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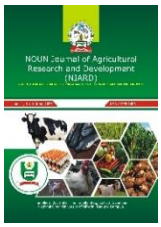

Original Article

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Evaluating the Effects of Weed Control Methods on the Growth and Yield of Jackbean (*Canavalia ensiformis* l.) in South West Nigeria

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ABSTRACT

Field trials were conducted over three cropping seasons in 2013 to 2015, to evaluate the effect of weed control methods on the growth and yield of jackbean at the Federal University of Agriculture, Abeokuta, Nigeria (07^0 20′ N, 3^o 23′ E, 159 m above sea level). The treatments were arranged in a randomized complete block design with three replications. Weed control treatments consisted of eight weed control methods viz: Probaben^R (prometryne + metolachlor, 200+200 g of a.i. per L), Super Union^R (prometryne + acetochlor, 130+380 g of a.i. per L) each applied at 2.4 kg a.i ha, 1.6 kg a.i/ha, 1.6 kg a.i/ha followed by supplementary hoe weeding, two hoe-weedings at 3 and 6 weeks after planting (WAP) and a weedy check. Data collected on jackbean growth and yield were subjected to analysis of variance (ANOVA), and treatment means separated using 5% least significant difference (LSD at $p \leq 0.05$). Results showed that jackbean growth and yield were improved by the weed control treatments compared to untreated plots. Across the three years, plots treated with Probaben^R and Super Union^R plus supplementary hoe weeding led to maximum pod and kernel yields. Uncontrolled weeds led to 60.42%, 61.48% and 65.97% losses in number of pods, pod yield and kernel yield, respectively in jackbean compared to application of Super Union^R plus supplementary hoe weeding. The study concluded that application of Probaben^R at 1.6 kg a.i/ha and Super Union^R followed by hoe weeding proved more effective and can be adopted by farmers for improved jackbean production.

***Keywords:** Jackbean, weed control, growth, yield, weedy check.*

INTRODUCTION

Jackbean (*Canavalia ensiformis*) is increasingly getting attention for its multiple benefits which include rich nutrient profile, nitrogen-fixing ability, enhancement of soil fertility, forage potential, and its suitability for low-input farming systems and resilience to climate variability (Sarasia et al, 2017; Darini et al, 2021). However, these benefits are not fully utilized/exploited when weed infestation is not managed effectively.

Jackbean faces yield constraints due to weed competition, especially in the early growth stages (Oyelakin & Olaniyi, 2019). In the early growth stages of jackbean, slow canopy development allows weeds to aggressively compete for essential resources—light, water, nutrients, and space. This competition often results in reduced crop establishment, biomass accumulation, suppressed pod formation, and low seed yield (Sosibo & Ncube, 2015; Kusumawati, & Subekti, 2017). Therefore, effective weed control is crucial for optimizing yield and ensuring the long-term viability of jackbean as a sustainable crop in integrated farming systems.

Conventional weed control methods like manual hoe weeding are labour-intensive and often untimely due to labour shortages and other constraints like bad weather (Moond et al., 2023). Sole dependence on manual methods may therefore result in inadequate weed control, especially during the critical early stages of crop growth and development.

On the other hand, chemical weed control, particularly pre-emergence herbicides, provides early and broad-spectrum weed suppression, offering the crop a competitive advantage during its most vulnerable stages (Nath et al., 2024). Herbicide use required approximately 2 hours of labour in one hectare, while hand weeding is evaluated to take 400 hours per hectare (Gouse et al., 2006). Osunleti et al. (2022) reported 74% reduction in man days when pre-emergence herbicide was used in comparison to manually weeding plots with a hoe. However, over-reliance on herbicides may lead to environmental concerns, weed resistance, and soil residue issues (Chikoye et al., 2005; Osunleti et al., 2022a).

