Afropolitan Journals

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ISSN: 3027-2637 www.afropolitanjournals.com

# Evaluation of Different Weed Control Methods on the Performance of Soybean (Glycine max( L.) Merrill)

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***DOI**: https://doi.org/10.62154/ajasfr.2025.020.01015*

## Abstract

Evaluation of different weed control methods on performance of soybean yield was carried out at Teaching and Research Farm of the Department of Agricultural Technology, The Federal Polytechnic, Ado- Ekiti from June to October, 2023. The experimental design was Randomized Complete Block Design (RCBD) with five treatments and replicated three times. The treatments were Hoe weeding thoroughly, Hoe weeding + Imazamox, Hoe weeding + Imezatapyr, Butachlor + Imazamox and Butachlor + Imezatapyr. Weed control methods significantly influenced the number of pods, soybean yield and weight of 100 seeds. Total variable cost of soybean production was significantly influenced by cost of weed control methods. Hoe weeding three times consecutively recorded the highest soybean yield (746.6 kg/ha) but was not economical due to highest cost of weed control. Combination of Pre-emergence and Post- emergence herbicides (Butachlor + Imezatapyr) had the lowest total cost but Butachlor + Imazamox resulted in highest gross profit (# 444,400) which contributed to the highest benefit-cost ratio (4.09). This study suggests that combination of Pre-emergence and post-emergence herbicides (Butachlor + Imazamox) for weed control could help in yield optimization and increase the profitability of soybean production especially for both smallholder farmers and commercial production level.

**Keywords:** Soybean, Weed Control, Herbicides, Benefit-Cost Ratio, Yield.

## Introduction

Soybean (*Glycine max* L. Merrill) is a wonder crop of the twentieth-century and an important source of protein and vegetable oil for human and animal consumption (Ajokporise *et al.*, 2018). Today, the largest soybean producers in the world are the USA, Brazil, and Argentina (Cattelan and Agnol, 2018; FAO, 2017). Nigeria is the second-largest producer of soybeans after South Africa in Sub Saharan Africa, with a larger percentage had grown mainly by smallholder farmers (Khojely *et al.*, 2018). During soybean production cycle, weed infestation is a major factor that reduces crop yield. The competition between the crop and weeds for water, light and nutrient has become the regulating factor for soybean (Hammer *et al.*, 2018). According to Imoloame (2014) and Daramola *et al.* (2020), among different factors attributed to the poor yield and productivity of soybean in Nigeria and other parts of SSA, weed infestation appears to be the most harmful, with 37% yield reduction. Sedaghati and Hokmabadi (2014) reported that the extent of weed damage on soybean crop varies with the weed species involved due to soybean vulnerability to early

weed competition. When weeds are uncontrolled for the entire season, yield reduction of up to 75% occurs due to weed-soybean competition. Heavy weed infestations in soybeans highly interfere with the timeliness and efficiency of harvests, and if not controlled, cause severe losses in crops out-rightly (Heinrichs and Muniappan, 2018).

Weed control is a very important cultural operation for optimum growth and yield of soybean. In soybean, weeds are generally controlled using cultural (Hand weeding or Hoe weeding), mechanical, chemical (Pre or post emergence herbicides) and combination of two or more than methods which tagged as Integrated weed management (IWM). Currently, the most frequent methods for weed management in soybean are manual, mechanical and chemical methods (Yadav *et al.*, 2017).

Today, soybean farmers are increasingly turning to herbicide treatments due to labour shortages, high manpower costs, large areas for cultivation and economics values. Thus, chemical weed control is necessary to decrease cost and to increase productivity, so the advantages of herbicide use are high efficiency and the presence of selective products of soybean at the lowest cost, compared to other available weed control methods (Peer *et al.*, 2013). According to Chauhan *et al.*, (2012), weed management using herbicides has become an integral part of modern agriculture. Herbicides offer greater flexibility of operation, more effective and are often cost-effective compared with most other methods of weed management. Knowing the best herbicide to use in controlling weeds in soybean farms will bring great relief to farmers.

Recent studies have addressed that hand weeding limits the agricultural productivity because it places a limitation to the size of the land to be cultivated even with free labour (Omovbude and Udensi, 2013). Also, there is an issue with existing pre-emergence and post-emergence herbicides in soybean about it consistent in their spectrum of effectiveness on weed control which translate to the profitability of the production. This may be as a result of weed resistance that some weeds are exhibiting. Also, pre-emergence application is insufficient alone to deal with weed flushes during the raining season which demanding a post-emergence solution. With increase in soybean production in Nigeria, there is a need to identify most effective weed control method that will boost and give a good yield at a reduced cost of production. Imazamox and Imezathapyr which are the recently introduced new post-emergence herbicides in Nigeria market had not been well experimented by farmers. Hence, the objective of this study was to evaluate the effectiveness of these post-emergence herbicides for weed control in soybean and also to determine the cost benefit analysis in soybean.

