Comparative Performance of Raptor and Iris Herbicides on Weed Suppression and Grain Yield of Cowpea in Two Agro-Ecological Zones of Nigeria

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ABSTRACT

A field experiment was conducted during the 2021 rainy season to evaluate the performance of two post-emergence herbicides, Raptor and Iris, on weed suppression and grain yield of cowpea (Vigna unguiculata (L.) Walp.) in the Sudan and Northern Guinea savannas of Nigeria. The study was carried out at the Teaching and Research Farm, Bayero University, Kano (Sudan savanna) and the International Institute of Tropical Agriculture (IITA) research station, Zaria (Northern Guinea savanna). Treatments consisted of two cowpea varieties (IT99K-573-1-1 and UAM14-122-17-7), three application rates of Raptor (1.5, 1.0 and 0.5 L ha^{-1}), three application rates of Iris (0.8, 0.6 and 0.4 L ha^{-1}), hoe weeding, and a no-weeding control. The treatments were arranged in a split-plot design with three replications. Data were collected on weed cover, weed density, weed biomass, weed control efficiency, phytotoxicity, phenological traits, and grain yield.

Results showed that weed control methods significantly influenced weed suppression and grain yield at both locations. Hoe weeding and Raptor, particularly at 1.5 and 1.0 L ha^{-1}, consistently recorded lower weed density, higher weed control efficiency, and superior grain yield compared to Iris treatments and the unweeded control. Iris herbicide, especially at higher application rates, caused significant phytotoxic effects on cowpea plants at the Sudan savanna location, leading to delayed flowering and reduced yield. Grain yield was highest under Raptor at 1.5 L ha^{-1} at Kano and Raptor at 1.0 L ha^{-1} at Zaria. The performance of the cowpea varieties varied across locations, with IT99K-573-1-1 performing better at Kano and UAM14-122-17-7 showing superior performance at Zaria.

The study concludes that Raptor herbicide is more effective and safer than Iris for post-emergence weed control in cowpea across both agro-ecological zones. Application of Raptor at 0.5 L ha^{-1} in the Sudan savanna and 1.0 L ha^{-1} in the Northern Guinea savanna is recommended for effective weed suppression, reduced phytotoxicity, and improved grain yield.

Keywords: Cowpea, post-emergence herbicides, weed control efficiency, Raptor, Iris, savanna agro-ecologies

INTRODUCTION

Cowpea (Vigna unguiculata (L.) Walp.) is an important grain legume cultivated extensively in sub-Saharan Africa, where it serves as a major source of dietary protein, income, and livestock feed (Kormawa et al., 2000; FAO, 2022). In Nigeria, cowpea contributes significantly to food security and soil fertility improvement through biological nitrogen fixation, particularly in the Sudan and Northern Guinea savannas where harsh climatic conditions limit the production of many other crops (Obatolu, 2003; Ravelombola et al., 2017). Despite its importance, cowpea yields in farmers' fields remain low, averaging less than 500 kg ha^{-1}, compared with attainable yields of 1,500–3,000 kg ha^{-1} under improved management (Ajeigbe et al., 2005; FAOSTAT, 2010).

Weed infestation is one of the most severe constraints to cowpea production in the savanna agro-ecologies of Nigeria. Weeds compete with cowpea for light, nutrients, water, and space, especially during the early stages of crop growth when cowpea exhibits slow canopy development (Adigun et al., 2014; Osipitan et al., 2016). Yield losses due to weed interference in cowpea have been reported to range from 25% to over 76%, depending on weed species composition, density, duration of competition, and environmental conditions (Gupta et al., 2016; Ugbe et al., 2016). In extreme cases, weed infestation can result in yield losses exceeding 90%, forcing farmers to abandon heavily infested fields (Freitas et al., 2009).

Manual hoe weeding remains the most common weed control practice among smallholder cowpea farmers in Nigeria. Although effective, this method is labor-intensive, costly, and often constrained by labor shortages during peak farming periods (Lagoke et al., 1981; Adigun et al., 2014). Delayed or inadequate weeding frequently results in irreversible yield losses, particularly during the critical period of weed competition, which has been reported to occur between 14 and 40 days after sowing in cowpea (Akinyemiju and Echendu, 1987; Osipitan et al., 2016).

