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Effectiveness of Integrated Organic Weed Management in Fluted Pumpkin (*Telfairia occidentalis* Hook F.) Field

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ABSTRACT

Organic weed management is an indispensable technique for effective, environmentally friendly *and* sustainable weed suppression in organic crop fields. A field experiment was conducted during the 2023 late cropping season at the University of Calabar Teaching *and* Research Farm, Calabar, to determine the effectiveness of integrated use of dead organic mulches [oil palm bunch refuse (OPBR), dry neem leaves (DNL)] *and* h*and* weeding frequency [h*and* weeding once (H_1), h*and* weeding twice (H_2), h*and* weeding thrice (H_3), regular weeding/weed-free check (WFC) *and* no weeding/weedy check (WC)] on weed suppression *and* the performance of fluted pumpkin (*Telfairia occidentalis* Hook F.). The experiment was a Randomized Complete Block Design (RCBD), with three replications. The 10 treatments were: OPBR+DNL+ H_3, OPBR+ H_3, DNL+ H_3, OPBR+ H_2, DNL+ H_2, OPBR+ H_1, DNL+ H_1, H_3, WFC *and* WC. Data were collected on weeds, vegetative characteristics *and* vine yield of fluted pumpkin *and* analyzed using the Analysis of Variance (ANOVA) method. The means were compared using the Duncan's New Multiple Range Test (DNMRT) at 5 % level of probability. The results indicated that generally, weeds were suppressed *and* crop performance improved by weed control treatments relative to no weeding. The WFC which had no weeds, produced the highest vine yield (16.84 t/ha), statistically ($P < 0.05$) similar to OPBR+DNL+ H_3 (17.87 t/ha). No weeding throughout the cropping season (WC) resulted in higher cumulative weed dry matter of 61.85 % *and* 73.39 % compared with the integrated weed management treatments *and* three times h*and* weeding, respectively, *and* consequently, suppressed fluted pumpkin vine yield by 59.28 %. Conclusively, the results demonstrated that, OPBR+DNL+ H_3 effectively controlled weeds *and* enhanced the growth *and* vine yield of fluted pumpkin more than the farmers' practice of three times h*and* weeding *and* could be a viable alternative to regular h*and* weeding.

Key Words: *Fluted Pumpkin, Oil Palm Bunch Refuse, Dry Neem Leaves, Weeding Frequency, Vine Yield.*

INTRODUCTION

Fluted pumpkin (*Telfairia occidentalis*), a tropical cucurbit indigenous to the rainforest region of West Africa (Ojimelukwe, 2022), is an important vine grown widely in the region as a leaf vegetable *and* for its edible seed (Ekpunobi *et al.,* 2024). Fluted pumpkin is estimated to be consumed by 30 to 50 million people in Nigeria, mostly in the Southeastern part of the country (Uwalaka, *et al.,* 2019; Ojimelukwe, 2022). It has both healing *and* medicinal properties (Akoroda, 1990; Ndor *and* Dauda, 2013). Resilient *and* profitable, fluted pumpkin is now a commercial crop on which many families depend for food *and* income, thereby contributing to food security, creating employment *and* enhancing rural *and* urban livelihoods, especially for women (Aakata *et al.,* 2025; Ikwuazom *and* Ejike 2026; Obiekwe, 2025).

Nigeria is the largest producer *and* consumer of fluted pumpkin in West Africa. The major producing areas are the southern states of Abia, Akwa Ibom, Anambra, Ebonyi, Enugu, Cross River *and* Rivers, but its production is also gaining prominence in the southwest *and* north central areas such as Oyo *and* Nasarawa states, respectively (Ndor *and* Dauda, 2013; Oyekunle *and* Abosede, 2012, Sanusi *et al.,* 2025). Reported fresh edible vine yields of fluted pumpkin obtained across Nigeria varied widely from 153.15 kg/ha to 556.65 kg/ha in the South West (Oyekunle *and* Abosede, 2012), 689.45 kg/ha to 1,234 kg/ha in the North Central (Ndor *and* Dauda, 2013) *and* 1, 000 kg/ha to 1,058 kg/ha in the South East (Uwalaka *et al.,* 2019). Moreover, relatively very high vine yields of 12.79 t/ha to 36.65 t/ha have been obtained in the southeastern coastal areas with rainfall almost all the year round (Akata *et al.,* 2025; Akpan *and* Udo, 2017). These vine yield variations in fluted pumpkin are attributable to management methods adopted such as fertilizer use (Olaniyi *and* Ajao, 2011), tillage practices (Obalum *et al.,* 2017), spacing (Obalum *et al.,* 2017) *and* weed control (Okugie *et al.,* 1988; Osadebe *et al.,* 2014).

