EVALUATION OF *IMPERATA CYLINDRICA* GROWTH PARAMETERS IN RELATION TO ECOTYPE AND WEEDING FREQUENCY

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ABSTRACT

Imperata cylindrica "speargrass" is a noxious weed that suppresses the growth and development of field crops; thus, a pot experiment laid out in a split-plot RCBD replicated four times was conducted in 2022 at the research farm of Michael Okpara University of Agriculture Umudike to evaluate its growth parameters in relation to ecotypes and weeding frequency. The main plot factor was three ecotypes from Anambra,Abia and Ebonyi States. The subplot factor was the weeding frequency which consisted of (1) unweeded (control),(2) two-hand weeding at 2 and 4 weeks after Sprouting WAS, (3) three-hand weedings at 2,4 and 6 WAS, (4) four-hand weedings at 2,4,6and 8 WAS, (5) five-hand weedings at 2,4,6, 8 and 10 WAS and (6) six-hand weedings at 2,4,6,8, 10 and 12 WAS. Overall, there were significant differences ($\leq$ 0.5) among ecotypes. The ecotype 3 had the highest rhizome length, especially in the unweeded plots. The study also revealed that ecotype 2 had the highest number of rhizome nodesper meter square in the unweeded plot compared to other ecotypes. Rhizome length and node number, shoot and bud density decreased with an increase in the weeding frequency in all the ecotypes. Plots weeded five times showed a drastic reduction in all the growth parameters compared to the other weeding frequencies suggesting that at least up to five hoe weedings are required to control the weed under a non-crop situation.

Keywords: *Imperatacylindrica*, ecotypes, weeding frequency, rhizome.

INTRODUCTION

Speargrass,*Imperata cylindrica* [L.] is a perennial rhizomatous C4 grass from the Poaceae family. It is a monocarpic, strong, colonizing and competitive weed in the humid savannah of sub-Saharan Africa *(*Avav and Okereke,1997*)*. It produces mainly vegetatively from underground stems called rhizoms that contain vast amounts of carbohydrates. Speargrass regenerates rapidly after the foliage has been burnt or slashed. The aggressive and persistent behaviour of this noxious weed is mainly related to its underground network of rhizomes, which have buds that are capable of growing out even when herbicides are applied (Wong,1973).Rhizomes have a high regenerative ability because of the numerous buds that rapidly sprout into new shoots after fragmentation by tillage or any other form of disturbance(Holm *et al*., 1977).

Speargrass's aggressive and invasive nature is attributed to its rhizomes, the primary mechanism for local regeneration and spread (Ekeleme*et al.,* 2004). The rhizomes' hard, sharp points (ramets) penetrate other plants' roots, bulbs, and tubers, leading to infection (MacDonald,2004).

Yields of annual crops are severely reduced by competition from speargrass. It causes a yield reduction of 51-62 % in maize when the crop is weeded 2-4 times (Akobundu and Ekeleme, 2000). Complete crop failure usually occurs when crops are grown in slashed plots without additional weeding. In cassava, yield losses of 50-90 % have been reported (Chikoye*et al.*, 2001), and in soybean, Avav (2000) reported losses of 29-53 % in the middle belt of Nigeria.

Controlling speargrass in smallholder farms is very difficult; hence, infestation has been reported to cause high crop yield reduction (Chikoye*et al.,* 2001). Because poor control of speargrass leads to severe crop losses, there is a need to develop effective and sustainable methods for managing the harmful effect of speargrass on root and tuber crops, especially cassava, yam and other annual crops. Udensi *et al.*(1999) have reported the existence of technologies for speargrass control in large estates and commercial farms where there is ample supply of labour, herbicides and capital. Nevertheless, its use in small-scale farmers is still tricky because of the high cost of delivery, inadequate skill in the use of pesticides and lack of technical support for resource-poor farmers (Chikoye*et al.*, 2001). More information on speargrass biology, especially on the soil rhizome bud bank characteristics and behaviour, is required to improve its management and control.

The objective of the study was to evaluate the growth parameters of *Imperata cylindrica* in relation to ecotype and weeding frequency. The specific objectives of this study are to:

1. Assess the effect of speargrass ecotype and weeding frequency on rhizome length and biomass.
2. Assess the effect of speargrass ecotype and weeding frequency on shoot density and biomass.
3. Assess the effect of ecotype and weeding frequency on speargrass node number and bud bank population.