Chemical weed control using herbicides has therefore emerged as an effective alternative due to its timeliness, reduced labor requirement, and suitability for large-scale production (Dadari, 2003; Gianessi and Reigner, 2007). Post-emergence herbicides are particularly advantageous because they target weeds that escape pre-emergence control and can be applied after crop establishment. However, the effectiveness and safety of post-emergence herbicides in cowpea depend on herbicide selectivity, application rate, crop variety, and environmental conditions (Silva et al., 2009; Souza et al., 2016).

Raptor (imazamox-based) and Iris (sodium acifluorfen + clodinafop-propargyl) are post-emergence herbicides with broad-spectrum activity against grasses and broadleaf weeds. While these herbicides have been widely evaluated in soybean and other legumes, information on their comparative performance, crop safety, and yield response in cowpea under Nigerian savanna conditions remains limited (Freitas et al., 2009; Osipitan and Dille, 2017). Inappropriate application may lead to phytotoxic effects, delayed phenological development, and yield reduction, thereby undermining potential benefits.

Given the contrasting climatic and edaphic conditions of the Sudan and Northern Guinea savannas, evaluating the performance of these herbicides across agro-ecological zones is necessary to develop location-specific recommendations. Therefore, this study was conducted to compare the performance of Raptor and Iris herbicides on weed suppression, crop safety, and grain yield of cowpea in two agro-ecological zones of Nigeria.

Statement of the Problem

Weed infestation remains one of the most serious constraints to cowpea production in Nigeria. Weeds compete aggressively with cowpea plants for essential growth resources, leading to poor crop growth and significant yield reductions. In many cowpea-growing areas, farmers still rely heavily on manual weeding, which is labor-intensive, costly, and often untimely due to limited labor availability during critical periods of crop growth.

Although herbicides provide a practical alternative for weed management, the adoption of chemical weed control in cowpea production has been limited by insufficient information regarding the effectiveness and crop safety of available herbicides under local conditions. In particular, there is limited research comparing the performance of Raptor and Iris herbicides in cowpea production systems within the Sudan and Northern Guinea savannas of Nigeria.

Without adequate knowledge of the most effective herbicide types and application rates, farmers may apply inappropriate weed control measures, leading to poor weed suppression, crop injury, or reduced grain yield. Therefore, there is a need to evaluate the performance of these herbicides across different agro-ecological zones in order to develop effective and safe weed management strategies for cowpea production.

Objectives of the Study

- To evaluate the comparative performance of Raptor and Iris herbicides on weed suppression and grain yield of cowpea in two agro-ecological zones of Nigeria.
- To evaluate the phytotoxic effects of the herbicides on cowpea growth and development.

Justification and Scope of the Study

Cowpea is a major staple crop that contributes significantly to food security and livelihoods in Nigeria and other parts of sub-Saharan Africa. Improving its productivity is essential for meeting the increasing demand for affordable plant protein and enhancing the income of smallholder farmers. Effective weed management is a key component in achieving higher cowpea yields.

The evaluation of suitable herbicides that provide efficient weed control without causing crop injury is therefore important for sustainable cowpea production. Raptor and Iris herbicides have shown potential in controlling a wide range of weeds, but information on their comparative performance and crop safety in cowpea under Nigerian savanna conditions remains limited.

This study provides valuable information on the effectiveness of these herbicides in suppressing weeds and improving cowpea yield under two distinct agro-ecological zones. The findings will help guide farmers, researchers, and extension agents in selecting appropriate weed control strategies for improved cowpea production.

The scope of the study was limited to evaluating the performance of Raptor and Iris herbicides on weed suppression, crop safety, and grain yield of two cowpea varieties under field conditions in the Sudan and Northern Guinea savannas of Nigeria.

MATERIALS AND METHODS

Experimental Sites

Field experiments were conducted during the 2021 rainy season at two locations representing distinct agro-ecological zones of Nigeria. The first site was the Teaching and Research Farm of Bayero University, Kano (11°58′N, 8°25′E), located in the Sudan savanna zone. The second site was the International Institute of Tropical Agriculture (IITA) research station, Zaria (11°07′N, 7°44′E), situated in the Northern Guinea savanna zone. The Sudan savanna is characterized by a shorter growing season, lower annual rainfall, and higher temperatures compared to the Northern Guinea savanna, which has relatively higher rainfall and longer growing season.