It has been observed that the use of one method of weed control was unable to give season-long control of weeds, hence the use of supplementary hoe-weeding (Adeyemi et al., 2019). The incompetence of application of pre emergence herbicide alone, to give efficient weed control agrees with the results of Olorunmaiye and Osunleti (2025). In this context, the integration of pre-emergence herbicides with manual hoe weeding emerges as a viable and balanced weed management strategy. This approach combines the efficacy of early chemical control with the selectivity and precision of manual weeding, potentially leading to improved weed suppression, higher crop performance, and reduced environmental risk.

The objective of this study therefore, was to evaluate the effectiveness of application of two pre-emergence herbicides at different rates and hoe weeding, both individually and in combination, on the growth, development, and yield performance of jackbean.

MATERIALS AND METHODS

The field experiments were conducted on the farm of the Federal University of Agriculture, Alabata Road, Abeokuta (07^0 20′ N, 3^o 23′ E, 159 m above sea level) in the forest – savanna transition agroecological zone of South Western Nigeria. The experiments spanned through three cropping seasons: 2013, 2014 and 2015. The soils at the experimental sites were sandy-loam. Before planting in each year, the experimental fields were ploughed and harrowed at two-weeks intervals to ensure the soil tilths were weed-free. The fields were then divided into various plots after removing weed stumps and debris.

Experimental Design and Treatments

In each year, the experiment was laid out in a Randomized Complete Block Design (RCBD) with three replicates. Each plot measured 6 m × 3 m with a 1 m buffer between plots.

Weed control treatments consisted of eight weed control methods viz:

T1 – Probaben^R (prometryne + metolachlor, 200+200 g of a.i. per L) applied at 2.4 kg a.i ha

T2 – Probaben^R applied at 1.6 kg a.i ha

T3 – Probaben^R applied at 1.6 kg a.i ha followed by (fb) supplementary hoe-weeding (SHW) at 6 WAP

T4 – Super Union^R (prometryne + acetochlor, 130+380 g of a.i. per L) applied at 2.4 kg a.i ha

T5 – Super Union^R applied at 1.6 kg a.i/ha

T6 – Super Union^R applied at 1.6 kg a.i/ha plus supplementary hoe-weeding at 6 WAP

T7 – Hoe weeding at 3 and 6 weeks after planting, WAP

T8 – Weedy check (no weeding throughout crop growth)

(Both herbicides used in this study were gotten from open market in Ibadan, Oyo state).

After the removal of weed stumps and debris, the fields were marked out for crop planting on the flat. Two seeds of jackbean were planted and later thinned down to one plant per stand at two weeks after planting. Jackbean seeds were spaced at 75 cm x 50 cm spacing, giving 26,666 plants/ha. Pre-emergence herbicide were applied a day after planting in a spray volume of 230 L/ha using a CP3 knapsack sprayer. Hoe-weeding was carried out according to the treatments using a West African hand hoe.

Data Collection and Analysis

Data was collected on growth and yield of jackbean. Growth parameters included stand count, cover score, canopy height, canopy spread and dry matter. While yield data included number of pods, pod yield (weight), 100-kernel weight and total kernel yield (kg/ha). Data was also collected on total weed dry matter production at harvest.

Data collected were subjected to Analysis of Variance (ANOVA) using the GENSTAT procedures. Means were separated using least significant difference LSD at a 5% level of significance.

RESULTS

Effects of Weed Control Treatments on Jackbean Crop Growth Parameters

Jackbean stand count

The effect of weed control treatments was significant on jack bean stand count at 9 WAP in 2015 (Table 1). The weedy check significantly reduced jackbean stand count compared to the plots with weed control.