Although cucurbits (Mondal, 2020) *and* in particular, fluted pumpkin (Odiaka *and* Schippers, 2004; National Institute for Horticultural Research [NIHORT], 2020) can smother weeds by spreading their vines at the later stage of growth, drastic leaf yield reduction of 85.26 % due to uncontrolled weed growth in *Telfairia occidentalis* field has been recorded (Osadebe, *et al.,* 2015). Fields reclaimed from fallow are usually predominated by broad leaf weeds in the first few years of cropping; however, as cropping continues, the weed spectrum shifts in favour of perennial grasses *and* sedges which are usually more competitive *and* aggressive (Claire, 2013). Manual weeding should be carried out at least three times in the rainy season *and* two times in the dry season (Odiaka *and* Schippers, 2004), *and* should commence 2-4 weeks after planting NIHORT, 2020).

No single weed management method gives effective control of weeds of all forms *and* in all situations (Mondal *et al.,* 2020). Although conventional methods such as h*and* weeding *and* herbicides application are very useful in weed control, h*and* weeding alone is often uneconomical due to the high cost of labour *and* the need for repeated operations. On the other hand, herbicides have negative impact on human health *and* the environment (Osadebe *et al.,* 2015). Integrated weed management which combines two or more methods of weed control is believed to be a panacea for effective *and* environmentally friendly weed management (Nwagwu *and* Udo, 2019).

Mulching is an organic method of weed control that has been used in agriculture throughout the world to suppress weed growth (Nwagwu et. al., 2020a; Claire, 2013). Organic mulches such as compost, leaves, *and* grasses clipping have added benefits; they add nutrients to the soil as they decompose *and* improve soil biological activities (Odiaka *and* Schippers, 2004). Specifically, organic mulches of grasses (Okugie *et al.,* 1988) *and* sawdust (Osadebe *et al.,* 2014) have been evaluated for weed control in fluted pumpkin with promising results. However, organic mulches alone do not usually provide season-long weed control in most crop farms, hence the need to combine mulching with other weed management methods for effective weed control *and* enhanced crop yield (Nwagwu *et al.,* 2020a; Osadebe *et al.,* 2014). It has been demonstrated that, the integration of living or dead organic mulches with h*and* weeding can reduce weed competition, reduce the frequency of weeding *and* enhance yields of field crops (Nwagwu *et al.,* 2020a; Nwagwu *and* Udo, 2019), including fluted pumpkin (Osadebe *et al.,* 2014; Osadebe *et al.,* 2015). Neem products have been shown to contribute to pest management in organic cropping *and* the ease of obtaining dry neem leaves (DNL) from our environment through litter fall or pruning of trees, makes it a desirable organic pest control material for resource –poor farmers (Adhikari *et al.,* 2020). Similarly, oil palm bunch refuse (OPBR) mulch has been reported to significantly reduce the germination *and* growth of weeds, increase the diversity *and* abundance of beneficial soil organisms, *and* increase crop yield (Hettiarachchi, 2019).

There is paucity of information on the integration of OPBR *and* DNL mulches with h*and* weeding in fluted pumpkin field in the Calabar rainforest area where the crop is a major staple *and* income generating crop for the traditional farmers, especially women. Therefore, the present study was undertaken to examine the effectiveness of combined use of dead organic mulches (OPBR *and* DNL) *and* different h*and* weeding frequencies on weed control *and* the performance of fluted pumpkin in Calabar, Nigeria

Materials *and* Methods

Experimental site

The experiment was carried out at the University of Calabar Teaching *and* Research Farm, Calabar, from August to November 2023. Calabar is located in the southeast rainforest agro-ecological zone of Nigeria (05° 32'N *and* 04° 27'N; 07° 15'E *and* 09° 28'E), 39 m above sea level, *and* has an annual rainfall distribution ranging from 3000-3500 mm, with mean annual temperature range of 22-23 °C minimum *and* 28-35 °C maximum, *and* relative humidity of 75-88 % (Efiong, 2011).

