



EFFICACY OF PENDIMETHALIN AS WEED CONTROL ON IRRIGATED ONION IN LOKO, SONG LOCAL GOVERNMENT AREA, ADAMAWA STATE, NIGERIA

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ABSTRACT

Field experiments were conducted in 2013/2014 dry season under irrigation at Loko *Fadama* area, Song Local Government Area, Adamawa State, Nigeria, to determine the effects of Pendimethalin on the performance of onions (*Allium Cepa*). The experimental plots size were measured 2m x 3m (6m²) and a distance of 1m between replication; and 0.5m between plots with net plot size of 1.6m x 2.2m (3.52m²). The experiment consisted of three different rates of Pendimethalin of 2.02, 4.77 and 7.33 a.i/ha, along with hoe-weeded and unweeded checks, and replicated three times in Randomised Complete Block Design (RCBD). Results revealed that application of 4.77 and 7.33kg a.i/ha Pendimethalin rates significantly reduced weed density at 3, 6 and 9 WAT, but enhanced bulb diameter, bulb weight and yield; and economic returns. However, seedling establishment was not affected by the treatments.

Keywords: Experiment, irrigation, Nigeria, Onions, Pendimethalin.

INTRODUCTION

Onion (*Allium Cepa L.*) is a very important vegetable crop not only in Nigeria but all over the world. In terms of area of production, India has the largest under cultivation followed by China, United States of America (USA), Pakistan, Bangladesh and Indonesia (USAID, 2012). According to FAO (2012), the global production of onion was estimated at over 86.34 million metric tonnes. Going by specifics, CTA (2014) reported that China was by far the largest producing nation with an estimated output of 20, 507, 760 metric tonnes, then followed by India with output of 15, 118, 000 metric tonnes, USA had 3, 349, 170 metric tonnes and Egypt was fourth with total production of 1, 728, 417 metric tonnes. In Africa, Egypt ranked the highest producer of onion, followed by Algeria, while Nigeria was placed third with 621, 000 metric tonnes per year.

Onion is believed to have originated from Asia though it may have been growing in the wild on every continent of the world (Tanya, 2003). It is grown to about 175 countries under temperate, sub-tropical and tropical conditions. The crop's performances are significantly affected by temperature. Optimum ambient temperature for seedling growth is 20-25⁰ C, for vegetative growth is 13-14⁰ C, before bulbing is 15-21⁰ C and for bulb development is 20-25⁰ C (Netafim, 2011).

The demand for onion is worldwide. It is used both in raw and in mature bulb stage as vegetable and spices. The pungency in onion is due to a volatile oil known as allyl-propyl disulphide (Ghosh, 2004). It was documented by Rogers (1995) that onion is being consumed by athletes in large quantity because it lightens the balance of blood. Further, it has been prescribed to alleviate headaches, snake bites and even hair loss by physicians. Tanya



(2003) affirmed that today, onion has continued to be an important part of people's diet, and that it contains antioxidants that help cancer and appears to lower cholesterol.

With all these benefits accruable to onion, Ibrahim *et al.* (2011) noted that little prominence is accorded this crop, as there has been a remarkable decline in the production of onion in *Fadama* areas hitherto known as producing zones due to weeds problem. Traditional methods of weeds control especially hoe-weeding are the most common practices by farmers in the savanna ecological zones of Nigeria. Adigun *et al.* (2003) stated that this method is not only labour intensive and strenuous, but can also cause mechanical damage to the growing branches and roots of the plants. In addition to high cost, uncertainty of labour availability thus making timelines of weeding difficult to attain, is another huddle to battle with. These lead to greater yield loss.

As there is limited knowledge or information on the use of chemicals (herbicides) to control weeds on onion in the country (Ibrahim *et al.*, 2011), coupled with the massive dependence of farmers on the application of manual weeds control methods in Song Local Government Area (LGA), Adamawa State, Nigeria, there couldn't have been a better period for this study in the area than now. The findings would avail huge information for all stakeholders for the betterment of onion production, and by extension improve on the output.

