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Evaluation of Diuron for Post Emergence Weed Control in Pineapples [*Ananas comosus* (L). Merr]

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Abstract

Field experiment was conducted between July and August 2007, at the pineapple plantation of the Teaching and Research Farm of the Federal University of Technology, Akure to evaluate the herbicidal efficacy of diuron in pineapple plantation. The experimental design was a Randomized Complete Block Design (RCBD) consisting of 5 treatments with 4 replications. Treatments were weedy check, diuron applied at 1.5, 1.75, 2.0 and 2.25 kg a.i $ha^{-1.}$ Results from the study showed that herbicidal efficacy on total weed density, weed fresh weight as well as dry weight increased with increasing concentration of diuron. Diuron at 2.25 kg a.i provided the optimum weed control. Regressing percentage herbicidal efficacy (Y) against increasing level of diuron (X) ($p \leq 0.001$) indicated significantly positive relationship with an average correlation coefficient (r) of + 0.97. It was concluded that although application of diuron at 2.25 kg a.i ha^{-1} gave the optimum weed control, it may be necessary to further evaluate diuron at higher rates to see whether weed control can be improved.

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Introduction

Pineapples [*Ananas comosus* (I) Merr.] belong to the family Bromeliacea. Pineapple is the second harvest of importance after banana, contributing to over 20% of the world production of tropical fruits (Coveca, 2002). Nearly 70% of the pineapple is consumed as fresh fruits in producing countries. They are believed to have originated from South America, although now widely distributed throughout the tropics and subtropics (Akobundu, 1987). Thailand, Philippines, Brazil and China are the main producers in the world supplying nearly 50% of the total output (FAO, 2004). Other important producers include India, Nigeria, Kenya, Indonesia, Mexico and Costa Rica and these countries provide most of the remaining fruit available. Pineapples are perennial herbs grown for their juicy fruits. It is one of the choicest fruits all over the world because of its pleasant taste and flavours. Pineapples are a good source of vitamin C and minerals like calcium, magnesium potassium and iron. It is also a source of bromelin, a digestive enzyme. In addition to being eaten fresh, the fruit can also be canned and processed in different forms (Batholomew et al., 2003)

Most small holder farmers in the tropics grow pineapples in home gardens and compound farms as an under storey component of home gardens. Pineapples are planted at densities of 40,000 – 65,000 plants per hectare in commercial farms with a spacing of 30 cm between plant and plant, 60 cm between rows and 90 cm between beds (Barbeau et al., 1994). However, pineapple cultivation remains limited in terms of area and production, from agronomic point of view (Barbeau et al., 1994), this observation can be explained by environmental constraints where the growing condition are far from the plants, soil/climatic requirements. Moreover, the reduced production areas are often seen to be linked with the poor availability of good planting materials, especially in the case of the development of a newly introduced variety.

Weeds constitute a major constraint in pineapple because the crop has a slow initial growth habit and full canopy is never attained (Akobundu, 1987). In Nigeria, cultural control methods using hand weeding and chemical control are by far the most widely practiced weed control methods in pineapples. However, hoe weeding can be a problem in an established pineapple plantation, particularly when varieties with prickly leaves are grown (Akobundu, 1987).

Additionally, damage to pineapple roots can occur if the weeding hoe digs deep into the soil, because the crop has fibrous and superficial roots. Therefore chemical weed control is a logical weed control method for use in pineapples plantations. Diuron is a non-selective herbicide mainly used for control of weeds in hard surfaces, such as roads, railway tracks and paths (at around 3 kg/ha) and to control weeds in crops such as pear, and apple trees, forestry ornamental trees and shrubs, pineapples, sugarcane, cotton, alfafa and wheat (at low rates of around 1.8 kg/ha a.i (Giacomezz and Cochet, 2004). The present study aimed to evaluate the herbicidal efficacy of diuron for post emergence treatment in a pineapple plantation.