L*and* preparation

The experimental site was under secondary vegetation after a melon crop was grown the previous year with the following predominant weeds: *Mimosa pudica*, *Cyperus rotundus*, *Panicum maximum*, *and Centrocema pubescence*. The existing vegetation was cleared with machete *and* debris packed. The soil was tilled, pulverized *and* mapped out into uniform units to meet the design specification.

Experimental design *and* layout

The experiment was laid out in a randomized complete block design (RCBD) *and* replicated three times. Each replication had ten (10) treatments namely: Oil palm bunch refuse +

Dry neem leaves + h*and* weeding thrice (OPBR+DNL+ H_3) Oil palm bunch refuse + h*and* weeding thrice (OPBR+ H_3), Oil palm bunch refuse + h*and* weeding twice (OPBR+H_2). Oil palm bunch refuse + h*and* weeding once (OPBR+ H_1), Dry neem leaves + h*and* weeding thrice (DNL+ H_3), Dry neem leaves + h*and* weeding twice (DNL+ H_2), Dry neem leaves + h*and* weeding once (DNL + H_1), h*and* heeding thrice only (H_3), Weed-free check (WFC), *and* Weedy check (WC). Each plot measured 4 m × 4 m with 1m path separating one plot from another *and* one replication from another, giving a total area of 686 m^2. Each treatment had 16 stands of fluted pumpkin with the four innermost plants as the net plot (4m^2).

Sowing material *and* sowing

Mature fluted pumpkin pods were obtained from the Cross River State Ministry of Agriculture, Calabar. The pods were carefully sliced open at both ends *and* vertically to extract the seeds. The extracted seeds were sun-dried for 48 hours before sowing. One seed was sown per st*and* at a spacing of 1 m apart, giving a population of 10,000 per hectare. Supplying of missing stands was done two weeks after sowing. The supplied stands were not used for evaluation to avoid age differences.

Sources of mulching materials

The dry neem leaves were sourced from the University of Calabar premises *and* each sole treatment received a total of 3.6 kg of dry neem leaves. The oil palm bunch refuse was obtained from a palm oil mill located in Akamkpa Local Government Area in Cross River State; each sole treatment received a total of 20 kg of OPBR while the combination of OPBR + DNL treatment got half of each mulch material (i. e 1.8 kg DNL+10 kg OPBR/plot). The mulch materials were evenly spread on the soil surface.

Data collection

The weed density was determined using a 50 cm × 50 cm quadrat; it was placed randomly on a location per plot. The total number of weeds within the quadrat was counted *and* recorded at 4, 6, 8 *and* 10 weeks after sowing (WAS). The weeds within the quadrat were then harvested, sorted into different morphological group *and* the number within each recorded.

At each sampling period, all the harvested weeds within the quadrat were oven dried at 70°c to a constant weight to obtain the weed dry weight which was expressed in g/m^2.

Growth *and* yield parameters of fluted pumpkin were determined at 6, 8, *and* 10 WAP using four tagged plants in the net plot. The vine length was measured from 5 cm above the ground to the tip of the longest vine using a measuring tape, *and* the mean values recorded in centimeters. The number of leaves per plant was determined by counting all the leaves on the vines of each tagged plant *and* the average recorded. The leaf area was determined using the non-destructive linear method proposed by (Akoroda, 1993), which uses the equation:

$LA = 0.9467 + 0.275lw + 0.9724lwn$,

Where: LA = Leaf area

l = length of central leaflet,

w = maximum width of central leaflet

n = number of leaflets per leaf.

The vines with leaves were harvested fresh *and* weighed using a M-Metlar (M411L) electronic compact scale *and* the mean values expressed in tonnes per hectare (t/ha).

Data Analysis

All data collected were subjected to statistical analyses using the Analysis of Variance Method (ANOVA). The means were compared using the Duncan's New Multiple Range (DNMRT) at 5% level of probability.

