



Evaluation of Pre-Emergence Herbicides with Supplementary Hoe Weeding for Weed Management in Cowpea (*Vigna unguiculata* L. Walp) in Makurdi, Benue State, Nigeria

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This study was conducted at the Agronomy Teaching and Research Farm, Joseph Sarwuan Tarka University Makurdi, Benue State on weed management in cowpea. The study aims to evaluate the growth, yield attributes, and yield of cowpea (*Vigna unguiculata* L. Walp) under the influence of pre-emergence herbicides supplemented with hoe weeding at predetermined weeks after sowing (WAS). The experiment was laid out in a randomized complete block design with three replications. Six treatments involving three pre-emergence herbicides were evaluated, as T1, T2, T3, T4, T5 and T6. Data were collected on crop percentage emergence counts, plant height, number of leaves, number of branches, yield components, seed yield, and weed density at 6 WAS. Results showed that the weed flora were dominated by *Rottboellia* spp., *Cyperus* spp., and *Tridax procumbens*. Percentage emergence counts were high across all treatments, ranging from 89.66 to 96.66 percent, indicating no severe herbicide phytotoxicity. T6 recorded a 60 percent reduction in seed yield (10.00 grams per plant) compared to the T5 (25.10 grams per plant). T1 produced seed yield (20.50 grams per plant) that was statistically comparable to T5. All weed management treatments significantly reduced weed density at 6WAS (3.53 to 4.06 plants /m²) compared to T6 (6.86 plants/ m²). The study concludes that integrated weed management combining pre-emergence herbicides, particularly, T1 offers effective weed control and yield improvement comparable to T4. This strategy is recommended for smallholder farmers in Makurdi and similar agro-ecologies to reduce labor demand while sustaining cowpea productivity.

Keywords: Hoe weeding, Pre-emergence, Herbicides, Seed-yield, Weed density.

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) is an important grain legume widely cultivated in sub-Saharan Africa, serving as a vital source of dietary protein, income, and soil fertility improvement through biological nitrogen fixation. According (Nwagboso *et al.*, 2024) Nigeria is largest cowpea producing country, producing about 3.63 million metric tons (MT) of cowpea across an extensive land area of 4.97 million hectares. Benue State is ranked twelfth among the cowpea producing states in Nigeria with a production tonnage of 138,510 MT on 126,450 hectares as reported by National Extension and Research Liaison

Services (NAERLS, 2021). However, productivity remains far below the genetic potential due to several constraints, among which weed competition is paramount (Ogunremi *et al.*, 2021).

Weeds compete with cowpea for light, water, nutrients, and space, particularly during the first 4–6 weeks after sowing, which is the critical period for weed control. Uncontrolled weed infestations in cowpea can cause yield losses of 50–90%, depending on weed species, density, and duration of competition (Adigun *et al.*, 2014, (Ogunremi *et al.*, 2021)). The weed flora in the southern Guinea savanna of

Nigeria is typically a composite of annual and perennial broadleaved weeds, grasses, and sedges, therefore, making their management challenging (Usman *et al.*, 2013). Yield losses due to weeds alone in cowpea production can range from 25% to 76% depending on the cultivar and environment (Adigun *et al.*, 2014; Gupta *et al.*, 2016). Problems caused by weed in cowpea production include reduction in crop yield, less efficient land use, higher cost of production due to insects and plant disease control, reduction in crop quality, water management problems, and less efficient utilization of labour (Osipitan, 2017). Primarily, weed reduced crop yield through inter and intra competitions for water, soil nutrient, light, and carbon dioxide. Weeds may also reduce crop yield by releasing allelochemicals into the environment (Fisichelli *et al.*, 2014). Some parasitic weeds also cause considerable damage to cowpea, with substantial yield reduction especially in Africa (Adigun *et al.*, 2014). The magnitude of yield loss depends on crop variety, weed density, type of weeds, weed persistence, duration of weed interference and crop management practices (Osipitan, 2017). The effects of weed could be directly or indirectly ((Usman and Time, 2025).