Materials and Methods

The study was conducted at the Teaching and Research Farm of the Federal University of Technology, Akure (7^0 16'N, 5^0 12'E) located in the rainforest vegetation zone of Nigeria during the early cropping season of the 2007. The average annual rainfall is about 1300 mm with a mean temperature of 27^0C and the climate is of the sub-humid type. The pineapple plantation was established in 2001 with suckers of smooth cayenne and planted at the standard spacing of 0.9m x 1.0 m. the soil at the site in the year was a sandy clay loam. Chemical; analysis of the soil at 15 cm depth before treatment application commenced is given in Table 1. In the year, the experiment consisted of five treatments: (i) a weedy check where there was no application of herbicide during the experimental period, (ii) diuron applied singly ay 1.5 kg a.i ha^{-1}, (iii) 1.75 kg a.i ha^{-1}, (iv) 2.0 kg a.i ha^{-1}, (v) 2.25 kg a.i ha^{-1}. The main weed population in the experimental area that year comprised: *Ipomea batatas, Synedrella nodiflora, Sida acuta, Aspilia africana, Calopogonium mucunoides, Spigelia anthelmia, Ageratum conyzoides, Euphorbia heterophylla, Cormellina diffusa,* and *Talinum triangulare;* prominent among which were *Talinum triangulare, Cormellina diffusa,* and *Euphorbia heterophylla*. Weed control assessment was conducted after herbicide application 6 WAT to determine the weed spectrum, density, and weight of total as well as individual weed species using 50 x 50 quadrats along a diagonal in each plot from which weed samples were collected and analyzed for the foregoing parameters. Collected weed samples were bulked, separated by species, counted, oven-dried at 89 ^{0}C for 48 hrs and subsequently weighed. Percentage herbicidal efficacy on total as well as on individual weed population including their fresh and dry weights were determined using the Abbot formula based on non-uniform weed infestation in the plots before herbicide application. The use of this formula to determine herbicidal efficacy can result in negative percentage values if weed infestation for particular weed species is higher in the treated plots than in the reference weedy check plots following treatment application.

In such a situation, percentage data values should be coded to facilitate arc sine transformation recommended for percentage-based data prior to the analysis of variance (ANOVA). It is recommended that the reference check plots that are often arbitrarily given a rating of zero be excluded from the ANOVA since the arbitrarily assigned values of zero have no variance. Their variance therefore differs from that of other treatments, so that the assumption of homogeneity of variance is automatically violated (Little and Hills, 1978). Data on weed density were normalized prior to ANOVA using the square-root transformation and those on percentage herbicidal efficacy on individual weed populations were coded by adding 100 and dividing by 10 prior to arcsine transformation and ANOVA; since these data were negative for some weeds, particularly the *E. heterophylla, C. diffusa and T. triangulare*. Simple linear correlation and regression between herbicidal efficacy on weed growth parameters (Y) and increasing rate of diuron was carried out.

Results

Data collected during the experiment are summarized in Tables 1-6. The physic-chemical properties of the soil at the experimental site (Pineapple plantation) are presented in Table 1. The results showed that the soil was moderately acidic with a pH of 6.0. In that year, there were significant differences (p≤0.05) amongst the treatment in weed density; weed fresh weight and weed dry weight at 6WAT application (Table 2). The foregoing parameters were significantly higher (p≤0.05) in the weedy check plots compared with the remaining treatments. Weed density was also observed to decrease with increasing rate of application of diuron. Simple correlation and linear regression between weed growth parameters (Y) and increasing rates of diuron (X) (n=4) indicated significant (p≤0.05) negative relationships (Table 3). Assessment of total herbicidal efficacy based on the Abbot formula showed that there were significant differences amongst treatments in terms of percentage weed control either by density, weed fresh weight or weed dry weight respectively (Table 4). Diuron applied at the rate of 2.25 kg a.i ha^{-1} showed a better performance than the other rates. Regressing herbicidal efficacy (Y) against increasing concentration of diuron (X) showed positive relationship for percentage weed controlled by weed density, weed fresh weight and weed dry weight (Table 5). Herbicidal efficacy on individual weed species based on weed density varied amongst treatments (Table 6).

Most of the weeds prevalent in the plots were efficiently controlled by most treatments except *T. triangulare*, *E. heterophylla* and *C. diffusa*. Percentage weed control led by density varied from 12.50% to 100%. *I. batatas, S. nodiflora, S. acuta, A. africana, C. mucunoides, S. anthelmia* and *A. conyzoides* were controlled 100% where they occurred. Most of the treatments proved highly effective in reducing weed population in the treated plots compared with the weedy check. However, the diuron treatment not only failed to control *E. heterophylla, C. diffusa* and *T. triangulare* but also significantly increased their population over those observed in the weedy control which resulted in their having negative percent efficacy values (Table 6).