MATERIALS AND METHODS

EXPERIMENTAL DESIGN AND FIELD LAYOUT

A pot experiment was conducted in 2022 to evaluate the effect of ecotype and weeding frequencies on speargrass growth parameters at the Michael Okpara University of Agriculture Umudike, research farm, Abia state, Nigeria. The research farm is located in the humid forest agroecological zone of Southeastern Nigeria, with an average annual temperature of 29^{0}C. The experimental design was split plot in RCBD replicated four times. The main plot factor was three speargrass ecotypes from Anambra, Abia, and Ebonyi States (from now on, referred to as Ecotype 1, Ecotype 2, and Ecotype 3, respectively). The subplot factor was six levels of weeding frequencies, namely:

(1) Unweeded control,

(2) Hand weeded manually twice at 2 and 4 weeks after sprouting (WAS),

(3) Hand weeded manually three times at 2,4 and 6 WAS,

(4) Hand weeded manually four times at 2,4,6 and 8 WAS,

(5) Hand weeded manually five times at 2,4,6,8 and 10 WAS and

(6) Hand weeded manually six times at 2,4,6,8,10 and 12 WAS.

Source of Planting Material, Pot Preparation and Planting

Speargrass rhizomes were collected from three ecological zones (Anambra,Ebonyi and Abia States). The fresh rhizomes were cut into segments having five visible buds. The length of each fresh rhizome segment was measured and weighed using a sensitive weighing balance. Each potused in the experiment had a height of 0.23m, an upper radius of 0.12 meters and a bottom radius of 0.085m. The volume of the experimental pot was 0.00645m^3 or 6.45 liters. The pots were perforated at the bottom for adequate infiltration and filled with soil to the top. Two rhizome segments with five buds each were planted in each pot immediately after cutting at a depth of 1cm to prevent desiccation. The pots were laid out in the field in a split-plot design. There was a 50cm alley between speargrass ecotypes and 50cm between pots. Hand weeding was carried out at 2 weeks intervals after sprouting using a scissors to cut off the shoot from the base of the pot

SOIL ANALYSIS

Before planting, soil used for planting was collected randomly at a 0 -15 cm depth along a belt transect at the same sites where the different speargrass ecotypes were collected with a soil auger. The soil samples were air-dried and sieved through a 2mm sieve before being taken to the laboratory. The physical and chemical properties of the soil were determined at the soil science laboratory of Michael Okpara University of Agriculture Umudike.

DATA COLLECTION

The following data were collected before weeding, starting at Two weeks after sprouting (2WAS) and continuing until twelve weeks after sprouting (12WAS):

(1) Number of Shoots: Speargrass shoots were counted every two weeks before weeding in each pot.

(2) Plant average height: Five plants were tagged for data collection in each pot. The height of each plant was measured with a ruler from the soil surface to the tip of the longest leaf. Plant height was measured every two weeks.

(3) Leaf dry weight: The leaves were harvested at 2,4,6,8,10, and 12 WAS, air dried, tied together with a rubber band to obtain a uniform shape and weighed using a sensitive weighing balance to get the dry leaf weight.

(4)Number of buds: The number of buds on the rhizome in each pot were measured at 12 WAS. All the rhizomes in each pot were harvested and washed with water, and the number of buds on the rhizomes was counted.

(5) Rhizome length: The experiment was terminated at 12 WAS, and the length of the rhizomes in each pot was individually measured with a ruler.

(6) Rhizome dry weight: At 12WASthe rhizomes harvested from each pot were dried and weighed after the bud number and rhizome length were measured.

Statistical analysis

Data collected was subjected to analysis of variance(ANOVA) using SAS, version 12.1. Significant treatment means were compared using Fisher's Least Significant Difference (LSD) at a 5% probability level.

RESULTS AND DISCUSSION

RESULTS

Soil physical-chemical properties used in the experiment.

The physical and chemical properties of the soil used for the experiment is presented in Table (4.1). The textural class of the experimental site was found to be sandy clay-loamy with a particle size distribution of *23% clay, 6% silt and 71% sand*. The average pH of the soil was 5.2. This shows that the soil is well-drained but acidic. The soil chemical analysis indicated that the soil is deficient in nitrogen (0.1%), potassium (0.22cmol/kg) and magnesium (1.2mol/kg). The soil showed sufficient amount of phosphorus (26.5mg/kg) which is above the critical level of 15mg/kg. The organic matter content is moderately low (2.2%) but slightly above the critical level of 2.0%. The soil was acidic and moderately fertile but deficient in some essential element like nitrogen, magnesium and potassium.