Farmers in Makurdi primarily rely on hoe weeding, which is labor-intensive, time-consuming, and often poorly timed due to labor shortages. Pre-emergence herbicides such as butachlor, pendimethalin, and metolachlor offer potential alternatives or complements to manual weeding. However, their efficacy and effects on cowpea growth and yield under local conditions require empirical validation (Sunday and Udensi, 2013). Therefore, this study aimed to evaluate the effect of these herbicides on weed management, crop growth, yield attributes and cowpea yield in Makurdi.

MATERIALS AND METHODS

Study Area

The experiment was conducted during the 2025 cropping season at the Teaching and Research Farm of the College of Agronomy, Joseph Sarwuan Tarka University, Makurdi.

The site is located on latitude 7° 45' 43.3'' N, longitude 8°37' 25.4'' E, on elevation of 104 m above sea level). The site lies entirely within the River Benue flood plains, North central Nigeria as shown in the map (Figure 1). The map was extracted from existing Benue map using the coordinates for location generated with the aid GPS model Gemini. The map was plotted using Google earth, 2026.

The existing vegetation of the site was cleared using cutlass. The land was mapped out and plots manually ridged with hoe. Makurdi is an urban area with land area of 800Km² and falls within Southern Guinea savanna agro-ecological zone of Nigeria. The area is characterized by a tropical humid climate of wet and dry type. Temperature is generally high throughout the year, with February and March as the hottest months (NIMET, 2024). The daily minimum and maximum temperatures are about 25.5⁰C and 40⁰C respectively, while mean monthly relative humidity varies between 44 % in January to 82% in July to September periods (NIMET, 2024). The rainy season is from April to October while the dry season is November to March. The mean annual rainfall is between 1120–1175 mm (NIMET, 2024). The natural vegetation consisted of savanna grassland interspersed with many trees and shrubs. The plots were previously grown to soybean and groundnut and left fallow for three years prior to this study. The natural bush re-growth at the end of the fallow period consisted of broadleaved weeds, grasses and sedges (Table 1). The site drains into River Benue which is about 2 Km away. Furthermore, the drainage systems comprise River Benue, other small rivers and streams.

Topography of the site is slightly undulating and elevation ranges from 70 to 163 m above sea level. Soils of the site are formed from shale as parent material (Idoga *et al.*, 1998). There are two major soil types in Makurdi. The hydromorphic soil developed from the processes of pedogenic eluviation and illuviation and is found along the river plain and the red ferrasols from sedimentary rocks away from the immediate river channel (Idoga *et al.*, 1998). Makurdi is the capital city of

Benue State and it is inhabited by many tribes mainly the Tivs, Idomas and Igede. The people are largely engaged in civil service,

commercial activities and farming (Yusuf et al., 2020).



Figure 1: Map of Makurdi, Benue State showing study location

Source: (Google Earth, 2026)

Treatments and Experimental Design

Six weed management treatments were evaluated: T1= butachlor (500 g ai/ha) + hoe weeding at 3 week after sowing (WAS), T2 = pendimethalin (400 g ai/ha) + hoe weeding at 3 WAS, T3 = metolachlor (960 g ai/ha) + hoe weeding at 3 WAS, T4 = hoe weedings at 2 and 4 WAS, T5 = weed-free and T6 = weedy check (no weed control). Treatments were arranged in a randomized complete block design (RCBD) with three replications. Each experimental plot was 3.5 m × 2 m (7 m²) made up of four ridges of 2m long, with intra and inter-row spacing of 20 and 50cm respectively with a gross area of {7mx27m (189m²)}.

Source of Planting Material, Herbicide Application and Weed Identification

Cowpea variety (FUAMPEA 1) was obtained from Seed centre, JoSTUM. The seeds were dressed with Apron-star at the rate of 10 g of the chemical per 4kg of seed before sowing in order to protect the seeds from fungal and insect pests. Seeds were sown at 2 seeds per hole and later thinned to one plant per stand at 1 WAS. Pre-emergence herbicides were applied within 24 hours after sowing using a calibrated CP15 knapsack sprayer. Hoe weeding was performed manually as per treatment specifications. No fertilizer or irrigation was applied. Prior to planting, fields were surveyed for weed types and distribution by random placement of a meter square quadrat per plot and counting all the weed species found within. The average number of weed species found within the quadrat were scored visually on a 1 -9 scale, where 1 - 3 = low density (+), 4 -6 = medium density (+ +), and 7- 9 = high density (+ + +) (Usman et al., 2013). Weed species were identified using weed identification guide book by Akobundu et al; (2016).

