared to the weed free control (Table 1). The number of sympodia in the unweeded control was significantly lower than all other treatments. The number of branches and plant height are a reflection of growth vigour that in turn reflects availability of nutrients. Both late initiation and reduced number of cultivations resulted in more aggressive weed growth, adversely affecting plant vigour and also generally reduced plant height. Significant reductions occurred in zero weeding and in herbicide treatments.

Fruiting Positions and Abortion. There was no definite consistency between individual treatments in number of Fps and abortion. It was clear however, that the more frequent the weeding the more Fps the cotton produced. This was more apparent in the early than late weeded treatments. Use of herbicide or no weeding at all, significantly reduced the number of Fps. Abortion of Fps was significantly increased by no weeding compared to the weed free treatments. Unweeded plots had a complex ecosystem consisting of different plant species and insect pests. This combination presumably increased abortion through pest damage, while the high weed density possibility reduced the light penetration in the cotton crop. This is known to reduce the leaf weight ratio, specific leaf ratio, stem weight ratio and hence, net assimilation ratio (Huxley, 1964).

Bolls, yield and quality. As a result of increased abortion in the unweeded plots, the number of good bolls was reduced with less weeding (Table 2). Similarly, yield dropped with reduced weeding. Both the time of initiation and number of cultivations influenced yield and quality (Table 2 and 3). Although late initiation of weeding reduced yields compared to early weeding, there was an improvement both in yield and quality with increased number of cultivations. Herbicide was not effective and resulted in reduced yields because the herbicide did not control most weeds, especially dicotyledonous weeds. This implies that if the herbicide is to be used, it has to be supplemented with some weeding or combined with another herbicide that can kill monocotyledonous weeds. More study is required. Similar conclusions have been reached in studies where a combination of cultural methods and herbicide controlled weeds better than herbicides alone (Paller and Lijauco, 1981).

Weeding Cost, Total Revenue and Margin. The more frequently cotton was weeded as in the weed-free controls weeded six times starting 30 dap, the higher the revenues were (Table 3 and 4). Without any weeding at all nothing was harvested, hence no revenue. Use of herbicide similarly resulted to low revenue. Late weeding generally resulted to lower revenues compared to early weeding. For both the early weeded and late weeded cotton, yields, revenue, weeding costs and margins directly increased with weeding frequency. However beyond a weeding frequency of five times, the rate of increment in revenue obtained was lower than the rate of increment in weeding cost. As a result weeding margin became lower at the highest weeding frequency of six times.

Conclusions and Recommendations

Results of this study confirm that weeding is essential in cotton production. The earlier and more frequently it is done, the higher the yields. Information is required on the effects of initiation of cultivation earlier than 30 dap and the interval between cultivations on cotton performance and returns. This will require similar trials in various agro-ecological zones and more seasons.

Weeding only five times when started early appears to be the optimum option with regard to weeding margin, but farmers can freely choose between weeding twice and five times. The use of herbicide alone is not effective and may require supplementation with cultivation. However, since cotton is resistant to Tomen herbicide, it could be a good option for

Ugandan farmers who lack knowledge on herbicide application.

Weeding of cotton in trials at research institutes, especially in early screening of varieties, should commence early with as many as six cultivations to enable the cotton to show its maximum potential. Such a practice is justifiable only if the objective of the study is to offset extra weeding costs. Weeding costs are generally very high in cotton production. A review and increase in cotton prices could offset this constraint.

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Table 1. Weeding effects on cotton height (cm), numbers of branches and fruiting positions (Fps) per plant, and on abortion of Fps at SAARI in 1996.

Weeding treatment	Plant height	Monopodia	Sympodia	Fps	Abortion (%)
EW1	96.1 bc	0.5 cd	14.5 bc	36.0 bc	86.5 ab
EW2	101.5 abc	0.5 cd	14.4 bc	43.0 bc	83.3 bcd
EW3	101.6 abc	0.7 cd	16.2 abc	41.6 ab	82.2 bcd
EW4	101.1 bc	0.5 cd	14.1 bc	39.0 bc	80.1 d
EW5	116.4 ab	1.4 b	17.5 ab	50.8 a	84.5 bcd
LW6	125.2 a	0.2 a	20.0 a	45.8 ab	80.8 cd
LW1	92.8 bcd	0.9 c	15.0 bc	36.6 bc	85.3 bc
LW2	104.4 abc	0.8 cd	16.1 abc	37.0 bc	83.5 bcd
LW3	109.3 abc	0.5 cd	15.9 bc	43.8 ab	85.7 b
LW4	94.6 bc	0.4 d	13.6 bc	35.0 bc	84.9 bcd
TOMEN	87.5 cd	0.5 cd	13.1 c	29.5 cd	86.2 ab
NW	69.5 d	0.5 cd	9.2 d	18.7 d	90.8 a
Mean	100.0	0.8	15.0	38.1	84.5
LSD	24.0	0.5	4.0	11.0	4.9
CV (%)	16.7	43.1	18.4	20.0	4.0