Table 1: Effects of Weed Control Treatments on Jack Bean Stand Count ('000/ha)at 9 and 12 WAP at Alabata Road, Abeokuta

	Stand Count of Jack Bean ('000/ha)					
	9 WAP			12 WAP		
Treatments	2013	2014	2015	2013	2014	2015
Weed Control Method (WC)						
Probaben^{R} at 2.4 kg a.i/ha	16.42	20.57	18.71a	15.91	20.57	17.18
Probaben^{R} at 1.6 kg a.i/ha	15.91	20.57	18.45a	15.41	20.57	16.93
Probaben^{R} at 1.6 kg a.i/ha fb SHW	16.42	20.57	19.05a	15.91	20.57	17.44
Super Union^{R} at 2.4 kg a.i/ha	16.08	20.62	18.79a	15.58	20.62	17.27
Super Union^{R} 1.6 kg a.i/ha	16.25	20.34	18.03a	15.74	20.25	16.59
Super Union^{R} 1.6 kg a.i/ha fb SHW	16.34	20.24	18.37a	15.83	20.19	16.84
Hoe Weeding at 3 and 6 WAP	16.08	20.48	18.96a	15.58	20.48	17.52
Weedy Check	16.51	20.62	15.49b	16.00	20.62	14.47
SE ± (WC)	0.268ns	0.103ns	0.622	0.269ns	0.130ns	0.595ns

Jackbean canopy cover score

Jackbean canopy cover score was significantly affected by weed control treatments at 9 and 12 WAP in all the trials (Table 2). All the weed control methods resulted in higher cover score than the weedy check at 9 WAP in 2013, and at both 9 and 12 WAP in 2014 and 2015. However, the application of Super Union^{R} alone at 1.6 and 2.4 kg a.i/ha in 2015 significantly depressed jackbean canopy cover compared to the best-performing treatment (Probaben^{R} at 1.6 kg a.i/ha fb SHW) at 9 WAP. Probaben^{R} alone at 2.4 kg a.i/ha still improved cover over the weedy check and performed comparably to Probaben^{R} at 1.6 kg a.i/ha fb SHW at 12 WAP in the 2015.

Table 2: Effects of Weed Control Treatment on Jackbean Cover Score* at 9 and 12 WAP at Alabata Road, Abeokuta

	9 WAP			12 WAP		
Treatments	2013	2014	2015	2013	2014	2015
Weed Control Method (WC)						
Probaben^{R} at 2.4 kg a.i/ha	6.30a	6.80a	5.60ab	6.00ab	6.70a	6.40a
Probaben^{R} at 1.6 kg a.i/ha	5.90a	7.10a	5.60ab	5.50abc	7.00a	6.30a
Probaben^{R} at 1.6 kg a.i/ha fb SHW	6.10a	7.40a	5.90a	6.80ab	7.60a	7.10a
Super Union^{R} at 2.4 kg a.i/ha	5.40a	6.60a	5.30b	4.70bc	7.10a	6.80a
Super Union^{R} 1.6 kg a.i/ha	5.80a	7.10a	5.30b	4.80bc	6.90a	6.40a
Super Union^{R} 1.6 kg a.i/ha fb SHW	6.30a	7.20a	5.50ab	7.30a	7.30a	6.90a
Hoe Weeding at 3 and 6 WAP	6.30a	7.50a	5.40ab	7.60a^{6}	7.40a	6.80a
Weedy Check	4.30b	4.50b	3.50c	3.80c	5.20b	2.70b
SE ± (WC)	0.33	0.30	0.17	0.64	0.33	0.24

Jackbean canopy height and spread

The effect of weed control treatments on jackbean plant canopy height and canopy spread at 9 WAP was significant in 2014 and 2015, respectively (Table 3). In 2014, application of Probaben^{R} alone at 2.4 kg a.i/ha, Super Union^{R} at 1.6 kg a.i/ha with and without SHW and two hoe weedings resulted in taller jackbean plants than those of the weedy check. In 2015, the plots treated with Probaben^{R} at 1.6 kg a.i/ha fb SHW resulted in the maximum canopy spread while the minimum value occurred on the plots left weed-infested. The plots hoe-weeded twice and those of the two herbicides each at 2.4 kg a.i/ha and Super Union^{R} at 1.6 kg a.i/ha fb SHW resulted in canopy spread comparable to the maximum and significantly higher than that of the weedy check. While there was no significant difference on canopy height in 2013 and 2015, and on canopy spread in 2013 and 2014, lowers values were recorded in the weedy check plots compared to various weed control methods.