Data Collection

Data were collected on cowpea percentage emergence counts at 1WAS, plant heights (cm) at 2-8WAS, cowpea number of leaves at 2-8WAS, number of branches at

4-8WAS, number of pods per cowpea plant, cowpea pod length (cm), cowpea seed yield (g), weed density (N/m²) at 6WAS and 100 seed weight (g). Omoigui et al., 2022; Petal et al., 2020 and Udensi et al., 2020 reported utilization of the above data and procedures below in assessing effects of herbicides and other weed management on growth, yields and yield attributes of crops.

Percentage germination or percentage emergence count

This is the proportion of seeds that successfully sprout and grow into normal seedlings within a specific period. It measures seed viability and helps calculate proper planting rates.

It is calculated using the formula:

Percentage Germination = (Number of germinated seeds/Total number of seeds tested) x 100

Plant height at 2-8 WAS

Five cowpea plants were tagged from each plot and their height measured in centimetre (cm) with a ruler from the ground level or the base to the top of the flag leaf at 2- 8WAS and the average height of the five plants was determined and recorded.

Number of leaves at 2-8WAS

Five cowpea plants were tagged from each plot and their leaves counted, and average determined and recorded at 2- 8 WAS

Number of branches

Five cowpea plants were tagged from each plot and their branches counted, and average determined and recorded at 4- 8 WAS. 4WAS was used as starting point because branches initiation starts at 3-4WAS in cowpea variety under study.

Number of pods per cowpea plant

At harvest, pods were picked from the five tagged plants in each plot, counted and average determined and recorded.

Cowpea pod length (cm)

At harvest, pods were picked from each of the five tagged plants in each plot and their length measured in centimetre using ruler and average determined and recorded.

Cowpea seed yield/plant (g)

At harvest, pods from each plot were picked, threshed, winnowed and weighed using a weighing balance and recorded.

Weed density (N/m²) at 6WAS

Weed density was determined by random placement of 1 m² quadrat in each plot and counting the weed species found within at 6 WAS.

Data Analysis

Data collected were analysed using SAS (9.2 edition). Significant differences among treatment means were separated using New Duncan's Multiple Range Test (NDMRT) at a 5% probability level.

RESULTS AND DISCUSSION

Prior to planting, the experimental site hosted a diverse weed community comprising broadleaved species, grasses, and sedges (Table 1). Among the broadleaved weeds were *Gladiolus* spp., *Hyptis suaveolens*, and *Tridax procumbens* which occurred at high densities, indicating their strong presence in the soil weed seedbank. *Rottboellia* spp. was the dominant grass, while *Cyperus* spp. was the most prevalent sedge. The presence of perennial weeds such as *Cyperus* spp. and *Gladiolus* spp. suggests that weed control would be challenging and therefore, require strategies effective against both annual seedlings and perennial propagules. This diverse weed spectrum justified the testing of multiple pre-emergence herbicides combined with supplementary hoe weeding. The high prevalence of species such as *Hyptis suaveolens* and *Rottboellia* spp. suggests their adaptability to the humid tropical environment of Makurdi. This observation aligns with recent findings that these weed species are consistently dominant in cowpea agroecosystems under humid tropical conditions due to their rapid germination and competitive growth (Omoigui et al., 2022). The diversity of weed flora

emphasizes the need for effective management strategies. Weed species with high density, such as *Hyptis suaveolens* and *Cyperus* spp., pose a substantial risk for competition with cowpea seedlings, potentially affecting early growth and subsequent yield (Abubakar et al., 2019). The dominance of *Rottboellia* spp., *Cyperus* spp., and *Tridax procumbens* is consistent with earlier reports from similar agro-ecologies (Chikoye et al., (2019), Patel et al. (2020) and Udensi et al., 2020). The presence of perennial weed species such as *Cyperus* (sedge) is of particular concern because these weeds are not easily controlled by pre-emergence herbicides alone, which explains why supplementary hoe weeding was necessary across most treatments. Farmers in Makurdi should therefore, expect that chemical weed control alone may not be sufficient where perennial weeds are established.