## Materials and Methods

### Experimental Site

The study was conducted between June to October, 2023at the Teaching and Research Farm of the Department of Agricultural Technology, The Federal Polytechnic, Ado-Ekiti (latitude 7° 60′ 53′ N and longitude 5° 28′ 87′ E) in the forest-savannah transitions zone of

Nigeria. The rainfall is bimodal pattern with peak in June and September with a little break in August. The mean monthly temperature ranges from 28° and 30°.

**Field Procedure**

The land was manually slashed, stumped and levelling the soil surface. The plot size was 1 m x 1 m with 0.5 alley spacing maintained in between the plots and replicates. The soybean seed variety TGX1448-2E was planted at spacing of 60 by 20 cm. The experimental design was Randomized Complete Block Design (RCBD). There were five (5) treatments and replicated three times in the experiment which included hoe weeding as a control. The treatment were as followings;

T1 - Hoe weeding all through (Control)
T2 - Hoe weeding+ Imazamox
T3 - Hoe weeding +Imezethapyr
T4 - Butachlor + Imazamox
T5 - Butachlor + Imezethapyr

All herbicides were applied using knapsack sprayer and data were collected from these following parameters;

Number of pods per plant by visual counting, Weight of fresh and dry plants (g), weight of yield per plot (g) and weight of 100seeds (g)

**Data Analysis**

All data were analyzed using DSAATAT software (version 1.101 and means that were significant were separated using Lest Significant Difference (LSD) at 5% level probability.

## Results and Discussion

**Effects of Different Weed Control Methods on Number of Pods of Soybean**

The study showed that there was significant difference ($p \geq 0.05$) among the herbicides applied plot and hoe weeding treated plot. At 12 weeks after sowing (WAS), T5 (Butachlor +Imazethapyr) applied plot recorded the lowest number of pods (13.20) while T2 (Hoe weeding+ Imazamox) plot recorded the highest number of pods (29.67) followed by T1 (Hoe weeding all through) plot with (22.60). However, Hoe weeding+ Imazamox treated plot was significantly higher than other treated plots (Table 1). Also, at 14 WAS, similar trend was observed. T2 (Hoe weeding+ Imazamox) applied plot recorded the highest number of pods (31.80) while lowest number of pods was recorded in the T5 (Butachlor +Imazethapyr) treated plot. However, T2 (Hoe weeding+ Imazamox) treated plot was significantly different from all other treated plots (Table 1).

**Effects of Different Weed Control Methods on Weight of 100 seeds of Soybean**

At harvest, T2 (Hoe weeding+ Imazamox) treated plot recorded the weight of 100 seeds (14.70 g) while the T5 (Butachlor +Imazethapyr) plot recorded the least weight of 100 seeds

(12.12 g). However, T2 (Butachlor +Imazethapyr) treated plot was significantly different (p≥0.05) from all other treated plots (Table 2).

**Effects of Different Weed Control Methods on Grain Yield of Soybean (kg/ha)**

The grain yield of soybean was significantly affected by weed control treatments. T1 (Hoe weeding) plot recorded the highest grain yield of soybean (680 kg/ha) while T5 (Butachlor +Imazethapyr) plot recorded the lowest grain yield (580 kg/ha). Although, hoe weeding plot was not significantly different from other treated plots. However, hoe weeding was significantly higher than other soybean treated plots (Figure 1).

**Cost of Production and Economic Evaluation of Different Weed Control Methods on Soybean**

The value of the production outputs per hectare (Total revenue) from the treated plots with different weed control methods. Treatment with highest cost of production was hoe weeding plot (#161,500) and the lowest cost was recorded in Hoe weeding + Imazethapyr plot (#143,000). Although, hoe weeding plot had the highest yield (746.6 kg a. i./ha) while the lowest was recorded in the Hoe weeding + Imazamox plot (638.3 kg. a. i /ha). The value of the production outputs per hectare (Gross Revenue) from the treated plots with different weed control methods was quite difference. The highest GR (#597,280) was recorded in hoe weeding plot followed by hoe weeding + Imazamox (#594,640) (Table 3). The differences in the GR of treated plots were influenced by yield/ha recorded in different treatments. The highest cost benefit ratio which had a better economic value was a plot treated with Butachlor + Imazamox (4.09) which had 735.5 kg.a.i/ha yield and the lowest was recorded in Hoe weeding + Imazethapyr which had cost-benefit ratio of (3.34 kg. a. i/ha) with (638.3 kg a. i./ha) (Table 3).