MATERIALS AND METHODS

Environmental Site

The experiment was conducted at Loko Village in Song LGA, northern guinea savanna, Nigeria; a settlement that has a high concentration of onion farmers. The village lies at an altitude of 189.5m, latitude 9° 50' N and longitude 12° 13' E (Adamawa State Diary, 1989). It has mean annual rainfall of 2500mm with August or September being the peak periods. Hottest months are March and April, while coldest periods are between November and February. Loko community is dominated by Hausa, Yungur, Bata and Fulani ethic groups, but the most spoken language is Hausa. The economy is primarily based on peasant agriculture. The common crops grown during the rainy season are maize, millets, and rice among others. During the dry season, the farmers grow vegetable such as onion, pepper, tomato, sorrel, amaranthus and egg plants under irrigation in the *Fadama* areas. Other economic activities in the area include, weaving and dyeing.

Experimental Chemical

Scientific Name: N-(I-ethylpropyl)-3, 4 dimethyl-2, 6-dinitrobenzenamine

Common Name: Pendimethalin

Trade Name: Prowl, Herbadox, Stomp, Sipaxol, Go-Go-San, Way-up, Penoxalin, AC92557, Pendant and Missile.

Physical Properties: Orange-yellow crystalline solid with a faint nutty or fruit-like odour (USAID, 2012).

Molecular Formula: C₁₃H₁₉N₃O₄.

Chemical Family: Dinitroaniline.

Sources of Seeds and Pendimethalin

Onion seeds were procured locally from Jimeta Market in Adamawa State, Nigeria, while Pendimethalin 33% EC was obtained from a known Africa Agro-Chemical Company which is a registered dealer for quality assurance.

Treatments and Experimental Design

The experiment was laid out in RCBD with three replications. The treatments consisted three rates of Pendimethalin 2.02, 4.77 and 7.33 kg a.i./ha along with hoe-weeded and unweeded checks as control.

Plot size

Each plot measured 3m long and 2m wide (6m^2) with alley way of 0.5m distance between plots and 1m between blocks. The field layout of the experimental plots is shown explicitly in Figure 1.