Cowpea percentage emergence count was generally high across all treatments, ranging from approximately 90% to 97% (figure 2). T4 gave the highest emergence value (96.66%), which was statistically similar to T2 (94.33%), T3 (95.66%), T5 (95.33%), and even T6 (93.33%). The only treatment that showed a significantly lower emergence was T1 (89.66%), though the reduction was modest compared to the best treatment. This slightly lower emergence in T1 treated plots (89.66%) could be attributed to minor phytotoxic effects, which is consistent with reports that pre-emergence herbicides may transiently affect seedling vigor (Aboyaji, 2017, Sousa et al., 2023). Importantly, none of the pre-emergence herbicides caused severe emergence problems, showing that at the applied rates, they were safe for the cowpea variety use. This gives farmers confidence that chemical weed control can be initiated from the day of sowing without fear of reducing stand density.

Table 1: Major weed species occurrence at the experimental site before planting

Weed Species	Family	Life-form
Broadleaved Weed		
<i>Acanthospermum hispidum</i> DC	Asteraceae	Annual
<i>Ageratum conyzoides</i> Linn	Asteraceae	Annual
<i>Aspilia africana</i> (Pers.) C.D Adams	Asteraceae	Annual
<i>Commelina</i> spp	Commelinaceae	Annual
<i>Euphorbia heterophylla</i> Linn.	Euphorbiaceae	Annual
<i>Gladiolus</i> spp	Araceae	Perennial
<i>Hyptis suaveolus</i> Poit	Lamiaeaceae	Annual
<i>Tridax procumbens</i> Linn.	Asteraceae	Annual
Grasses		
<i>Rottboellia</i> spp.	Poaceae	Annual
<i>Paspalum</i> spp.	Poaceae	Annual
Sedges		
<i>Cyperus</i> spp	Cyperaceae	Perennial
<i>Mariscus</i> spp	Cyperaceae	Perennial

Legend: += Low density, ++ = Medium density, +++ = High density

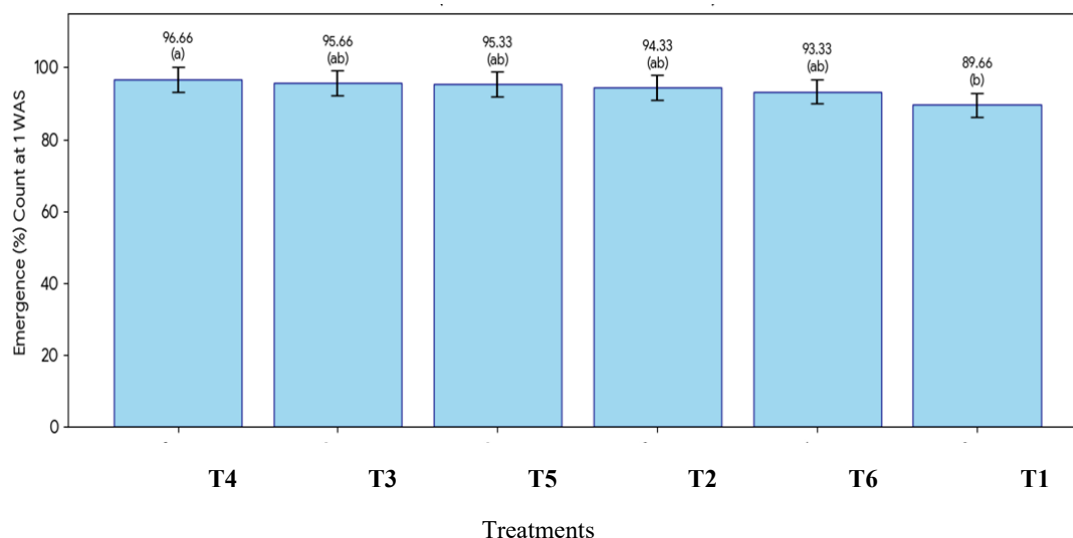


Figure 2: Effect of pre-emergence herbicides and supplementary hoe weedings on percentage cowpea emergence count at 1 WAS with error bars based on CV 3.7%.