RESULTS *AND* DISCUSSIONS

Weed density *and* weed morphological groups populations

The effects of integrated organic weed management methods on weed density *and* populations of the different weed morphological groups (broadleaves, grasses *and* sedges) in fluted pumpkin field are presented in Tables 1 *and* 2. Weed density *and* broadleaf weeds population increased over time from 4-10 WAS in all weed management treatments except the weed–free check. This increase could be as a result of periodic emergence of weed seedlings following l*and* preparation *and* soil disturbance through h*and* weeding operations. It has been observed that soil disturbance leads to increase in weed populations through scarification *and* bringing weed seeds buried in the soil to the top soil, thereby breaking their dormancy *and* triggering their germination *and* emergence (Nwagwu *et al.,* 2008; OKore *et al.,* 2001). In the case of the weedy check treatment, periodicity of weed seed germination might have played a dominant role, as earlier observed by Akobundu (1987). The population of grass weeds declined at 6 WAS in the weeded plots, *and* thereafter, tended to increase. This decrease in the population of grass weeds at 6 WAS is attributable to the weed management treatments applied, as the weedy check tended to increase in the number of grasses at the same period under review. The increase in grass weed population beyond 6 WAS is similar to the findings of Osadebe et al. (2015), who reported increases in weed infestation at the later stage of cropping, attributing it to waning efficacy of the weed management treatments over time.

There were no significant (p > 05) differences in weed density among the treatments at 4 WAS. Furthermore, there were no statistical differences in the populations of each of the broadleaves, grasses *and* sedges at 4-6 WAS, 4-8 WAS, *and* throughout the sampling periods, respectively. This finding suggests that the weed management methods adopted had similar suppressive effects on weed density *and* the weed morphological groups populations in the weeded plots. In the case of the weedy plots, the earlier emerged weeds coupled with the trailing vines of the fluted pumpkin, must have competed with, and/or smothered some later emerging weeds through shading, leading to similar weed density between the weedy plots *and* the weeded treatments at these early stages of the crop growth. This finding is in agreement with the result of Osadebe et al. (2014), who reported similarity in weed dry matter among weed management treatments at three weeks after transplanting.

At 6 -10 WAS, there were significant ($p < 0.05$) differences among the weed management treatments in weed density. The weedy check produced the highest weed density, while the weed-free treatment had no weeds visibly present within this period. These findings consistent with those of previous researchers (Okugie *et al.,* 1988; Orji *et al.,* 2015; Osadebe *et al.,* 2015), who recorded maximum weed densities in weedy-checks relative to weeded plots of *Telfairia occidentalis.* Similarly, Nwagwu et al. (2020b) reported significantly highest weed density in weedy cowpea plots compared with weeded treatments.

At 6 WAS, OPBR+DN+H_3, DNL+H_3 *and* DNL+H_1 significantly reduced weed density compared with the weedy-check. Also, at 8 WAS, the OPBR+DNL+H_3, OPBR+H_2 *and* DNL+H_1 significantly reduced the population of broadleaves. This finding indicates that the integration of oil palm bunch refuse and/or dry neem leaves with appropriate h*and* weeding regimes could effectively suppress weeds in fluted pumpkin field. Previous reports indicated that organic mulches of grasses *and* sawdust integrated with h*and* weeding two times enhanced weed suppression in fluted pumpkin field (Okugie *et al.,* 1988; Osadebe *et al.,* 2014; 2015). Similarly, oil palm bunch refuse (OPBR) mulch significantly reduced populations in a young rubber plantation (Hettiarachchi, 2019).