Table 3: Effects of Weed Control Treatments on Jackbean Canopy Height and Spread at Alabata Road, Abeokuta

	Jackbean Canopy Height (cm) at 9 WAP			Jackbean Canopy Spread at 9 WAP		
Treatments	2013	2014	2015	2013	2014	2015
Weed Control Method (WC)						
Probaben^{R} at 2.4 kg a.i/ha	86.1	113.4a	80.1	64.0	73.7	64.4ab
Probaben^{R} at 1.6 kg a.i/ha	88.1	98.0bc	70.2	67.7	72.0	61.4abc
Probaben^{R} at 1.6 kg a.i/ha fb SHW	85.3	101.0abc	78.2	65.6	78.2	70.7a
Super Union^{R} at 2.4 kg a.i/ha	84.6	105.3abc	73.4	66.4	78.5	67.1ab
Super Union^{R} 1.6 kg a.i/ha	84.8	112.7a	76.8	65.1	83.2	59.0bc
Super Union^{R} 1.6 kg a.i/ha fb SHW	86.6	111.2ab	79.7	62.9	76.0	68.3ab
Hoe Weeding at 3 and 6 WAP	87.5	111.1ab	75.7	64.9	78.9	65.3ab
Weedy Check	81.1	94.6c	68.6	55.2	67.2	51.5c
SE ± (WC)	2.85ns	4.24	3.37ns	2.47ns	6.38ns	3.26

Jackbean dry matter production

Weed control treatments had significant effect on jackbean dry matter production at 9 WAP in 2013 and 2015 (Table 4). In 2013, dry matter yield was maximum with application of Probaben^{R} at 2.4 kg a.i./ha and was significantly higher than Probaben at 1.6 kg a.i./ha fb SHW, Super Union^{R} at 2.4 kg a.i./ha, hoe weeding and weedy check. However in 2015, Probaben^{R} at 1.6 kg a.i./ha fb SHW resulted in jackbean dry matter production that was comparable to the maximum of the two hoe weedings and significantly higher than that of the weedy check. Uncontrolled weed infestation reduced dry matter production of jack bean at 9 WAP by 39.7 and 49.7% in 2013 and 2015 respectively.

Table 4: Effects of Weed Control Treatment on Jackbean Dry Matter Production at 9 WAP at Alabata Road, Abeokuta

Treatments	Jackbean Dry Matter Production (g/plant)		
	2013	2014	2015
Weed Control Method (WC)			
Probaben^{R} at 2.4 kg a.i/ha	68.8a	38.6	38.0bc
Probaben^{R} at 1.6 kg a.i/ha	47.8ab	41.5	39.6bc
Probaben^{R} at 1.6 kg a.i/ha fb SHW	41.4b	42.8	46.3ab
Super Union^{R} at 2.4 kg a.i/ha	35.8b	38.3	36.7bc
Super Union^{R} 1.6 kg a.i/ha	49.4ab	40.6	32.6bc
Super Union^{R} 1.6 kg a.i/ha fb SHW	44.8ab	42.3	41.8bc
Hoe Weeding at 3 and 6 WAP	38.1b	52.6	57.5a
Weedy Check	41.5b	40.4	28.9c
SE ± (WC)	7.13	3.68ns	4.95

Effects of Weed Control Treatments on Jackbean Yield Parameters

Number and Yield of Jackbean Pod

The number and yield of jackbean pods were significantly improved by weed control treatments in 2013 (Table 5). The highest pod numbers and yields resulted from plots treated with Probaben^{R} and Super Union^{R} each at 1.6 kg a.i./ha followed by supplementary hoe weeding, Super Union^{R} at 2.4 kg a.i./ha alone, and in plots hoe-weeded twice. These results were significantly better than those of the weedy check. Furthermore, Super Union^{R} at 2.4 kg a.i./ha and hoe weeding twice produced higher pod numbers and yields than Super Union^{R} at 1.6 kg a.i./ha alone. Uncontrolled weed infestation reduced the number and yield of jackbean pods by 60.5 and 61.5%, respectively in the trial.