Legend: T1 = Butachlor (Pre) at 500g ai/ha + Hoe weeding at 3 WAS, T2 = Pendimethalin (Pre) at 400g ai/ha + Hoe weeding at 3 WAS, T3 = Metolachlor (Pre) at 960g/ai/ha + Hoe weeding at 3 WAS, T4 = Hoe weedings at 2 and 4 WAS, T5 = Weed Free and T6 = Weedy Check (No weed control)

Plant height increased steadily from 2-8 WAS across all treatments (Table 2). At 2 WAS, plant heights ranged from 15.03 cm to 16.46 cm, with no significant differences among treatments. At 3 WAS, T4 at 2 and 4 WAS produced the tallest plants (17.66 cm), which was significantly taller than T2 (16.40 cm) and T6 (16.30 cm), but similar to other treatments. At 4

WAS, T4 again gave the highest height (20.56 cm) which was significantly taller than T1 (19.06 cm), T2 (18.50 cm), T3 (18.40 cm), and T5 (19.30 cm). At 5 and 6 WAS, the pattern continued, with T4 maintaining numerical advantages, though differences narrowed. At 8 WAS, T3 produced the tallest plants (45.57 cm), but no significant differences were detected

among any treatments at this stage. T6 consistently showed lower heights, ranging from 15.83 cm at 2 WAS to 34.07 cm at 8 WAS, demonstrating that uncontrolled weeds suppressed vertical growth throughout the crop's development.

These findings highlight the negative impact of uncontrolled weed competition on cowpea growth. Weeds limit access to light, water, and nutrients, thereby restricting vegetative development. This study corroborates the report by Abubakar *et al.*, (2019) that weed interference reduces plant height and biomass

accumulation in legumes, ultimately affecting canopy development and yield potential. The fact that metolachlor produced the tallest plants at 8WAS (45.57 cm) is interesting, but the very high coefficient of variation at that stage suggests that other factors, possibly micro-environmental differences or uneven weed pressure may have influenced the final height. Nevertheless, the consistent suppression of height in the weedy check serves as a clear reminder that early weed control is non-negotiable for good crop establishment.

Table 2: Effect Effect of pre-emergence herbicides and supplementary hoe weeding on plant height (cm) at 2-8 WAS

Treatment	2WAS	3WAS	4WAS	5WAS	6WAS	7WAS	8WAS
T1	15.36 ^a	16.63 ^{ab}	19.06 ^b	26.73 ^{ab}	28.00 ^{ab}	30.83 ^{ab}	33.67 ^a
T2	15.63 ^a	16.40 ^b	18.50 ^b	26.20 ^{abc}	27.73 ^{ab}	30.86 ^{ab}	33.90 ^a
T3	15.13 ^a	16.80 ^{ab}	18.40 ^b	26.73 ^{ab}	28.63 ^{ab}	32.13 ^{ab}	45.57 ^a
T4	15.03 ^a	17.66 ^a	20.56 ^a	27.80 ^a	29.56 ^a	32.83 ^a	36.73 ^a
T5	16.46 ^a	16.73 ^{ab}	19.30 ^b	25.56 ^{bc}	27.23 ^{ab}	30.56 ^{ab}	34.57 ^a
T6	15.83 ^a	16.30 ^b	19.40 ^{ab}	24.40 ^c	25.90 ^b	29.90 ^b	34.07 ^a
CV	5.82	3.82	3.46	4.62	5.43	5.06	55.77

Means followed by same superscript (s) within a column are not significantly different at 5% probability (NDMRT).