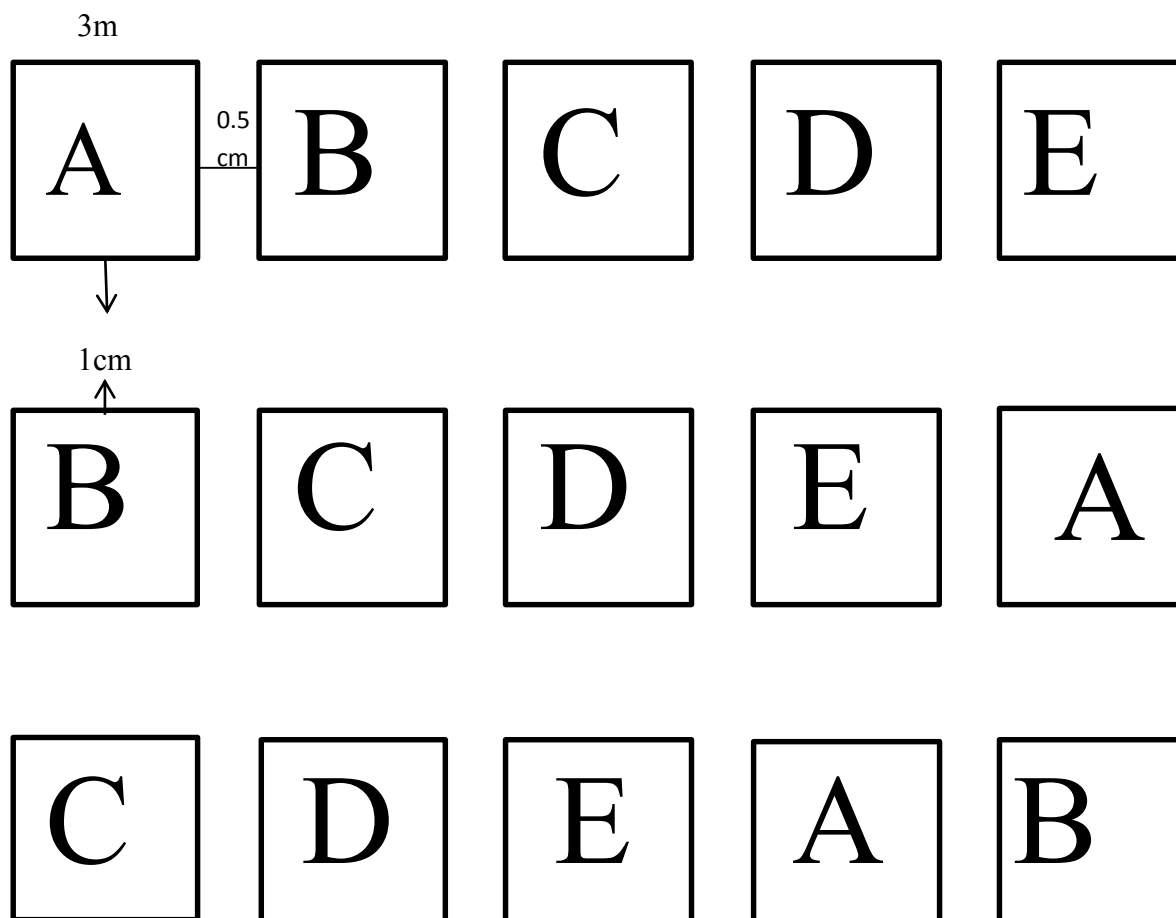


Figure 1: *Field Layout of Experiment*

Note: Treatment = *Pendimethalin Rates (kg a.i./ha)*; A = 0 (unweeded); B = 2.02; C = 4.77; D = 7.33; E = Hoe-weeded (check).

Land preparation

The field was first cleared, and burnt to sterilize the soil. Thereafter, it was cultivated using hand hoe. The prepared plots were left for two weeks for the sun to heat the soil in order to sterilize the plots before check basins are constructed.

Nursery bed preparation/seed sowing

A check basin was constructed as nursery bed and irrigated a day before sowing. The seeds were sown on the November 11, 2013 at about 1cm deep in grooves that were 10cm apart. Water was applied to the bed immediately after sowing of the seeds.



Mulching

The beds were mulched using grasses and paddy straw which were collected for the purpose. The mulch was removed seven days after seed germination.

Transplanting of onion seedlings

The onion seedlings were transplanted into the experimental plots on December 16, 2013, at 2-3 leaves stage. Transplanting was done into check basins at the spacing of 20cm between rows and 10cm within rows.

Application of herbicide

Herbicide was applied one Day after Transplanting (DAT) at the rate for each treating. A 20 litres knapsack sprayer with the application rate of 220 litres/ha was used.

Fertilizer application

Fertilizer was applied to all plots at the rate of 450, 600g and 300g per plot using NPK 20-10-10 just before transplanting. At 4 Weeks After Transplanting (WAT), second fertilizer was also applied using NPK 20-10-10 at the rate of 450, 600g and 300g/plot, respectively.

Weeding

The hoe-weeded treatment was done at 25, 50 and 75 DAT. Supplementary hand weeding was done at 50 DAT of the plots treated with Pendimethalin. Unweeded (control) plots were left without removing weeds as control treatment.

Irrigation of onion plots

At the initial growth periods, water was applied to the crops at the intervals of 3-4 days. But at the later stages of the growth, water was supplied to the crops at the interval of 7days upto maturity.

Data Collection

Weed density/m²

Weed density was assessed using a quadrat size of 0.3 x 0.5m at three points in each plot at 3, 6 and 9 WAT. The mean of density for each plot was expressed in number of weeds per m². The density of grasses, sedges and broad leaves weeds and the total weed were recorded.

Seedlings establishment count

The number of survived onion seedlings in each plot at 2 WAT was taken and expressed in percentage.

Onion bulb diameter (mm)

At harvest twenty bulbs were taken from each plot and their diameter were determined using digital verniercalipers. The mean diameter was recorded.

Weight of onion plants (kg)

The weight of onion plants from each plot at harvest was taken using graduated Salter measuring scale. The weight was then converted to yield per hectare.

Yield of onion bulbs

After curing of onion bulbs, the bulbs from each net plot was taken using a sensitive electrical scale and converted to yield per hectare.

$$\text{Yield} = \frac{\text{Weight of bulb/plot}}{\text{Plot size (m}^2\text{)}} \times 10,000\text{m}^2 \quad \dots (1)$$

Economic returns

This is the yield of onion at harvest converted to monetary values.

$$\text{Economic Returns} = \frac{\text{Yield/ha}}{67 \text{ kg (Weight of bag)}} \times \text{cost of bag of onion} \quad \dots (2)$$



Data Analysis

All data collected were subjected to statistical analysis using SAS software which separated the means using Duncan multiple range at 5% level of significance.