Weed **Dry Matter**

The weed dry matter was significantly ($p < 0.05$) affected by weed management methods at all sampling periods (Table 3). The WFC had the lowest weed dry matter (zero values), while the WC had the highest weed dry matter at each sampling period. Cumulatively, weed dry matter was similar among most of the integrated weed management plots, *and* compared favourably with the farmer's practice of h*and* weeding three times. This underscores the effectiveness of the integration of the dead organic mulched with at least one h*and* weeding in weed suppression in fluted pumpkin field, aligning with the findings of previous researchers on the weed suppressive effects of dead organic mulches. Osadebe et al. (2014) reported similar weed dry matter in sawdust-mulched plots supplemented with two h*and* weeding as those h*and* weeded every four weeks *and* the weed free treatments. Okugie et al. (1988) recorded better weed control under grass mulch than un-mulched plots. Leaving the plot weedy throughout the cropping season resulted in higher cumulative weed dry matter of 62.37 % *and* 73.39 % compared with the integrated weed management treatments *and* the farmers' practice of h*and* weeding three times, respectively. This finding agrees with previous reports that season-long weed competition results in highest weed dry matter in *Telfairia occidentalis* field (Okugie *et al.,* 1988; Osadebe, *et al.,* 2014; 2015), cassava field (Nwagwu, *and* Udo, 2019), *and* maize field (Nwagwu *et al.,* 2020a), relative to weeded treatments. Also, Hettiarachchi, (2019) obtained significantly better weed control under oil palm bunch refuse than the weedy control in a young rubber plantation.

Growth parameters of fluted pumpkin

There were no statistical ($p > 0.05$) differences in the number of leaves per plant *and* the number of branches per plant at 4 WAS (Table 4); a similar trend followed in vine length *and* leaf area (Table 5). This similarity among the growth characteristics at 4 WAS could be due to lack of severe competition between the crops *and* weeds at this period. It further suggests that the critical period of weed competition had not been attained at 4 WAS, as supported by the similarity in weed density across the weeded *and* weedy check at this early stage. This agrees with Osadebe et al. (2014), who obtained similar vine length among plots mulched with sawdust *and* h*and* weeded treatments up to two months after transplanting of *Telfairia occidentalis*.

Significant ($p < 0.05$) effects of weed management treatments on the vegetative performance of fluted pumpkin were observed from 6-10 WAS (Table 4). Generally, at this period, fluted pumpkin in the weeded treatments attained superior vegetative performance than these in the weedy check. The significant decline in vegetative characteristics (numbers of leaves, numbers of branches/plant, vine length, leaf area in the weedy check at 8 and 10 WAS could be attributed to competitive advantage of the weeds over the crop. At this period, weed density, weed dry matter were significantly highest in the weedy check compared with most of the weeded treatments. Consequently, crop vegetative performance became hampered as the weeds competed better for growth factors such as water, nutrients and sunlight. This finding suggests that the critical period of weed competition in fluted pumpkin in the area of study appears to start around 8-10 WAS. If weeding is not done up to this period, significant losses are inevitable in the vegetative performance of the crop. This finding agrees with that of Osadebe et al. (2015) who recorded suppressed vine length, number of branches *and* number of leaves of fluted pumpkin at 8 weeks after transplanting in weedy treatments.

Among the weeded treatments, OPBR+H_1 *and* DNL+H_1 produced significantly ($p < 0.05$) shorter vines at 10 WAS *and* significantly narrower leaf area at 8 *and* 10 WAS than those integrated with hand weeding 3 or 2 times. This could be as a result of grater weed competition in these treatments weeded once, but the crop was able to pick up later, possibly due to is inherent ability to smother weeds (NIHORT, 2020; Odiaka, *and* Shippers, 2004).

On the other hand, integrating the organic mulches with two or three h*and* weeding regimes demonstrated effectiveness in suppressing weeds for a longer period as seen in the relatively lower weed dry matter in those plots, *and* consequently resulted in better crop vegetative performance. Also, the organic mulches must have improved the soil conditions, leading to better crop performance (Obalum *et al.,* 2017; Okugie, *et al.,* 1988; Olaniyi *and* Ajao, 2011).

Vine yield

Table 6 shows the effect of integrated weed management on the vine yield of fluted pumpkin. The results indicate significant ($p < 0.05$) effect of the treatments at all harvest periods. The WFC had consistently the highest vine yield, statistically similar to OPBR+DNL+H3 at all sampling periods. Vine yield tended to decrease with decreasing weeding frequency in the mulched plots. Cumulatively, WFC produced the highest vine yield (17.87 t/ha), followed without statistical difference by OPBR+DNL+3HW (16.84 t/ha). The weedy check had statistically ($p < 0.05$) the lowest cumulative vine yield (5.20 t/ha), which was equivalent to 59.28 % reduction in vine yield compared with weeded treatments.