**Table 1: Effects of Different Weed Control Methods on Number of Pods of soybean**

| | 12 | 14 |
|---|---|---|
| Treatment | WAS | |
| T1 | 22.60[b] | 24.93[ab] |
| T2 | 29.67[a] | 31.80[a] |
| T3 | 17.33[c] | 19.73[b] |
| T4 | 14.33[c] | 16.60[c] |
| T5 | 13.20[c] | 15.73[c] |
| SE± | ±6.18 | ±6.25 |
| LSD | 7.18 | 6.38 |

Means with the same letter within a column are not significantly different at 5% level of significance using Least Significant Difference.

WAS-Weeks after Sowing.

T1 - Hoe weeding all through; T2 - Hoe weeding+ Imazamox

T3 - Hoe weeding +Imazethapyr; T4 - Butachlor + Imazamox
T5 - Butachlor + Imezethapyr

**Table 2: Effects of Different Weed Control Methods on Weight of 100 seeds of soybean (kg/ha)**

| Treatments | Weight of 100 seeds |
|---|---|
| T1 | 14.00[a] |
| T2 | 14.70[a] |
| T3 | 13.67[ab] |
| T4 | 14.10[a] |
| T5 | 12.12[b] |
| SE± | ±1.50 |
| LSD | 4.88 |

Means with the same letter within a column are not significantly different at 5% level of significance using Least Significant Difference (LSD).
T1 - Hoe weeding all through; T2 - Hoe weeding+ Imazamox
T3 - Hoe weeding +Imazethapyr; T4 - Butachlor + Imazamox
T5 - Butachlor + Imezethapyr

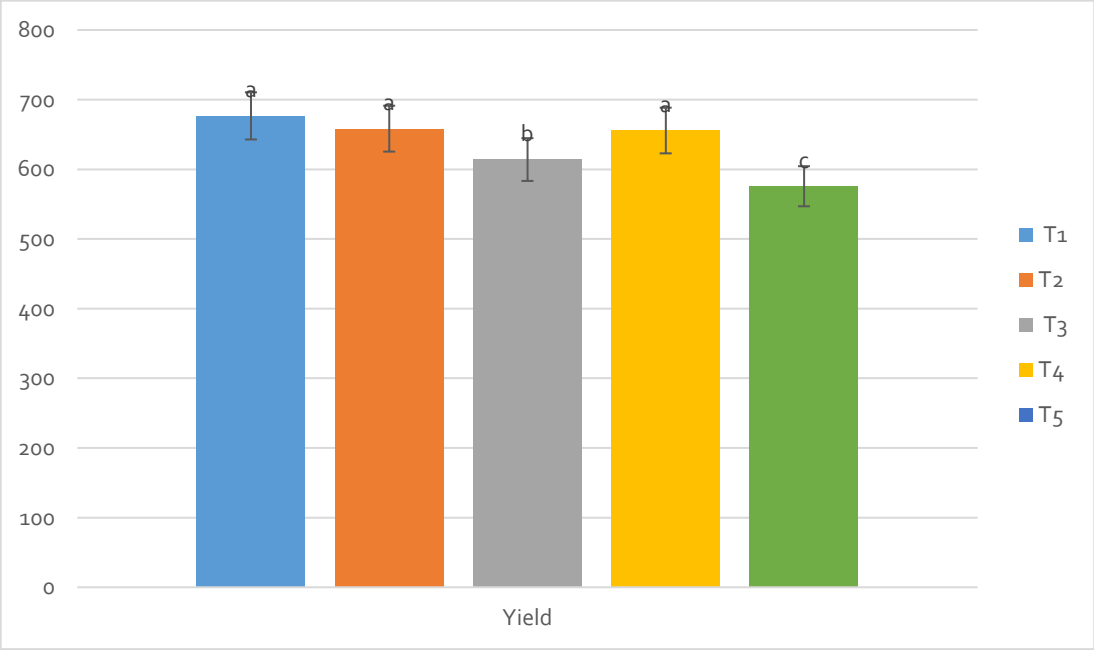



Figure 1: Effects of Different Weed Control Methods on Grain Yield of Soybean (kg. a. i/ha).

