

# EFFECT OF DIFFERENT METHODS AND TIMING OF WEED CONTROL ON THE YIELD AND YIELD COMPONENTS OF GRAIN SORGHUM

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## ABSTRACT

Differences in grain yield between the different methods of weed control were not statistically significant; however, highly significant differences were observed on the timing of weed control. Results showed that early application of weed control treatments resulted in increased grain and stover yields. Clean culture and application of atrazine 2 weeks after planting and at pre-emergence resulted in increased yields, while late application at 4 and 6 weeks after planting gave lower yields. Similarly, split application of atrazine produced undesirable results. Hand-weeding at 2 weeks and at 2 and 6 weeks after planting produced results comparable to clean culture. Lowest yields were obtained from unweeded plots. Results indicated that chemical weed control was comparable to hand-weeding in increasing yields of sorghum.

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## INTRODUCTION

Sorghum (*Sorghum bicolor* (L) Moench), which belongs to family Gramineae, is gaining popularity in the Philippines because of its varied uses. It is consumed as human food, utilized as substitute for corn as feed grain and used as base material in fermentation process in the brewing industry (PCARR, 1975). Due to its potentials, the production of sorghum is being encouraged.

Weed control is one factor which ensures high production of sorghum. Weeds may be controlled either by chemical and mechanical means. This study presents the effects of chemical and manual methods of weed control on sorghum plants under ViSCA conditions.

## MATERIALS AND METHODS

*Land Preparation.* — An area of 858.75 sq m was prepared by

plowing and harrowing alternately with animal-drawn implements. Two plowing operations followed by two harrowings were done at one-week interval to allow the weed seeds to germinate and at the same time to pulverize the soil.

*Field Layout and Experimental Design.* — A split-plot experimental design arranged in randomized complete block with three replications was used with weed control method as the main plot and time of application of weed control as the sub-plot. The two main plots were herbicide treatment using atrazine (2 - chloro - 4 - ethylamino - 6 - isopropylamino - 1, 3, 5 - triazine) (2 kg a.i./ha) and hand-weeding. For the herbicide treatment, the sub-plots were unweeded, kept weed-free by spraying with herbicide everytime weeds appeared (clean culture), applied at pre-emergence, at 2, 4 and 6 weeks after planting, and at 2 and 6 weeks after planting (1 kg a.i./ha in each application). For the hand-weeding treatments, the sub-plots were unweeded, kept in a clean culture, hand-weeded at 2, 4 and 6 weeks after planting, and at 2 and 6 weeks after planting.

Each treatment plot consisted of 5 rows of plants spaced 5 m long and 75 cm apart. Every sub-plot had an area of 18.75 sq meters.

*Planting.* — Sorghum variety Cosor 3 was planted immediately after the land was thoroughly prepared. Seeds were drilled in the furrows and thinned 2 weeks after germination to obtain the desired population

of 200,000 plants/ha (15 plants/linear meter).

*Fertilizer Application.* — Complete fertilizer (14-14-14) was applied at the rate of 60 kg N, 60 kg  $P_2O_5$  and 60 kg  $K_2O$ . Before planting, the fertilizer was applied uniformly by broadcast method and then incorporated into the soil using an animal-drawn implement.

*Control of Insects and Fungal Diseases.* — Thiodan and Benlate were sprayed periodically to control insects and fungal diseases, respectively.

## RESULTS AND DISCUSSION

### *Plant Height (cm) at Maturity.*

Highly significant differences in plant height were observed among the different treatments with varying timing of application of weed control. However, the main effects of weeding methods and the interaction between weeding method and time of application were not significant. No significant difference was noted in the average plant height between plants treated with herbicide (145 cm) and those that were hand-weeded (151 cm) as shown in Table 1.

In general, the plants grew taller in clean culture plots and in the plots which were weeded early. Slow development of the plants was noted when no weeding or late weeding was done, with the shortest plants observed in these plots. This was due to weed competition during

*Grain Yield (t/ha).*

A significant increase in grain yield was obtained in plots which were weeded early. In these treatments, the plots were kept free from weeds at the early stage, hence, the growth and development of plants was rapid resulting in higher production. On the other hand, a remarkable decrease in yield was obtained in plots which were weeded late. Weed infestation during the early stage of the crop could have seriously hampered growth and development of the plants.

In chemically-treated plots, spraying atrazine 2 weeks after planting resulted in a significant increase in grain yield which was comparable to clean culture and the application of pre-emergence herbicide. During this period, weeds were still young and small, hence, they were highly susceptible to atrazine. However, atrazine applied 4 weeks after planting resulted in lower grain yield. Similarly, split application of atrazine 2 and 6 weeks after planting gave lower yields. These results suggest that when using atrazine, application should be done not later than 2 weeks after planting to obtain the maximum benefit.

Hand-weeding 2 weeks or 2 and 6 weeks after planting resulted in grain yields comparable to the yield obtained from clean culture plots. Further delay in hand-weeding to 4 and 6 weeks after planting resulted in reduction in yield almost comparable to the unweeded plots due to weed-crop competition for water,

light, mineral nutrients and space.