Legend: WAS= Weeks after sowing. T1 = Butachlor (Pre) at 500g ai/ha + Hoe weeding at 3 WAS, T2 = Pendimethalin (Pre) at 400g ai/ha + Hoe weeding at 3WAS, T3 = Metolachlor (Pre) at 960g/ai/ha + Hoe weeding at 3WAS, T4 = Hoe weedings at 2 and 4 WAS, T5 = Weed Free and T6 = Weedy Check (No weed control).

Leaf production followed a steady upward movement in all treatments, from approximately 7.8 leaves at 2 WAS to between 38 and 43 leaves at 8 WAS (Table 3). At 2, 3, 4, and 5 WAS, no significant differences were observed among treatments, with values ranging from 7.76 to 8.10 at 2 WAS and from 26.40 to 31.63 at 5 WAS. At 6 WAS, hoe weedings at 2, 4, and 6 WAS produced significantly more leaves (36.46) than both the weed-free (30.23) and weedy check (31.56) treatments. However, this was statistically similar to the herbicide treatments, which ranged from 32.96 to 33.66. At 7 WAS, the same pattern persisted, with hoe

weedings giving 40.50 leaves, significantly higher than weed-free (34.16) and weedy check (34.90). At 8 WAS, all treatments converged and no significant differences remained, with values ranging from 38.30 to 43.40. These results are consistent with previous research demonstrating that integrated weed control strategies optimize both growth and yield in tropical legume systems (Aboyaji, 2017). However, weed-free plots, although weed-free, received frequent mechanical disturbance during repeated weeding, which might have temporarily set back the crop.

Table 3: Effect of pre-emergence herbicides and supplementary hoe weeding on number of leaves of cowpea at 2-8WAS.

Treatments	2WAS	3WAS	4WAS	5WAS	6WAS	7WAS	8WAS
T1	7.76 ^a	15.03 ^a	20.73 ^a	31.63 ^a	33.66 ^{ab}	37.63 ^{ab}	40.63 ^a
T2	7.86 ^a	15.23 ^a	20.96 ^a	29.50 ^a	33.40 ^{ab}	36.46 ^{ab}	39.23 ^a
T3	8.10 ^a	16.10 ^a	20.83 ^a	29.40 ^a	32.96 ^{ab}	36.56 ^{ab}	40.23 ^a
T4	7.93 ^a	15.66 ^a	20.56 ^a	31.63 ^a	36.46 ^a	40.50 ^a	43.40 ^a
T5	7.93 ^a	15.23 ^a	20.03 ^a	26.40 ^a	30.23 ^b	34.16 ^b	38.40 ^a
T6	7.76 ^a	15.40 ^a	20.96 ^a	27.96 ^a	31.56 ^{ab}	34.90 ^b	38.30 ^a
CV %	4.30	3.80	6.81	10.81	9.27	7.36	7.12

Means followed by same superscript (s) within a column are not significantly different at 5% probability (NDMRT).

Legend: WAS= Weeks after sowing. T1 = Butachlor (Pre) at 500g ai/ha + Hoe weeding at 3 WAS, T2 = Pendimethalin (Pre) at 400g ai/ha + Hoe weeding at 3WAS, T3 = Metolachlor (Pre) at 960g/ai/ha + Hoe weeding at 3WAS, T4 = Hoe weedings at 2 and 4 WAS, T5 = Weed Free and T6 = Weedy Check (No weed control).

Branching increased gradually from 4 to 8 WAS across all treatments. At 4 WAS, no significant differences were found, with branch numbers ranging from 2.06 to 2.80 (Table 4). At 5 WAS, T2 (6.83) and T3 (6.53) produced significantly more branches than T6 (4.76), but were similar to T1 (6.20), T4 (6.16), and T5 (5.60). At 6 WAS, T2 (7.53) and T3 (7.40) again significantly out-performed the T6 (5.66),

while other treatments ranged from 6.06 to 7.00. At 7 WAS, all treatments were statistically similar, ranging from 7.33 to 8.73. At 8 WAS, all treatments converged to between 9.40 and 9.73, with no significant differences. This result is agreement with Reddy, (2012) who reported similar trend of branching, particularly, in plants with determinate growth.