Table 5: Effects of Weed Control Treatment and Cropping Pattern on Jackbean Pod Number and Yield at Alabata Road, Abeokuta

Treatments	Jack bean Pod Number ('000/ha)			Jack bean Pod Yield (kg/ha)		
	2013	2014	2015	2013	2014	2015
Weed Control Method (WC)						
Probaben^{R} at 2.4 kg a.i/ha	168.0a	25.00	100.0	5859a	638	2550
Probaben^{R} at 1.6 kg a.i/ha	123.5abc	27.00	98.00	4086abc	685	2808
Probaben^{R} at 1.6 kg a.i/ha fb SHW	154.0a	41.00	100.0	5392ab	1053	2862
Super Union^{R} at 2.4 kg a.i/ha	100.0abc	27.00	95.00	3539abc	766	2657
Super Union^{R} 1.6 kg a.i/ha	80.0bc	29.00	74.00	2885bc	848	1837
Super Union^{R} 1.6 kg a.i/ha fb SHW	147.5ab	28.00	101.0	5272ab	918	3216
Hoe Weeding at 3 and 6 WAP	156.0a	39.00	100.0	5512a	1103	2563
Weedy Check	66.5c	6.00	41.00	2257c^{6}	148	1160
SE ± (WC)	21.51	06.80ns	14.70ns	757.4	191.7	450.5

Jackbean kernel yield and *Jackbean 100-kernel weight*

Weed control treatments had significant effects on jackbean kernel yield in 2013 and on 100-kernel weight in 2014 and 2015 (Table 6). Application of Probaben^{R} at 1.6 kg a.i/ha fb SHW, two hoe weedings and Probaben^{R} at 2.4 kg a.i/ha alone produced kernel yields comparable to the maximum of Super Union^{R} at 1.6 kg a.i/ha fb SHW, and all were significantly higher than the weedy check. However, the plots treated with Super Union^{R} at 1.6 kg a.i/ha alone produced lower yield than the maximum observed. In 2014 and 2015, weed control methods resulted in higher 100-kernel weight of jackbean than uncontrolled weed infestation throughout crop lifecycle in both years.

Table 6: Effects of Weed Control Treatment and Cropping Pattern on Jackbean Kernel Yield (kg/ha) and100-Kernel Weight at Alabata Road, Abeokuta

Treatments	Jackbean Kernel Yield (kg/ha)			100-Kernel Weight (g)		
	2013	2014	2015	2013	2014	2015
Weed Control Method (WC)						
Probaben^{R} at 2.4 kg a.i/ha	2681.5ab	280	1322	147.1	85.1a	138.2a
Probaben^{R} at 1.6 kg a.i/ha	2117.5abc	300	1549	139.8	102.0a	138.0a
Probaben^{R} at 1.6 kg a.i/ha fb^{3} SHW^{4}	2677ab	494	1471	142.0	97.6a	138.9a
Super Union^{R} at 2.4 kg a.i/ha	1825 abc	327	1523	142.3	92.8a	141.3a
Super Union^{R} 1.6 kg a.i/ha	1384 bc	384	958	145.8	97.6a	134.4a
Super Union^{R} 1.6 kg a.i/ha fb^{3} SHW^{4}	2906.a	452	1609	153.3	112.4a	136.7a
Hoe Weeding at 3 and 6 WAP^{5}	2607ab	523	1305	150.9	110.3a	144.3a
Weedy Check	1047c	64.0	580.0	137.0	36.7b	122.6b
SE ± (WC)	401.8	93.50ns	239.6ns	04.11	10.48	03.15