It was observed that at 6 weeks after planting, weed infestation was already severe. At this time weeding was already late, thus causing a marked decrease in grain yield. On the other hand, hand-weeding 2 weeks after planting gave the crop favorable conditions for normal growth and development.

In general, the results showed that the total grain yield was highly dependent upon the yield components. An increased grain yield was due to the increase in number and weight of grains per panicle which were also influenced by the leaf area index.

*Fresh Weight (t/ha) of Stover.*

Statistical analysis showed significant effects of the different methods and time of applications of weed control on fresh weight of plant material. However, no significant interaction between weeding method and time of application was observed.

The average stover yield in hand-weeded plots (8.32 t/ha) was significantly higher than that of the chemically-treated plots (7.30 t/ha).

Early weeding resulted in higher fresh weight of plant material and, conversely, lower fresh stover weight in plots that were weeded late. The increase in production could be attributed to the early elimination of weeds during the early stage of growth which was favorable for plant growth and development. On the other hand, the low production of stover result-

ing from late weeding was due to heavy weed competition during the critical period of the plant growth resulting in decreased yield. In general, stover yield follows the same trend as that of grain yield, i.e., an increase in production of vegetative materials leads to increased grain yield.

The results of this experiment seemed to corroborate with the findings of other researchers that chemical weed control when applied early is as effective as hand-weeding in increasing grain yield of sorghum and in controlling weeds (Mittal, Chadrachar and Nombiar, 1968; Gita, Main and Denan, 1971; Nalewaja, 1975; and, Briones, 1970). In general, the overall results of this experiment showed the same trend between grain and stover yields and those of yield components. The results also indicate that total sorghum yields were highly influenced by all growth parameters studied. The normal growth and development of the crop as exhibited by taller plants, greater leaf area index and other morphological characteristics studied contributed largely not only to grain production but also to stover production.

### *Weed Incidence and Prevalent Weed Species.*

The four most abundant weed species observed were *Cleome rutidosperma*, *Ludwigia adscendens*, *Cyperus rotundus* and *Echinochloa colonum*. The fifth group was composed of the less prevalent weed species like *Eleusine indica*,

*Rottboellia exaltata*, *Mimosa pudica* and *Ageratum conyzoides* (Table 2).

Generally, the number and weight of weeds increased as the application of weed control treatments was delayed (Tables 2 and 3). Pre-emergence application of herbicide prevented the germination and growth of most weeds, some of which started to appear 3 weeks after planting. Germination of these weeds was facilitated by rain which occurred 2 weeks after planting. Furthermore, sufficient soil moisture perhaps diluted and reduced the effectiveness of the herbicide applied in the soil.

When atrazine was applied 2 weeks after planting, effective control of weeds was obtained. All weed species present were completely killed by the herbicide, except *C. rotundus*, which had a few plants left in the area 10 days after application. Late spraying of the herbicide produced no desirable effect since only few weeds were killed completely, primarily the small ones which appeared late. In the split application of herbicide, effective control was obtained with the first application done 2 weeks after planting. However, regrowth was observed 2 weeks after the second application with few weeds remaining unchecked probably because of the lower concentration of the herbicide. This was expected since atrazine is basically a pre-emergence herbicide.

Hand-weeding controlled weeds more efficiently. The weeds were completely controlled but some regrowth was observed 10 days

**Table 2.** Average number of individual weed species harvested 2 days before and 10 days after treatment.

TREATMENT	<i>C. rotidosperma</i>		<i>L. adscendens</i>		<i>C. rotundus</i>		<i>E. colonum</i>		Others	
	2B*	10A	2B	10A	2B	10A	2B	10A	2B	10A
Herbicide										
Application										
C <sub>00</sub>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C <sub>2</sub>	131.00	0.00	0.00	0.00	52.33	29.00	0.00	0.00	42.00	0.00
C <sub>3</sub>	49.00	29.00	991.33	82.17	122.57	100.97	30.73	19.10	18.04	9.63
C <sub>4</sub>	152.47	116.10	159.23	133.77	41.67	33.00	63.77	34.20	18.00	2.66
C <sub>5</sub> 1st	0.00	0.00	79.67	0.00	41.43	24.00	0.00	0.00	55.00	0.00
2nd	0.00	0.00	0.00	0.00	5.53	4.10	67.37	33.83	14.57	0.67
Hand-weeding										
H <sub>2</sub>	0.00	0.00	119.87	0.00	13.10	0.00	0.00	0.00	47.66	4.90
H <sub>3</sub>	150.43	9.90	109.57	0.00	108.43	1.67	42.90	0.00	42.23	10.87
H <sub>4</sub>	177.77	0.00	183.10	4.90	37.57	2.87	35.10	0.00	77.37	12.20
H <sub>5</sub> 1st	129.43	0.00	0.00	0.00	55.80	3.33	0.00	0.00	32.00	9.57
2nd	41.83	0.00	0.00	0.00	41.87	0.00	28.80	0.00	54.33	4.00