Table 4: Effect of pre-emergence herbicides and supplementary hoe weeding on number of branches of cowpea at 4 - 8WAS

Treatments	4WAS	5WAS	6WAS	7WAS	8WAS
T1	2.50 ^a	6.20 ^{ab}	6.90 ^{ab}	8.06 ^a	9.40 ^a
T2	2.40 ^a	6.83 ^a	7.53 ^a	8.46 ^a	9.73 ^a
T3	2.06 ^a	6.53 ^a	7.40 ^a	8.73 ^a	9.70 ^a
T4	2.80 ^a	6.16 ^{ab}	7.00 ^{ab}	7.80 ^a	9.40 ^a
T5	2.06 ^a	5.60 ^{ab}	6.06 ^{ab}	8.13 ^a	9.40 ^a
T6	2.33 ^a	4.76 ^b	5.66 ^b	7.33 ^a	9.40 ^a
CV %	18.14	13.13	12.02	10.74	7.08

Means followed by same superscript (s) within a column are not significantly different at 5% probability (NDMRT).

Legend: WAS= Weeks after sowing. T1 = Butachlor (Pre) at 500g ai/ha + Hoe weeding at 3 WAS, T2 = Pendimethalin (Pre) at 400g ai/ha + Hoe weeding at 3WAS, T3 = Metolachlor (Pre) at 960g/ai/ha + Hoe weeding at 3WAS, T4 = Hoe weedings at 2 and 4 WAS, T5 = Weed Free and T6 = Weedy Check (No weed control).

Table 5 presents the most critical findings of the study. For number of pods per plant, T5 (6.06) and all other treatments (ranging from 4.73 to 5.36) were statistically similar, but the T6 (2.63) was significantly lower than all others. For pod length, T5

gave the longest pods (15.50 cm), which was significantly longer than T3 (13.46 cm) and the T6 (12.60 cm), but similar to T1 (14.30 cm), T2 (13.66 cm), and T4 (13.93 cm). For pod weight per plant, T5 (35.66 g) significantly outperformed all

other treatments except T1 (28.40 g), which was statistically similar. T6 recorded the lowest pod weight (14.30 g) which was significantly lower than all treatments. For seed yield per plant, T5 (25.10 g) was significantly higher than all treatments except T1 (20.50 g), which was statistically similar. T6 again gave the lowest seed yield (10.00 g), representing approximately a 60% reduction compared to T5. For 100-seed weight, T6 (10.93 g) was significantly lower than all other treatments, which ranged from 11.93 g to 12.60 g. These results leave little doubt that effective weed management directly translates into better yields, with T1 emerging as a particularly promising option. The yield component data provide the most compelling evidence for the value of weed management in cowpea. A

reduction from 25.10 g per plant in the T5 to just 10.00 g per plant in T6 represents a 60% yield loss, which is substantial and aligns with previous studies that have reported yield losses ranging from 50% to 90% under severe weed competition (Ogunremi *et al.*, 2021; Adigun *et al.*, 2014). What makes this finding particularly useful for farmers is that T1 produced a seed yield of 20.50 g per plant, which was statistically indistinguishable from T5. This means that farmers do not need to maintain perfectly weed-free fields throughout the season; instead, a well-timed pre-emergence herbicide plus one hand weeding can achieve nearly the same result. Given the rising cost and scarcity of agricultural labor in Benue State, this is a practical and economically sensible recommendation.

Table 5: Effect of Pre-Emergence Herbicides and Supplementary Hoe Weeding on Yield and Yield Components of Cowpea

Treatments	Number of pods/plant	Pod length (cm)	Pod weight/ plant (g)	Number of seed/plant	Seed Yield/ Plant (g)	100 seed weight (g)
T1	5.36 ^a	14.30 ^{ab}	28.40 ^b	12.86 ^a	20.50 ^{ab}	.00 ^a
T2	4.90 ^a	13.66 ^{ab}	26.16 ^b	9.46 ^c	17.33 ^b	12.00 ^a
T3	4.73 ^a	13.46 ^b	24.03 ^b	10.30 ^{bc}	16.23 ^b	12.36 ^a
T4	4.80 ^a	13.93 ^{ab}	24.36 ^b	10.56 ^{bc}	17.83 ^b	12.60 ^a
T5	6.06 ^a	15.50 ^a	35.66 ^a	12.23 ^{ab}	25.10 ^a	11.93 ^a
T6	2.63 ^b	12.60 ^b	14.30 ^c	10.83 ^{abc}	10.00 ^c	10.93 ^b
CV %	16.54	7.33	14.63	10.77	18.39	3.76

Means followed by same superscript (s) within a column are not significantly different at 5% probability (NDMRT).