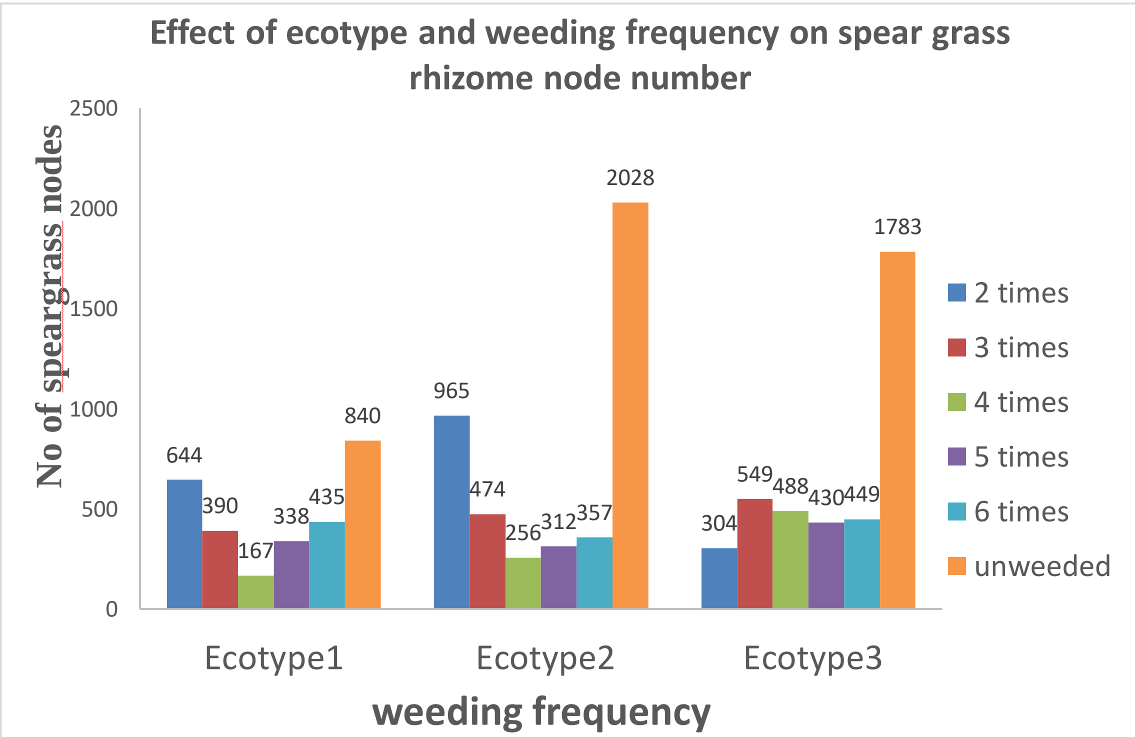
Table 4.1: Soil physic-chemical properties of the soil used in the experiment

Properties	Composition
Particle size distribution (%)	
Sand (%)	71.0
Silt (%)	6.0
Clay (%)	23.0
Textural class	Sandy Clay-loam
Chemical properties	
pH in H_2O	5.2
Organic C (%)	1.27
Organic M (%)	2.20
Total N (%)	0.10
Available P (mg/kg)	26.5
Ca (Cmol/kg)	2.40
Mg (Cmol/kg)	1.20
K (Cmol/kg)	0.22
Na (Cmol/kg)	0.12
Exchangeable acidity (Cmol/kg)	1.00
ECEC (Cmol/kg)	4.94
Base Saturation	80

Ecotypes and weeding frequency effects on speargrass rhizome node number.