## Legend:

- 2B - 2 days before treatment
- 10A - 10 days after treatment
- C<sub>00</sub> - Pre-emergence treatment
- C<sub>2</sub> - Herbicide application 2 weeks after planting
- C<sub>3</sub> - Herbicide application 4 weeks after planting
- C<sub>4</sub> - Herbicide application 6 weeks after planting
- C<sub>5</sub> - Herbicide application 2 and 6 weeks after planting
- H<sub>2</sub> - Hand-weeding 2 weeks after planting
- H<sub>3</sub> - Hand-weeding 4 weeks after planting
- H<sub>4</sub> - Hand-weeding 6 weeks after planting
- H<sub>5</sub> - Hand-weeding 2 and 6 weeks after planting

after. When herbicide was used, most of the weeds which survived 10 days following application were defoliated and gradually dried even at 2 weeks after application. This indicated that either the toxic effects of herbicide was slightly delayed or the weeds were tolerant to herbicide.

In the hand-weeded plots, more regrowth of weeds occurred 2 weeks after hand-weeding although the development was slow due to shading. Some grew and developed faster, especially those from plots which were weeded early. However, growth rate of weeds declined when the crop had fully-developed with overlapping leaves.

Unweeded plots were heavily infested with weeds, causing a severe decrease in grain yield. In clean culture plots, weeds were controlled completely due to the application of weed control measures every time weeds appeared until harvest.

#### *Physical Effects of Herbicide on Weeds.*

Pre-emergence application of herbicide prevented the germination of weeds at specific periods. However, 3 weeks after planting, some weeds appeared but they showed chlorotic leaves and were stunted in growth although some had normal

Table 3. Average fresh weight of individual weed species (g/m<sup>2</sup>) harvested 2 days before and 10 days after treatment.

TREATMENT	<i>C. rotidosperma</i>		<i>L. adscendens</i>		<i>C. rotundus</i>		<i>E. colonum</i>		Others	
	2B*	10A	2B	10A	2B	10A	2B	10A	2B	10A
Herbicide Application										
C <sub>00</sub>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C <sub>2</sub>	299.00	0.00	0.00	0.00	41.47	19.23	0.00	0.00	0.00	0.00
C <sub>3</sub>	228.63	105.07	838.10	252.07	147.33	50.40	0.00	0.00	2.57	0.00
C <sub>4</sub>	926.47	392.27	970.07	503.33	52.17	24.07	189.77	54.60	48.30	52.90
C <sub>5</sub> 1st	0.00	0.00	143.57	0.00	42.27	19.97	721.33	318.60	37.30	41.96
2nd	0.00	0.00	0.00	0.00	6.70	2.60	0.00	0.00	37.30	0.00
Hand-weeding										
H <sub>2</sub>	0.00	0.00	210.83	0.00	15.80	0.00	0.00	0.00	18.14	0.80
H <sub>3</sub>	575.07	0.83	498.77	0.00	117.27	1.23	0.00	0.00	60.10	0.50
H <sub>4</sub>	986.17	0.00	1107.33	0.23	48.37	3.07	247.03	0.00	45.70	1.63
H <sub>5</sub> 1st	219.70	0.00	0.00	0.00	64.10	2.10	0.00	0.00	6.77	0.17
2nd	163.60	0.00	0.00	0.00	47.70	0.00	185.40	0.00	17.63	0.17

## Legend:

- 2B - 2 days before treatment
- 10A - 10 days after treatment
- C<sub>00</sub> - Pre-emergence treatment
- C<sub>2</sub> - Herbicide application 2 weeks after planting
- C<sub>3</sub> - Herbicide application 4 weeks after planting
- C<sub>4</sub> - Herbicide application 6 weeks after planting
- C<sub>5</sub> - Herbicide application 2 and 6 weeks after planting
- H<sub>2</sub> - Hand-weeding 2 weeks after planting
- H<sub>3</sub> - Hand-weeding 4 weeks after planting
- H<sub>4</sub> - Hand-weeding 6 weeks after planting
- H<sub>5</sub> - Hand-weeding 2 and 6 weeks after planting

green leaves. The emergence of weeds suggested that the effectiveness of the herbicide in the soil was reduced due to the heavy rain which occurred 2 weeks after planting. Weeds emerged several weeks after sorghum. Hence, the latter had a headstart over the weeds, preventing severe competition.

In the post-emergence treatments, early application of herbicide 2 weeks after planting effectively controlled the weeds. Young weeds showed less resistance to the herbicide as shown by the drooping of their growing points. Leaves curled and became deformed, turned chlorotic, and eventually the whole plant died within 4 days after herbicide application. *C. rotundus* appeared

to be tolerant to the chemical applied even at 10 days after planting. Few leaves remained yellowish green, but later on turned completely yellow and the weeds eventually died.

Results showed that applying herbicide at 4 and 6 weeks after planting was undesirable. During these periods, weeds were already taller and bigger, and showed tolerance to herbicide. Weeds, which appeared late and therefore were younger and smaller, were effectively controlled. Young leaves were observed to be affected by the herbicide as shown by their curling and deformities. A delayed phytotoxic effect of the herbicide was noted in some mature weeds.

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