Legend: WAS= Weeks after sowing. T1 = Butachlor (Pre) at 500g ai/ha + Hoe weeding at 3 WAS, T2 = Pendimethalin (Pre) at 400g ai/ha + Hoe weeding at 3WAS, T3 = Metolachlor (Pre) at 960g/ai/ha + Hoe weeding at 3WAS, T4 = Hoe weedings at 2 and 4 WAS, T5 = Weed Free and T6 = Weedy Check (No weed control)

At 6 WAS, all weed management treatments successfully reduced weed density compared to the T6 (Table 6). T5 gave the lowest weed density (3.53 N/m²), followed by T1 (3.66 N/m²), T3 (3.73 N/m²), and T2 (4.06 N/m²). These four treatments were statistically similar to one another. As expected, T5 had zero weeds (0.00 N/m²). In contrast, T6 recorded a The weed density result confirms that integrated approaches work. Whether a farmer chooses a pre-emergence herbicide

weed density of 6.86 N/m², which was significantly higher than all weed management treatments. Importantly, a single hoe weeding at 3WAS, when combined with a pre-emergence herbicide, was just as effective at reducing weed density as t4 alone. This finding has practical implications for labor saving and costs.

plus one hoe weeding (weed densities of 3.66 to 4.06 N/m²) or simply T4 (3.53 N/m²), the outcome in terms of weed

suppression by mid-season is comparable. However, the herbicide-based approach requires less labor, which is a significant advantage during peak planting periods. For smallholder farmers who often struggle to secure labor at the right time, this study provides evidence that chemical weed control, when used responsibly and integrated with manual weeding, can be both effective and efficient.

This confirms the effectiveness of both pre-emergence herbicides and hoe-weeding in reducing weed pressure.

Table 6. Effects of Pre-Emergence Herbicides and Supplementary Hoe Weeding on Yield and Yield Components of Cowpea on Weed Density at 6 WAS

Treatment	Density (N/ m ²) at 6WAS
T1	3.66 ^b
T2	4.06 ^b
T3	3.73 ^b
T4	3.53 ^b
T5	0.00 ^c
T6	6.86 ^a
CV %	10.26

Means followed by same superscript (s) within a column are not significantly different at 5% probability (NDMRT).

Legend: WAS= Weeks after sowing. T1 = Butachlor (Pre) at 500g ai/ha + Hoe weeding at 3 WAS, T2 = Pendimethalin (Pre) at 400g ai/ha + Hoe weeding at 3WAS, T3 = Metolachlor (Pre) at 960g/ai/ha + Hoe weeding at 3WAS, T4 = Hoe weedings at 2 and 4 WAS, T5 = Weed Free and T6 = Weedy Check (No weed control)

CONCLUSION

The herbicides butachlor at 500g ai/ha), pendimethalin at 400g ai/ha, and metolachlor at 960gai/ha were safe for cowpea emergence at the recommended rates. However, integrated management proved most effective; T1 produced seed yields statistically comparable to T5 while reducing labor input. This study concludes that integrated weed management combining pre-emergence herbicides with strategic supplementary hoe weeding offers a practical, labor-saving solution for smallholder cowpea farmers in Makurdi and similar agro-ecologies.

Maintaining low weed density during the early growth period is essential for minimizing competition and ensuring optimal crop performance. Recent studies emphasize that integrated weed management is a key factor in sustainable cowpea production, as it combines chemical and manual control to maintain low weed populations efficiently (Omoigui et al., 2022). The above findings also corroborate the reports of Singh and Kumar, (2021) and Sunday and Udensi (2013) on efficacy of these herbicide.

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