Experimental Materials

Two improved cowpea (Vigna unguiculata (L.) Walp.) varieties, IT99K-573-1-1 and UAM14-122-17-7, were used for the study. Two post-emergence herbicides were evaluated: Raptor (active ingredient: imazamox) and Iris (a mixture of sodium acifluorfen and clodinafop-propargyl). Manual hoe weeding and an unweeded control were included for comparison.

Treatments and Experimental Design

The treatments consisted of three application rates of Raptor (1.5, 1.0, and 0.5 L ha^{-1}), three application rates of Iris (0.8, 0.6, and 0.4 L ha^{-1}), hoe weeding, and a no-weeding control. The two cowpea varieties constituted the main plot treatments, while weed control methods formed the sub-plot treatments. The experiment was laid out in a split-plot design with three replications at each location.

Each sub-plot measured 4 m × 3 m. Cowpea was sown at a spacing of 75 cm × 25 cm, and two seeds were planted per hole and later thinned to one plant per stand. All agronomic practices, except weed control treatments, were uniformly applied across plots.

Herbicide Application

Herbicides were applied at 3 weeks after sowing (WAS) using a knapsack sprayer calibrated to deliver a spray volume of 200 L ha^{-1}. Applications were made under calm weather conditions to minimize spray drift. Hoe weeding was carried out twice at 3 and 6 WAS, while the unweeded control plots were left untreated throughout the growing period.

Data Collection

Data were collected on weed and crop parameters. Weed cover score, weed density, and weed dry biomass were assessed at 6 WAS using a 0.5 m × 0.5 m quadrat placed randomly within each plot. Weeds within the quadrat were identified, counted, oven-dried at 70°C to constant weight, and weighed to determine dry biomass. Weed control efficiency was calculated based on weed dry matter relative to the unweeded control.

Crop phytotoxicity was visually assessed at 2 and 4 weeks after herbicide application using a scale of 0–10, where 0 indicated no visible injury and 10 indicated complete crop death. Phenological data including days to 50% flowering and days to physiological maturity were recorded. At harvest, grain yield was determined from the net plot area, adjusted to 12% moisture content, and converted to kg ha^{-1}.

Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) using appropriate statistical procedures for a split-plot design. Treatment means were separated using the Least Significant Difference (LSD) test at the 5% probability level. All statistical analyses were performed separately for each location to assess location-specific treatment effects.

RESULTS AND DISCUSSION

Weed Flora Composition and Density

The experimental fields at both locations were infested with a mixture of grasses, broadleaf weeds, and sedges, although weed species composition and density varied between the Sudan and Northern Guinea savannas. Broadleaf weeds constituted the dominant group at both sites, followed by grasses, while sedges occurred at relatively lower densities. Higher overall weed density and biomass were recorded at the Northern Guinea savanna location, which may be attributed to higher rainfall and more favorable growing conditions for weed proliferation. Similar observations have been reported in earlier studies conducted in the Nigerian savannas (Adigun et al., 2014; Osipitan et al., 2016).

Weed density was significantly influenced by weed control methods at both locations. Hoe-weeded plots and those treated with Raptor herbicide, particularly at 1.5 and 1.0 L ha^{-1}, recorded significantly lower weed densities compared with Iris-treated plots and the unweeded control. The lowest weed density was consistently observed under hoe weeding, followed closely by Raptor at the highest application rates. The unweeded control plots recorded the highest weed density throughout the sampling period.

Table 1: Effect of Weed Control Methods and Cowpea Varieties on Weed Flora Composition and Density during 2021 Rainy Season at both BUK and Zaria

	Grass		Broadleaf		Sedgess		Weed Density	
Weeding Methods	BUK	ZARIA	BUK	ZARIA	BUK	ZARIA	BUK	ZARIA
HOE Weeding	0.83c	1.83a	1.33bc	2.67b	0.67b	0.17a	6.50b	14.83de
IRIS_0.4 Lha^{-1}	2.17a	0.17bc	1.67b	2.83ab	1.17a	0.00b	37.33a	29.17a