DISCUSSION

The results obtained in this study clearly indicated that effective weed control significantly improves the growth and yield of jackbean. Reduction in performance of jackbean as a result of uncontrolled weed infestation throughout crop life cycle across several parameters and years could be attributed to uninterrupted weed infestation on the plots. Weeds have been reported to compete with crop for light, soil nutrients and moisture; harbour insect pests and in some cases exhibit allelopatic effects which affect the growth of crops negatively (KAU 2006).This clearly confirmed the critical role of controlling weeds in jackbean cultivation.

Conversely, the improved or enhanced growth and yield of jackbean recorded with application of herbicides, with or without supplementary hoe weeding and on the hoe weeded plots could be attributed to weed free situation on the plots. The weed free situation reduced weed-crop competition for nutrients and space, thereby making more nutrients available for the crop for good and healthy growth. Also, weed free situation reduced disease infestation as weeds have been reported to harbour insect pests capable of transmitting diseases causing reduction in crop vigour and at times resulting in crop death. These observations confirmed that weed competition limits early plant establishment and growth, as earlier reported by Oyelakin & Olaniyi, 2019. Significantly, dry matter production was reduced by up to 50% in the weed infested plots. This further established the negative impact of uncontrolled weed infestation on jackbean performance, which corroborates earlier reports of Sosibo & Ncube (2015) on the negative impacts of weeds on legumes including jackbean.

Furthermore, higher pod yield and kernels recorded on the treated plots compared to the weedy plots could be ascribed to efficient weed control on the plots which could have resulted in better growth performance and proper assimilate partitioning, hence higher yield. This implies that the growth parameters and yield are directly proportional. This corroborates earlier reports of Osunleti et al. (2024), who reported positive and significant correlation between growth parameters and crop yield. Specifically, among the herbicide treated plots, higher yield recorded with application of Probaben^{R} and Super Union^{R} plus supplementary hoe weeding could be attributed to effective weed management on the plots as the pre emergence herbicide takes care of initial weed infestation, while the hoe weeding takes care of the subsequent weed infestation. This further confirmed the synergistic effect of integrated weed management as earlier reported by Eni et al. (2021).

Comparatively, among the treatments evaluated, Probaben^{R} at 1.6 kg a.i/ha followed by hoe weeding frequently matched or performed better than other methods. While Super Union^{R} at higher doses (2.4 kg a.i/ha) performed well, lower doses sometimes depressed growth parameters, indicating dose sensitivity. This observation suggests the importance of selecting appropriate herbicide types and rates to avoid suboptimal crop growth. Several authors have also emphasized the importance of selecting appropriate type and rate of herbicides (Akobundu, 1987; Nath, 2024; Zimdahl & Basinger, 2024).

CONCLUSION

In this study, the diverse weed control methods significantly enhanced jackbean crop growth and yield performance, compared to the weedy plots. Over the three years period, uncontrolled weed infestation reduced jackbean number of pods, pod yield and kernel yield by 60.42%, 61.48% and 65.97%, respectively, compared to the maximum of those with application of Super Union^{R} plus supplementary hoe weeding. Application of Probaben^{R} and Super Union^{R} at 1.6 kg a.i/ha followed by supplementary hoe weeding were the most effective treatment at enhancing both growth and yield of jackbean. Therefore, application of Probaben^{R} or Super Union^{R} at 1.6 kg a.i/ha followed by supplementary hoe weeding is recommended for adoption by farmers for improved jackbean production in low-resource farming systems.

AUTHORS CONTRIBUTIONS

Eni, E. I.: The conceptualizing, methodology and writing the original manuscript
Falade, A. A.: Collection of data, review and editing
Osunleti, S. O.: Collection of data and analysis
Alama, S. I.: Review and editing

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