Means with the same letter within a column are not significantly different at 5% level of significance using Least Significant Difference.
T1 - Hoe weeding all through; T2 - Hoe weeding+ Imazamox

T3 - Hoe weeding +Imazethapyr; T4 - Butachlor + Imazamox
T5 - Butachlor + Imezethapyr

**Table 3: Cost of Production and Economic Evaluation of Different Weed Control Methods in Soybean**

| Operation/ Production variables | Hoe weeding all through | Hoe weeding + Imazamox | Hoe weeding + Imazethapyr | Butachlor + Imazamox | Butachlor + Imazethapyr |
|---|---|---|---|---|---|
| Land preparation(#) | 45,000 | 45,000 | 45,000 | 45,000 | 45,000 |
| Cost of seed(#) | 14,000 | 14,000 | 14,000 | 14,000 | 14,000 |
| Cost of planting(#) | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Cost of herbicides (#) | _ | 15,000 | 14,000 | 27,500 | 26,500 |
| Cost of herbicides application(#) | _ | 7,500 | 7,500 | 15,000 | 15,000 |
| Cost of Insecticides (#) | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| Cost of Insecticides Application (#) | 7,500 | 7,500 | 7,500 | 7,500 | 7,500 |
| Weeding (#) | 60,000 | 30,000 | 30,000 | _ | _ |
| Transportation | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Miscellaneous (#) | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Total Cost (TC) (#) | 161,500 | 154,000 | 153,000 | 144,000 | 143,000 |
| Yield (Kg. a.i /ha) | 746.6 | 743.3 | 638.3 | 735.5 | 639.9 |
| Amount (# per kg) | 800 | 800 | 800 | 800 | 800 |
| Gross revenue (GR) (#/ha) | 597,280 | 594,640 | 510,400 | 588,400 | 511,920 |
| Return management (GR-TC) (#/ha) | 435,780 | 440,640 | 357,400 | 444,400 | 368,920 |
| Cost Benefit ratio (GR/TC) | 3.70 | 3.86 | 3.34 | 4.09 | 3.58 |

## Discussion

This study revealed significantly the performance of different weed control methods on the number of pods. The highest yield components produced by Hoe weeding + Imaamox might have resulted from efficient weed control. A significant increase in growth at early stages of the crop subsequently led to the higher number of pods. This agreed with the findings of Dugie *et al*. (2013) who reported that weeding reduces the growth, development and competitive power of weeds which increased optimum pod formation. The early weed control with hoe weeding and subsequent post herbicide application of Imazamox maintained 100 percent weed control in the soybean. Also, Onuh *et al*, (2015) who reported similar findings that significantly reduced number of pods and poor yield in cowpea attributed to poor weeding at early stage. Moreover, Nainwal (2023) reported the higher number of pods per plant in a weed free plot. This disagreed with the findings of Alhassan

and Ukwetang (2022) who reported that weeded treatments in cowpea did not significantly different from uncontrolled weed plot on the number of pods and grain yield.

The use of Hoe weeding + Imazamox treatment resulted in significant weight of 100 seeds. This could be attributed to the early weed control especially at the critical period of weed interference between 2 weeks through hoe weeding and 8 weeks after sowing through post-emergence (Imazamox). This was in line with Halford *et al*. (2011) who reported decreased in the 100 seed weight of soybean with high weed infestation presence. The yield per hectare recorded by the different treatments accounted for variation observed in the value of gross revenue. Butachlor + Imazamox treatment was more profitable method of weed control. It also had the highest return and highest cost benefit ratio. Although, hoe weeding had the highest yield per hectare, but removing weeds by hoe weeding all through the soybean growing season incurred the highest cost of cultivation. The high cost of weeding was due to scarcity of labour. This agreed with Baghel *et al*. (2020) who reported the findings that herbicide had higher weed control efficiency and economical benefit than other weed control methods which lead to higher crop productivity and profitability. Also, variation in total variable costs between the treatments could be attributed to the difference in the inputs applied. This corroborates the findings of Kosemani and Bamgboye (2018) who reported the differences in the costs of inputs and other expenses per hectare during the production of cassava. This also corroborates Omovbude and Udensi (2013) who reported that applied herbicides enhanced productivity of cowpea through weed infestation reduction.

## Conclusion

The total variable cost of soybean production was significantly influence by cost of weed control. The applied herbicides enhanced the performance of soybean by reducing weed infestation. The combination of Butachlor + Imazamox had highest benefit cost ratio (4.09).and had seen as best weed control method. This study suggests that using Butachlor as pre-emergence complementing with post-emergence (Imazamox) could help to optimize yield and increase the profitability and cost-benefit ratio.

### Recommendation

It is recommended that soybean farmers should adopt using Butachlor as pre-emergence and complementing it with Imazamox as post-emergence in rainforest-savannah transition zones of Nigeria for a better economic value.

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