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IRIS_0.6 Lha^{-1}	1.50abc	0.17bc	1.50bc	2.67b	1.00ab	0.00b	33.83ab	20.17cd
IRIS_0.8 Lha^{-1}	1.50abc	0.33bc	1.33bc	2.50b	1.00ab	0.17a	36.33ab	17.83d
RAPTOR_0.5 Lha^{-1}	1.33c	0.83b	1.33bc	3.33ab	0.33bc	0.00b	9.50b	26.50ab
RAPTOR_1.0 Lha^{-1}	1.17bc	0.17bc	0.67cd	3.33ab	0.17c	0.17a	8.83b	15.33d
RAPTOR_1.5 Lha^{-1}	1.00c	0.00c	0.33cd	2.33b	0.10c	0.00b	4.83b	8.67e
No Weeding	1.33ab	2.50a	3.17a	4.00a	1.33a	0.17a	38.83a	32.67a
SE	0.26	0.26	0.33	0.34	0.25	0.12	2.08	2.17
Variety								
IT99K-573-1-1	1.50	0.67	1.42	2.38	0.79	0.13	23.42	21.00
UAM14-122-17-7	1.50	0.83	1.42	2.38	0.63	0.04	21.75	19.04
SE	0.13	0.13	0.17	0.17	0.12	0.06	1.04	1.08
Interaction WM*V	0.9395	0.4390	0.5592	0.9066	0.1893	0.4493	0.4687	0.1701

Means in the same column followed by the same letter (s) are not significantly different at 5% level of probability using SNK

Table 2: Effect of Weed Control Methods and Cowpea Varieties on Dry Weed Biomass and Weed Control Efficiency at BUK and Zaria

	Dry Weed Weight (m^{-2})		Weed Control Efficiency (%)	
Weeding Methods	BUK	ZARIA	BUK	ZARIA
HOE Weeding	65.12d	66.52f	85.70a	88.57a
IRIS_0.4 Lha^{-1}	287.83b	343.55b	32.63c	41.84e
IRIS_0.6 Lha^{-1}	283.08b	241.18c	35.57c	58.91d
IRIS_0.8 Lha^{-1}	188.98c	192.90d	57.99b	66.81cd
RAPTOR_0.5 Lha^{-1}	123.48cd	182.30d	72.15ab	68.58c
RAPTOR_1.0 Lha^{-1}	116.65cd	119.01e	73.42ab	79.80b
RAPTOR_1.5 Lha^{-1}	92.87d	78.65ef	79.70a	86.63a
No Weeding	474.55a	591.57a	0.00d	0.00f
SE	27.45	15.85	4.90	2.57

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Variety				
IT99K-573-1-1	222.22	241.02a	56.72	61.74
UAM14-122-17-7	185.92	212.9b	52.57	61.05
SE	13.73	7.92	2.45	1.29
Interaction WM*V	0.3985	0.0306	0.9236	0.2829

Means in the same column followed by the same letter (s) are not significantly different at 5% level of probability using SNK

Table 3: Effect of Weed Control Methods and Cowpea Varieties on Plant Phytotoxicity during 2021 Rainy Season at both BUK and Zaria

	Plant Phytotoxicity	
Weeding Methods	BUK	ZARIA
HOE Weeding	0.00c	0.00
IRIS_0.4 Lha^{-1}	6.50b	0.00
IRIS_0.6 Lha^{-1}	6.67b	0.00
IRIS_0.8 Lha^{-1}	8.00a	0.00
RAPTOR_0.5 Lha^{-1}	0.17c	0.00
RAPTOR_1.0 Lha^{-1}	0.33c	0.00
RAPTOR_1.5 Lha^{-1}	0.17c	0.00
No Weeding	0.00c	0.00
SE	0.23	0.00
Variety		
IT99K-573-1-1	2.63	0.00
UAM14-122-17-7	2.83	0.00
SE	0.15	0.00
Interaction WM*V	0.9101	0.7302

Table 4: Effect of Weed Control Methods and Cowpea Varieties on Days to 50% Flowering and Days to 95% Maturity during 2021 Rainy Season at both BUK and Zaria.

	Days to 50% Flowering		Days to 95% Maturity	
Weeding Methods	BUK	ZARIA	BUK	ZARIA
HOE Weeding	50.50ab	45.67b	76.00b	64.00c
IRIS_0.4 Lha^{-1}	57.17a	48.50a	82.67a	67.67a
IRIS_0.6 Lha^{-1}	58.50a	49.17a	84.00a	67.33a
IRIS_0.8 Lha^{-1}	58.67a	47.67ab	84.17a	67.17a
RAPTOR_0.5 Lha^{-1}	50.42ab	47.00ab	75.92b	67.00ab
RAPTOR_1.0 Lha^{-1}	51.00ab	43.17c	76.50b	67.50a
RAPTOR_1.5 Lha^{-1}	50.50ab	47.50ab	75.83b	67.17a
No Weeding	50.00b	47.33ab	75.50b	65.33b
SE	2.10	0.90	2.13	0.87
Variety				
IT99K-573-1-1	50.00b	44.71b	75.00b	66.67
UAM14-122-17-7	56.69a	49.29a	82.65a	66.63
SE	1.05	0.45	1.05	0.44
Interaction WM*V	0.0075	0.1846	0.0116	0.1813