The significantly highest vine yield obtained from OPBR+DNL+H_3, similar to that of regular weeding, indicates the superiority of this integrated organic weed management treatment over the other combined treatments tested. This observation agrees with the findings of Oyekunle *and* Abosede (2012) who reported highest vine *and* fruit yields of fluted pumpkin from plots treated with neem compost, followed by those treated with *Tithonia* compost. In a related development, Nwagwu *and* Udo. (2019) obtained similar cassava root tuber yield when live mulch was integrated with hand weeding twice, relative to hand weeding three times without cover crop. Furthermore, Nwagwu et al. (2000) observed increased vegetative performance of cocoyam when weeds were managed by integrating mulching with tillage, compared with tillage without cover crop. The vegetable yield enhancement of fluted pumpkin by dead organic mulches is also linked to the ability of the mulches improve soil conditions *and* add nutrients to the soil upon decay, which the crop can utilize to improve its yield (Obalum *et al.,* 2017; Okugie *et al.,* 1988; Olaniyi *et al.,* 2011)

The relatively lowest yield obtained from the weedy check has demonstrated the detrimental effect of season-long weed competition with the fluted pumpkin crop. The high weed dry matter in weedy check implies denial of growth factors such water, nutrients and sunlight from the crop by the weed. Das (2013) noted that the relationship between weed dry matter and crop yield is linear inverse in nature. The more weeds are allowed in the farmland temporary, the more biomass the weed accumulate, and conversely, the less yield the competing crop attains. The present results are consistent with those of previous researchers (Okugie at al., 1988; Osadebe *et al.,* 2014; 2015). However, appreciable vine yield obtained from the weedy check agrees with the results of Osadebe et al. (2015), buttressing the observation that fluted pumpkin can effectively compete with weeds (NIHORT, 2020; Odiaka, *and* Shippers, 2004). The ability to produce appreciable yield under full-season weed pressure has been reported in other crops such as cassava (Nwagwu *and* Udo, 2019) *and* maize (Nwagwu *et al.,* 20220a). Generally, the fluted pumpkin vine yields obtained from this research agree with those of other researchers in the rainforest zone of southeastern Nigeria (Akata *et al.,* 2025; Akpan *and* Udo, 2017).

Conclusion

The findings of this study indicate that integration of oil palm bunch refuse with dry neem leaves *and* three h*and* weeding effectively suppressed weeds *and* enhanced the vine yield of fluted pumpkin above the recommended h*and* weeding three times, *and* is a suitable alternative to regular weeding.

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Table 1: Effect of Integrated Organic Weed Management on Weed Density *and* Broadleaf Weeds Population in Fluted Pumpkin Field

Treatment	Weed density (no/m^2)				Broadleaf population (no/m^2)			
	4WAS	6WAS	8WAS	10WAS	4WAS	6WAS	8WAS	10WAS
OPBR+DNL+H_3	17.00a	15.33b	32.33ab	41.67ab	6.00a	12.33a	22.33b	28.33ab
OPBR+ H_3	16.33a	21.00ab	34.33ab	45.33ab	4.67a	17.00a	25.33ab	29.33ab
OPBR+H_2	14.33a	23.33ab	34.33ab	30.67b	8.67a	15.00a	23.00b	20.33ab
OPBR+ H_1	12.33a	22.67ab	41.67ab	39.33ab	1.67a	14.00a	28.00ab	26.67ab
DNL+ H_3	10.67a	13.33bc	34.67ab	24.67b	7.67a	10.67a	26.67ab	19.00ab
DNL+ H_2	15.33a	24.00ab	49.00a	46.67ab	5.00a	19.00a	37.00a	31.33ab
DNL+ H_1	12.67a	20.00b	27.67b	43.33ab	4.67a	14.67a	19.67b	27.33ab
H_3	18.33a	27.67a	40.67ab	24.67b	1.33a	21.67a	32.00ab	16.00b
WFC	0.00a	0.00c	0.00c	0.00c	0.00a	0.00a	0.00c	0.00b
WC	16.67a	34.33a	49.00a	62.00a	9.67a	23.33a	38.33a	33.67a

Means with the same letter(s) in a column are not significantly different (P = 0.05) DNMRT
OPBR = Oil palm bunch refuse, DNL = Dry neem leaves, H3 = Hand weeding thrice, H2 - Hand weeding
twice, H1 = Hand weeding once, WFC = Weed free check, WC = Weedy check, WAS = Weeks after sowing.