RESULTS AND DISCUSSION

Seedling Establishments Count and Weed Density

According to the results in Table 1, the rates of Pendimethalin had no significant effect on percentage stand count of onion seedlings. The results of weed density at 3, 6 and 9 weeks are presented in Table 1. The unweeded check exhibited the highest weed density, but was at par with the hoe-weeded treatment at 3 WAT. These two treatments gave significantly higher weed density than all Pendimethalin treated plots, which all sustained comparable weed density at this stage. At 6 WAT, the unweeded check also showed significantly higher weed density than all the other treatments. The hoe-weeded check and Pendimethalin at 4.77 and 7.33 kg active ingredients per hectare (a.i/ha) had comparable weed density. Application of 2.02 kg a.i/ha Pendimethalin gave the least weed density, which was appreciably lower than those of all the other treatments.

Table 1: Mean performance of onion seedling establishment and weed density at 3, 6 and 9 WAT in onion Plots at Loko 2013/2014 Irrigated Cropping Season

Treatment Pendimethalin Rate (kg.a.in/ha)	Seedling establishment (%)	Weed density/0.15m ²		
		3WAT	6WAT	9WAT
2.02	88.77	27.33b	35.33c	67.67a
4.77	91.20	23.33b	50.00b	52.00b
7.33	92.20	26.06b	34.33b	56.33b
Hoe weeded (check)	91.20	47.00a	59.67b	74.00a
Unweeded (check)	91.20	51.33a	75.67a	76.00a
S E ±	2.10	2.34	3.36	3.11
Level of significance	NS	*	*	*

Means followed by common letter(s) in each treatment group are not significantly different at 5% level of probability using Duncan multiple range test. * = Significance at 5 % level of probability; NS = Not Significant at 5% level of probability; WAT = Weeks after Transplanting.

At the 9 WAT Pendimethalin at 2.02kg a.i/ha, the unweeded checks recorded similar weed density that were all significantly higher than those of Pendimethalin at 4.77 and 7.33kg a.i/ha rates, which were both at par.

Diameter and Weight of Bulbs, Onion Yields and Economic Returns

As presented in Table 2, Onion bulb under the application of 7.33kg a.i/ha of Pendimethalin rate recorded the widest diameter which was appreciably wider than those of the unweeded check and the 2.02kg a.i/ha Pendimethalin rate. The unweeded check had the least bulb diameter. Similarly, the 7.33kg a.i/ha of Pendimethalin rate produced the heaviest bulb which were at par with those of the hoe-weeded check and the 4.77kg a.i/ha of Pendimethalin rate. All had heavier bulb weight than the 2.02kg a.i/ha of Pendimethalin rate, which in turn recorded considerably heavier bulb weight than the unweeded check.



The results on the yield of onion bulbs are also presented in table 2. It showed that the hoe-weeded check produced the highest bulb yield that surpassed the 2.02 kg a.i/ha of Pendimethalin rate and the unweeded check. However, it was comparable to the bulb yield of the 7.33 and 4.77 kg a.i/ha of Pendimethalin rates. The unweeded check exhibited the least yield. Similarly, the hoe-weeded check gave the highest economic returns which was significantly higher than the returns obtained from the unweeded check and the 2.02 kg a.i/ha of Pendimethalin rate (Table 2). All Pendimethalin rates gave comparable economic returns, whereas the unweeded check recorded the least economic return.

From the findings of this study it could be stated that, at all the rates used (2.02 – 7.33kg a.i/ha), Pendimethalin did not show appreciable reduction in plant establishment count. This indicates that transplanted onion can tolerate all these rates of Pendimethalin. Furthermore, the result revealed that all the rates of Pendimethalin reduced weed density below that of the unweeded check at 3 and 6 WAT. However, at 9 WAT, only the 4.77 and 7.33kg a.i/ha rates reduced weed density considerably below that of the unweeded check. It implies that, while Pendimethalin at 2.02kg a.i/ha can successfully control weeds in transplanted onion up to 6 WAT, its effectiveness declines with time. But the 4.77 and 7.33kg a.i/ha rates could suppress weed density up to 9 WAT.