Means in the same column followed by the same letter (s) are not significantly different at 5% level of probability using SNK

Table 8. Effect of Weed Control Methods and Cowpea Varieties on Grain Yield at BUK and Zaria

	Grain Yield (kg ha^{-1})	
Weeding Methods	BUK	ZARIA
HOE Weeding	1186.47a	1314.30abc
IRIS_0.4 Lha^{-1}	223.33c	781.20e
IRIS_0.6 Lha^{-1}	282.83bc	1204.90bcd
IRIS_0.8 Lha^{-1}	302.64bc	1167.52cd
RAPTOR_0.5 Lha^{-1}	1121.41a	901.20de
RAPTOR_1.0 Lha^{-1}	1175.88a	1572.60a
RAPTOR_1.5 Lha^{-1}	1272.90a	1545.30ab

No Weeding	479.44b	753.50e
SE	64.39	54.35
Variety		
IT99K-573-1-1	1012.00a	1290.82
UAM14-122-17-7	983.77b	1408.03
SE	32.19	27.17
Interaction WM*V	0.1258	0.0801

Means in the same column followed by the same letter (s) are not significantly different at 5% level of probability using SNK

Weed Biomass and Weed Control Efficiency

Weed dry biomass followed a trend similar to weed density. Hoe weeding and Raptor treatments significantly reduced weed biomass compared with Iris and the unweeded control at both locations. Raptor applied at 1.5 and 1.0 L ha^{-1} produced weed biomass reductions comparable to manual hoe weeding, indicating high weed control efficiency. In contrast, Iris herbicide, especially at lower application rates, resulted in relatively higher weed biomass, suggesting suboptimal weed suppression.

Weed control efficiency was highest under hoe weeding and Raptor treatments, with values exceeding 70% in most cases. Iris herbicide recorded moderate weed control efficiency, while the unweeded control consistently had the lowest efficiency. The superior performance of Raptor may be attributed to its broad-spectrum activity and systemic mode of action, which enables effective control of both grasses and broadleaf weeds. These findings are consistent with reports by Dadari (2003) and Freitas et al. (2009), who observed higher weed suppression with imazamox-based herbicides in grain legumes.

Crop Phytotoxicity

Crop injury symptoms varied significantly among weed control treatments and locations. Iris herbicide caused noticeable phytotoxic effects on cowpea, particularly at higher application rates and at the Sudan savanna location. Symptoms included leaf chlorosis, stunted growth, and delayed recovery, which persisted for several weeks after application. In contrast, Raptor-treated plots exhibited minimal to no visible injury, indicating better crop selectivity.

These results align with observations of Vencill (2002), who reported that “phytotoxic effects of herbicides on crops can vary greatly depending on the type of herbicide, with some herbicides such as 2,4-D and dicamba causing significant injury to sensitive crops, while others like glyphosate and glufosinate have minimal impact on most crops”. At Zaria, all treatments resulted in zero phytotoxicity, indicating no observable damage to the cowpea plants. These results align with previous studies by (Johnson *et al.*, 2002), who reported that “The same herbicide can exhibit varying levels of phytotoxicity on the same crop on different locations, due to factors such as soil type, climate and moisture levels, as demonstrated by the differential response of soybeans to glyphosate in Lowa and Arkansas.

The higher phytotoxicity observed with Iris may be linked to varietal sensitivity and environmental stress conditions, such as higher temperatures and lower soil moisture in the Sudan savanna. Herbicide injury under such conditions has been widely reported to reduce crop vigor and yield (Silva et al., 2009; Souza et al., 2016). The relative safety of Raptor observed in this study suggests its suitability for post-emergence weed control in cowpea under savanna conditions.

Phenological Development

Weed control methods significantly influenced phenological traits of cowpea at both locations. Plots treated with hoe weeding and Raptor reached 50% flowering and physiological maturity earlier than Iris-treated and unweeded plots. Delayed flowering and maturity were most pronounced in the unweeded control and high-rate Iris treatments, likely due to prolonged weed competition and herbicide-induced stress.