Table 2: Effect of Integrated Organic Weed Control on Grass and Sedge Weed Population

Treatment	Grasses population (no/m^2)				Sedges population (no/m^2)			
	4 WAS	6 WAS	8 WAS	10 WAS	4 WAS	6 WAS	8 WAS	10 WAS
OPBR+DNL+H_3	10.67a	2.67a	7.00a	9.67bc	0.33a	0.33a	3.00a	3.67a
OPBR+ H_3	8.00a	4.67a	5.67a	11.33bc	3.67a	2.67a	3.33a	4.67a
OPBR+H_2	4.33a	6.67a	8.33a	7.67bc	1.33a	1.67a	3.00a	2.67a
OPBR+ H_1	10.67a	5.67a	9.33a	9.00bc	0.00a	3.00a	4.33a	3.67a
DNL+ H_3	2.00a	1.33a	5.67a	2.33bc	1.00a	1.33a	2.33a	3.33a
DNL+ H_2	7.00a	4.00a	8.00a	9.33bc	3.33a	1.00a	4.00a	6.00a
DNL+ H_1	5.00a	2.00a	6.00a	10.67bc	3.00a	3.33a	1.67a	4.33a
H_3	15.00a	4.33a	4.67a	6.33bc	2.00	1.67a	4.00a	3.33a
WFC	0.00a	0.00a	0.00a	0.00c	0.00	0.00a	0.00a	0.00a
WC	4.00a	5.00a	7.67a	23.33a	3.00a	6.00a	3.00a	4.67a

same letter(s) in a column are not significantly different (P = 0.05) DNMRT
OPBR = Oil palm bunch refuse, DNL = Dry neem leaves, H3 = Hand weeding thrice, H2 - Hand weeding
twice, H1 = Hand weeding once, WFC = Weed

free check, WC = Weedy check, WAS = Weeks after sowing

Table 3: Weed Dry Matter as Affected by Integrated Organic Weed Management in Fluted Pumpkin Field

Treatment	Weed dry matter (g/m^2)				
	4 WAS	6 WAS	8 WAS	10 WAS	Cumulative
OPBR+DNL+H_3	17.40bc	12.93bc	12.70c	18.40b	61.43b
OPBR+ H_3	17.07bc	11.97c	11.67c	15.80c	56.51b
OPBR+H_2	16.23bc	14.10b	13.60c	17.47bc	61.40b
OPBR+ H_1	15.53c	12.97bc	16.13b	17.80b	62.43b
DNL + H_3	17.50bc	13.07bc	13.73c	17.27bc	61.57b
DNL+ H_2	16.23bc	13.80b	13.90c	16.73bc	60.66b
DNL+ H_1	17.77b	11.77c	17.13b	18.53b	65.20b
H_3	16.13bc	12.47bc	11.33c	17.30bc	57.23b
WFC	0.00d	0.00d	0.00d	0.00d	0.00c
WC	26.47a	18.03a	25.80a	28.93a	99.23a

Means with the same letter(s) in a column are not significantly different (P = 0.05) DNMRT
OPBR = Oil palm bunch refuse, DNL = Dry neem leaves, H3 = Hand weeding thrice, H2 - Hand weeding
twice, H1 = Hand weeding once, WFC = Weed free check, WC = Weedy check, WAS = Weeks after sowing.

Table 4: Effect of Organic Weed Management on the Number of Leaves and Number of Branches Per Plant of Fluted Pumpkin