Table 1. Nutrient status and pH of the experimental site

Year	pH	N (%)	P (mg kg^{-1})	K	Ca	Mg
				Mmol kg^{-1} soil		
2016	6.0	0.25	10.00	4.5	48.6	24

Table 2. Weed density, weed fresh weight and weed dry weight as affected by treatment application

Treatments	Weed density (nom^{-1})	Weed fresh weight (gm^{-2})	Weed dry weight (gm^{-2})
Weedy check	243.8	1230.5	170.0
Diuron @ 1.5 kg a.i ha^{-1}	74.8	634.0	74.3
Diuron @ 1.75 kg a.i ha^{-1}	54.5	284.5	61.5
Diuron @ 2.00 kg a.i ha^{-1}	44.0	273.0	54.5
Diuron @ 2.25 kg a.i ha^{-1}	35.5	205.5	36.5
LSD (P≤0.05	0.15	33.48	11.59

Table 3. Simple correlation and linear regression between weed growths parameters (Y) and increasing rates of diuron (X) (n=4)

Growth parameter	Correlation coefficient (r)	Regression equation
Weed density	-0.98	Y = 148.9-25.8X
Weed fresh weight	-0.87	Y = 1322-259.4X
Weed dry weight	-0.99	Y = 147-24.1X

Table.4 Total percentage efficacy of diuron after treatment application

Treatments	% control by density	% control by fresh weight	% control by dry weight
Weedy check	0.00	0.00	0.00
Diuron @ 1.5 kg a.i ha^{-1}	69.3	48.5	56.4
Diuron @ 1.75 kg a.i ha^{-1}	77.6	69.4	63.9
Diuron @ 2.00 kg a.i ha^{-1}	82.0	77.8	68.0
Diuron @ 2.25 kg a.i ha^{-1}	85.6	83.3	78.5
LSD (P≤0.05	1.53	0.90	6.52

Table.5 Simple correlation and linear regression between weed growths parameters (Y) and increasing rates of diuron (X) (n=4)

Growth parameter	Correlation coefficient (r)	Regression equation
Weed density	0.97	Y = 38.65 + 10.66X
Weed fresh weight	0.95	Y = 14.85 + 22.56X
Weed dry weight	0.99	Y = 1.9 + 14.08X

Table.6 Percentage efficacy (%) on individual weed species after treatment application

Treatment	*Ipomoea. batatas*	*Synedrella nodiflora*	*Sida acuta*	*Aspilia africana*	*Calopogonium mucunoides*	*Spigelia anthelmia*	*Ageratum conyzoides*	*Euphobia heterophylla*	*Commelina diffusa*	*Talinum triangulare*
Diuron@ 1.5kga,iha^{-1}	25	50	75.0	37.5	41.7	75.0	25	-49.0	-244.5	-0.75
Diuron@ 1.75kga,iha^{-1}	25	50	72.5	75.0	47.2	75.0	25	63.0	-55.8	-267.5
Diuron@ 2..00kga,iha^{-1}	25	50	75.0	75.0	50.0	68.8	25	-83.8	-98.8	-200
Diuron@ 2..25kga,iha^{-1}	25	50	75.0	50.0	50.0	71.9	25	-66.8	-107.5	-110.8

Discussion

The significant differences observed amongst the treatments in terms of weed fresh weight and weed dry weight at 6 WAT indicate that the extent of weed growth in the treatment varied with increasing rates of diuron. Weed growth decreased more or less significantly in the order of increasing rate of application of diuron presumably because high doses implies higher quantity of active components available to cause control (Akobundu, 1987).

The mechanism of action of diuron involved the blocking of the Hill reaction and electron transport during the non-cyclic electron flow in photosynthesis (Diuron fact sheet, 1983). This may have accounted for the observed reduction in weed growth parameters and increasing rates of diuron application. Total percentage herbicidal efficacy as measured by percent control by density, weeds fresh and weed dry weight was found to increase with increasing rates of diuron in the treatments. The significant difference indicated amongst treatments in herbicidal efficacy on individual weed species showed that there was considerable variation among the weeds in terms of their relative susceptibility.

The observed presence of some weeds e. g *Talinum triangulare, Cormellina diffusa,* and *Euphorbia heterophylla* even at the highest dosage level tend to also suggest that these weed species may have re-grown from other plant parts apart from the roots since diuron is absorbed principally through the root (Akobundu, 1987).

However, the results suggest diuron could be evaluated at higher doses to see whether better weed control can be achieved. Alternatively, it may be used in combination with other compatible herbicides in tank mixes to broaden the spectrum of weed control.

Conclusion

It was concluded that although application of diuron at 2.25 kg a.i ha^{-1} gave the optimum weed control, it may be necessary to tank mix diuron at reduced rate with other compatible herbicides to broaden the spectrum of weed control.

Conflict of interest statement

Authors declare that they have no conflict of interest.

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