Means followed by the same letter (a, b or c) in a column are not significantly different ($P \leq 0.05$)

Table 2. Weeding effects on number of bolls per plant and seed cotton yield at SAARI in 1996 and 1997.

Weeding treatment[1]	Bolls/plant		Yield (kg/ha)	
	1996	1997	1996	1997
EW1	4.8 d	4.9 c	768.3 de	987 d
EW2	7.0 abc	7.4 b	1838.1 ab	2348 c
EW3	7.4 abc	9.8 ab	2020.1 ab	2717 b
EW4	7.7 ab	9.4 a	2130.0 ab	2822 ab
EW5	7.9 ab	9.1 a	2275.1 a	3306 a
EW6	8.7 a	10.0 a	2282.8 a	3311 a
LW1	5.3 cd	6.8 b	1058.6 cd	345 e
LW2	6.1 bcd	5.4 c	1577.9 bc	434 e
LW3	6.2 bcd	5.6 c	1635.0 abc	470 e
LW4	5.3 cd	7.4 ab	1626.7 abc	493 e
TOMEN	4.3 d	----	164.3 ef	----
NW	1.8 e	-----	0.0 f	----
Mean	6.0	6.6	1448.1	1640
Lsd	2.2	1.7	682.5	297
CV (%)	24.9	36.3	32.5	25.6

Means followed by the same letter (a,b or c) in a column not significantly different ($P \leq 0.05$)

Table 3. Weeding effects on economics of cotton production at SAARI in 1996.

Weeding treatment[1]	Seed cotton yield (kg/ha)		Revenue in Uganda shillings			Weeding	
	"Safi"	"Fifi"	"Safi"	"Fifi"	Total	cost	margin
EW1	357.3	411.0	125,055	61,650	186,705	33,750	152,955
EW2	1100.9	737.0	385,315	110,550	495,865	67,500	428,365
EW3	1305.0	715.1	456,750	107,265	564,015	101,250	452,765
EW4	1365.3	764.7	477,855	114,705	592,560	135,000	457,560
EW5	1508.4	766.7	527,940	115,005	642,945	168,000	474,945
EW6	1611.7	671.1	564,095	100,665	664,760	202,500	462,260
LW1	437.0	621.4	152,950	93,210	246,160	33,750	212,410
LW2	932.5	643.4	6,375	96,510	422,885	67,500	355,385
LW3	925.7	719.4	323,995	107,910	431,905	101,250	330,655
LW4	958.1	668.6	335,335	100,290	435,625	135,000	300,625
TOMEN	135.2	29.1	47,320	4,365	51,685	42,000	9,685
NW	0.0	0.0	0	0	0	0	0

Table 4. Weeding effects on economics of cotton production at SAARI in 1997.

Weeding treatment[1]	Seed cotton yield (kg/ha)		Revenue in Uganda shillings			Weeding	
	"Safi"	"Fifi"	"Safi"	"Fifi"	Total	cost	margin
EW1	117	870	41,108	130,500	171,608	33750	137,850
EW2	1068	1280	373,919	192,000	565,919	67500	498,419
EW3	1847	870	646,646	130,500	777,146	101250	675,896
EW4	2026	796	709,168	119,400	828,568	135000	693,356
EW5	2783	523	974,278	78,450	1,052,728	168000	884,728
EW6	2622	609	917,809	103,350	1,021,159	202500	818,659
LW1	197	148	62,790	22,200	84,990	33750	51,240
LW2	273	161	95,848	24,150	119,998	67500	52,498
LW3	309	161	108,405	24,150	132,555	101250	31,305
LW4	402	191	140,926	28,650	169,570	135000	34,576

[1]Treatment legend:
EW and LW = early weeding and late weeding starting 30 and 45 dap, respectively. Figures 1 - 6 are weeding frequencies. NW = not weeded