Early flowering and maturity observed under effective weed control treatments indicate reduced competition for growth resources, allowing the crop to complete its growth cycle more efficiently. Similar effects of weed management on crop phenology have been reported by Akinyemiju and Echendu (1987) and Osipitan et al. (2016).

Grain Yield

Grain yield was significantly affected by weed control methods, cowpea variety, and location. At both locations, hoe weeding and Raptor treatments produced significantly higher grain yields compared with Iris treatments and the unweeded control. The highest grain yield at the Sudan savanna location was recorded under Raptor applied at 1.5 L ha^{-1}, while Raptor at 1.0 L ha^{-1} produced the highest yield at the Northern Guinea savanna location.

Iris herbicide treatments resulted in moderate grain yields, which were significantly lower than those obtained under Raptor and hoe weeding. The unweeded control consistently recorded the lowest grain yield, reflecting severe yield losses due to uncontrolled weed competition. Yield reductions in the unweeded plots exceeded 60% compared with the best-performing treatments, highlighting the critical importance of effective weed management in cowpea production.

The superior yield performance of Raptor-treated plots can be attributed to effective weed suppression combined with minimal crop injury, which enhanced resource availability and crop growth. These findings agree with earlier reports that effective weed control during the critical period of competition is essential for achieving optimum cowpea yield (Lagoke et al., 1981; Gupta et al., 2016).

Varietal and Location Effects

Cowpea varieties responded differently to weed control treatments across locations. IT99K-573-1-1 performed better under Sudan savanna conditions, while UAM14-122-17-7 recorded higher grain yield at the Northern Guinea savanna location. This differential response may be related to varietal adaptation to environmental conditions and tolerance to weed competition and herbicide stress.

Location effects were evident, with generally higher grain yields recorded at the Northern Guinea savanna compared with the Sudan savanna. This may be attributed to higher rainfall, better soil moisture availability, and longer growing season at the Northern Guinea savanna, which favored both crop growth and recovery from herbicide application.

CONCLUSION

This study evaluated the comparative performance of Raptor and Iris post-emergence herbicides on weed suppression and grain yield of cowpea in the Sudan and Northern Guinea savannas of Nigeria. The results demonstrated that weed control methods significantly influenced weed density, weed biomass, crop safety, phenological development, and grain yield of cowpea across both agro-ecological zones.

Raptor herbicide consistently provided superior weed suppression and higher weed control efficiency compared with Iris herbicide, with performance comparable to manual hoe weeding. Raptor treatments resulted in minimal crop phytotoxicity, earlier flowering, and higher grain yield, indicating good selectivity and suitability for cowpea production under savanna conditions. In contrast, Iris herbicide caused noticeable phytotoxic effects, particularly at higher application rates and under Sudan savanna conditions, which negatively affected crop growth and yield.

Grain yield was significantly higher in plots treated with Raptor at 1.5 L ha^{-1} in the Sudan savanna and 1.0 L ha^{-1} in the Northern Guinea savanna, highlighting the influence of agro-ecological conditions on optimal herbicide performance. Uncontrolled weed infestation led to severe yield losses, underscoring the critical importance of timely and effective weed management in cowpea production. Varietal responses varied across locations, suggesting that genotype–environment interactions play a role in cowpea performance under different weed management regimes.

Overall, the study confirms that effective post-emergence weed control is essential for improving cowpea productivity and that Raptor herbicide offers a reliable and safer alternative to manual weeding in the Nigerian savannas.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. Raptor herbicide is recommended for post-emergence weed control in cowpea due to its high weed control efficiency, low phytotoxicity, and superior grain yield performance across both agro-ecological zones.

2. Application rates of 0.5–1.0 L ha^{-1} of Raptor are recommended for the Sudan savanna, while 1.0 L ha^{-1} is optimal for the Northern Guinea savanna, to achieve effective weed suppression with minimal crop injury.

3. Iris herbicide should be used with caution in cowpea, particularly at higher application rates and under drier Sudan savanna conditions, due to its potential to cause crop phytotoxicity and yield reduction.

4. Farmers are advised to integrate chemical weed control with good agronomic practices, including timely planting and appropriate variety selection, to maximize cowpea productivity.

5. Further studies should focus on long-term environmental effects, economic analysis of herbicide use, and integration of post-emergence herbicides with other weed management strategies to promote sustainable cowpea production systems.

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