Treatment	Number of leaves/plant				Number of branches/plant			
	4 WAS	6 WAS	8 WAS	10 WAS	4 WAS	6 WAS	8 WAS	10 WAS
OPBR+DNL+H_3	35.63a	40.33b	73.17ab	53.33ab	0.00a	7.07ab	5.00ab	3.00a
OPBR+ H_3	43.43a	94.97a	79.00a	64.67a	1.00a	8.53a	6.33a	4.00a
OPBR+H_2	34.80a	64.97ab	54.33b	65.00a	0.67a	5.00b	3.00b	5.53a
OPBR+ H_1	37.47a	76.97ab	30.33b	62.67ab	0.57a	5.43ab	4.67ab	4.10a
DNL + H_3	34.33a	76.17ab	74.00ab	41.67b	0.33a	6.40ab	5.33a	4.33a
DNL+ H_2	28.13a	57.63b	62.00b	48.33b	0.00a	5.67ab	3.33b	4.87a
DNL+ H_1	26.00a	53.50b	39.67b	62.67ab	0.23a	5.13ab	2.67b	3.87a
H_3	38.77a	45.50b	72.00ab	57.67ab	0.33a	5.87ab	4.00ab	5.00a
WFC	28.80a	48.07b	60.33b	58.00ab	0.00a	7.00ab	4.00ab	3.33a
WC	26.33a	27.87b	10.00c	12.43c	0.43a	2.80b	1.00c	1.00b

Means with the same letter(s) in a column are not significantly different (P = 0.05) DNMRT
OPBR = Oil palm bunch refuse, DNL = Dry neem leaves, H3 = Hand weeding thrice, H2 - Hand
weeding twice, H1 = Hand weeding once, WFC = Weed free check, WC = Weedy check, WAS = Weeks after sowing

Table 5: Effect of Integrated Weed Control on Vine Length and Leaf Area of Fluted Pumpkin

Treatment	Vine length (cm)				Leaf area (cm^2)			
	4WAS	6WAS	8WAS	10WAS	4WAS	6WAS	8WAS	10WAS
OPBR+DNL+H_3	25.80a	79.23a	56.33a	56.33ab	42.83bc	39.93a	48.70a	48.70a
OPBR+ H_3	32.80a	86.90a	51.33ab	65.33ab	62.83a	41.87a	56.00a	56.00a
OPBR+H_2	27.37a	81.00a	51.33a	56.00b	44.03bc	48.33a	3.83a	53.83a
OPBR+ H_1	27.77a	61.57a	40.00b	40.33c	36.83c	32.97a	28.03b	28.03b
DNL + H_3	36.33a	75.43a	44.33b	54.67b	55.93ab	37.50a	60.93a	60.93a
DNL+ H_2	29.37a	82.10a	42.67b	63.33ab	45.20bc	47.67a	47.93a	47.93a
DNL+ H_1	25.03a	78.67a	49.83ab	42.00c	23.03c	30.97a	29.63b	29.63b
H_3	33.77a	62.77a	51.67ab	65.67ab	45.53bc	45.60a	57.67a	57.67a
WFC	31.03a	69.43a	44.33b	66.67a	50.17abc	41.93a	60.83a	60.83a
WC	26.47a	16.47b	8.00c	15.33d	26.77c	20.03a	27.00b	27.00b

Means with the same letter(s) in a column are not significantly different (P = 0.05) DNMRT
OPBR = Oil palm bunch refuse, DNL = Dry neem leaves, H3 = Hand weeding thrice, H2 - Hand weeding
twice, H1 = Hand weeding once, WFC = Weed free check, WC = Weedy check, WAS = Weeks after sowing.

Table 6: Effect of Integrated Weed Control on Vine Yield of Fluted Pumpkin

Treatment	Vine yield (t/ha)			
	6 WAS	8 WAS	10 WAS	Cumulative
OPBR+DNL+H_3	5.70ab	5.97a	5.17a	16.84a
OPBR+ H_3	4.93bc	5.00b	3.43bcd	13.36b
OPBR+H_2	4.13cd	3.50d	3.93b	11.56bc
OPBR+ H_1	3.43d	3.87cd	2.90de	10.20cd
DNL+ H_3	4.83bc	4.33c	3.70bc	12.86b
DNL+ H_2	4.87bc	4.27c	3.43bcd	12.57b
DNL+ H_1	3.43d	3.27d	2.53e	9.23d
H_3	3.67d	3.50d	3.27cd	10.44cd
WFC	6.07a	6.27a	5.53a	17.87a
WC	2.53e	1.37e	1.30f	5.20e

Means with the same letter(s) in a column are not significantly different (P = 0.05) DNMRT
OPBR = Oil palm bunch refuse, DNL = Dry neem leaves, H3 = Hand weeding thrice, H2 -
Hand weeding twice, H1 = Hand weeding once, WFC = Weed free check, WC = Weedy
check, WAS = Weeks after sowing

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