Table 2: Mean Performance of Weight of Bulb with Leaves per Plot, Bulb Diameter and Economic Return of Onion Plots at Loko 2013/2014 Irrigated Cropping Season

Treatment Pendimethalin Rates (kg.a.in/ha)	Bulb Diameter (mm)	Mean Weight (g)	Yield (kg/ha)	Economic Return (₦)
2.02	51.02b	62.68b	4310.80b	208131b
4.77	55.28ab	83.32a	4777.60ab	231656ab
7.33	63.31a	100.32a	4846.50ab	234573ab
Hoe weeded (check)	58.49ab	97.93a	5173.40a	250046a
Unweeded (check)	21.83c	14.03c	1737.80c	3703c
S E ±	2.48	5.68	172.91	9519.78
Level of significance	*	*	*	*

Means followed by common letter(s) in each treatment group are not significantly different at 5% level of probability using Duncan multiple range test. * = Significance at 5% level of probability; SE = Standard Error

Also, these two rates were more effective in reducing density at 3 and 9 WAT than hoe weeding. It appears that the 4.77 and 7.33kg a.i/ha Pendimethalin rates could be promising rates for weed control in transplanted onion. Yaduraju *et al.* (2006) reported that when recommended dose of Pendimethalin is used to reduce the growth vigour and population of weeds, it puts the crop at an advantage in maximum resource utilization.

The lowest bulb diameter of 21.83mm was obtained from the unweeded check. This implies that weeds seriously affected bulb size and drastically reduced onion yield. This, according to Marwat *et al.* (2003), can be attributed to the efficacy of Pendimethalin in reducing weed infestation. These results are in agreement with the findings of Hassan and Malik (2002) and Jilani *et al.* (2007) who reported that maximum bulb diameter in onion was obtained from Pendimethalin treatments as compared to hand weeding and weedy checks. Application of Pendimethalin and hoe weeding had profound effect on the weight of bulbs. The lowest bulb weight was recorded in unweeded control treatment. The comparable bulb yield obtained from



4.77 and 7.33kg a.i/ha of Pendimethalin rates to the hoe-weeded treatment showed the effectiveness of Pendimethalin at these rates in the control of weeds in transplanted onion.

Furthermore, hoe-weeding was more expensive than the use of Pendimethalin. This concurred with the findings of Nazeer *et al.* (2004) that a very lucrative cost-effective gain was recorded due to the application of Pendimethalin on onion, and that the gain in yield from the hand-weeded plots was nullified by the additional cost of weeding. Plots treated with Pendimethalin had high quality bulb yield and plant vigour at harvest. Yaduraju *et al.* (2006) reported increased yield in onion obtained in plots with less weed infestation or farm weeded regularly. The economic returns on onion bulbs findings show that the use of Pendimethalin is more profitable in the production of onion than hoe weeding. This is similar to the findings of Kehinde (2002) who reported optimum and highest net returns in the use of Pendimethalin as herbicide on onion production.

CONCLUSION AND RECOMMENDATIONS

Based on the results of this study, it can be concluded that the herbicide, Pendimethalin at 4.77, and 7.33kg a.i./ha rates, and hand weeding treatments were the most effective in weed control and yield improvement in onion production. Thus, Pendimethalin at 7.33kg a.i./ha as pre-emergence herbicide could serve as suitable options for effective weed control in transplanted onion. The study also revealed that Pendimethalin as pre-emergence herbicide did not ensure season-long weed control, as its efficacy decreased with time.

The following recommendations pooled from the results of this study are stated below;

- i. Pendimethalin at the rates of 4.77 to 7.33 kg a.i./ha can be used by farmers on their transplanted onion in the area of study, and those with similarities in ecological conditions.
- ii. Since pre-emergence herbicide loses its efficacy with time, supplementary weeding such as hoe-weeding should be carried out to increase the yield of the crop (onion).
- iii. Similar research should be carried out using improved varieties so as to boost onion production in Adamawa State and places with similar environmental terrain.

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