The result of the effect of weeding frequency on speargrass rhizome node number is presented in Figure4.1.Theunweeded plots had the highest rhizome node number compared to the weeded plots. This indicates that weeding reduced the number of nodes in all the ecotypes. This finding is in line with the finding of Eshetu and Addisu (2015), who opined that irrespective of the genetic background of speargrasses, unweeded plots could enhance the competition rate and, hence reduce crop yield.The result showed that ecotype 2 (from Abia State) had the highest number of rhizomenodesper meter square in the unweeded plot compared to other ecotypes. This shows that ecotype 2 was more aggressive and invasive and can cause higher crop yield losses in the farm if not properly managed. Increased weeding frequency reduced the rhizome node numbers in all the ecotypes. This shows that hand weeding is a good control measure for spear grass. Weeding four times drastically reduced the rhizome node number in all the ecotypes.

Figure 4.1. The effect of speargrass ecotype and weeding frequency on speargrass rhizome node number



Ecotypes and weeding frequency effects on speargrass shoot density.

Although Ecotype 3 (from Ebonyi State) had the highest number of shoot densities among the three, especially the unweeded plots, there were no significant differences in shoot density (≤ 0.5)among the ecotypes irrespective of the weeding frequency(Figure 4.2). This suggests that, in this particular context, genetic variations among ecotypes did not play a major role in determining shoot density. This highlights the importance of effective weed management practices in controlling speargrass population irrespective of the ecotype.

There were significant differences (≤ 0.5) in shoot density among the weeding frequencies. This shows that the higher the weeding frequency, the lower the shoot density in all the ecotypes. The higher shoot density observed in the unweeded treatment might be due to high weed density, which allowed the weeds to compete vigorously for nutrients, space, light, water, and carbon dioxide, resulting in higher biomass production. Also, the uninterrupted growth of the weeds in the unweeded plots might have offered increased utilization of various growth factors. The observation made in the present study was in accordance with the findings of Vissoh*etet al*. (2008), who observed that without management (unweeded), speargrass shoots and rhizome biomass increased by 31 % per month.Weeding 5 to 6 times reduced the shoot density significantly in all the ecotypes.

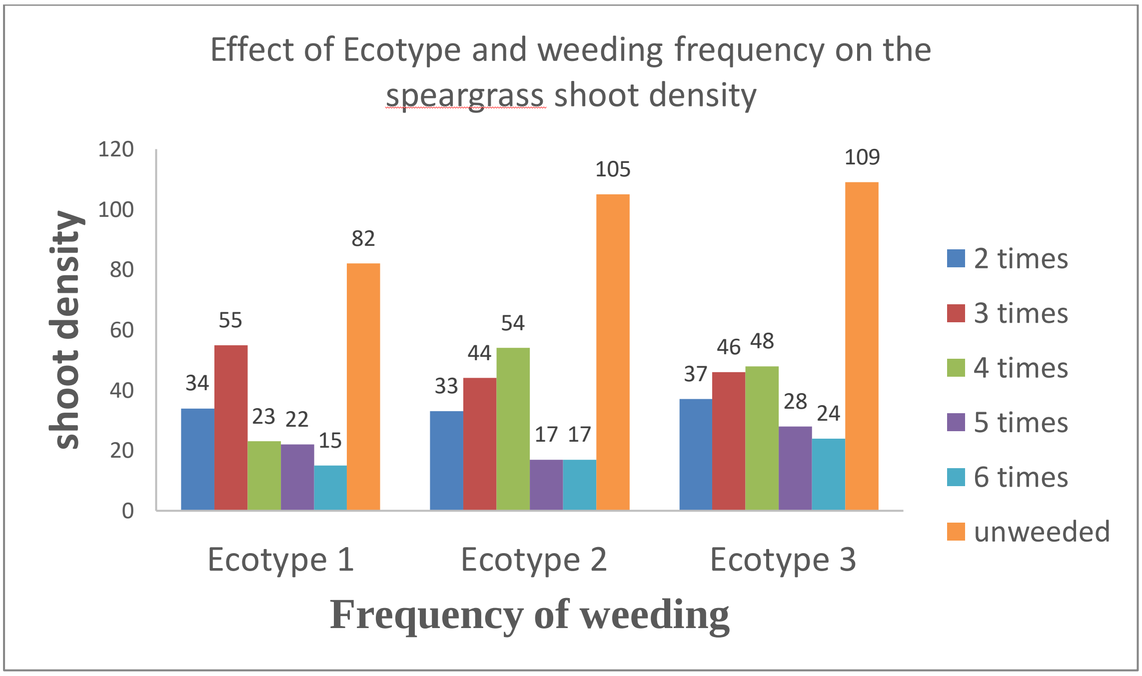
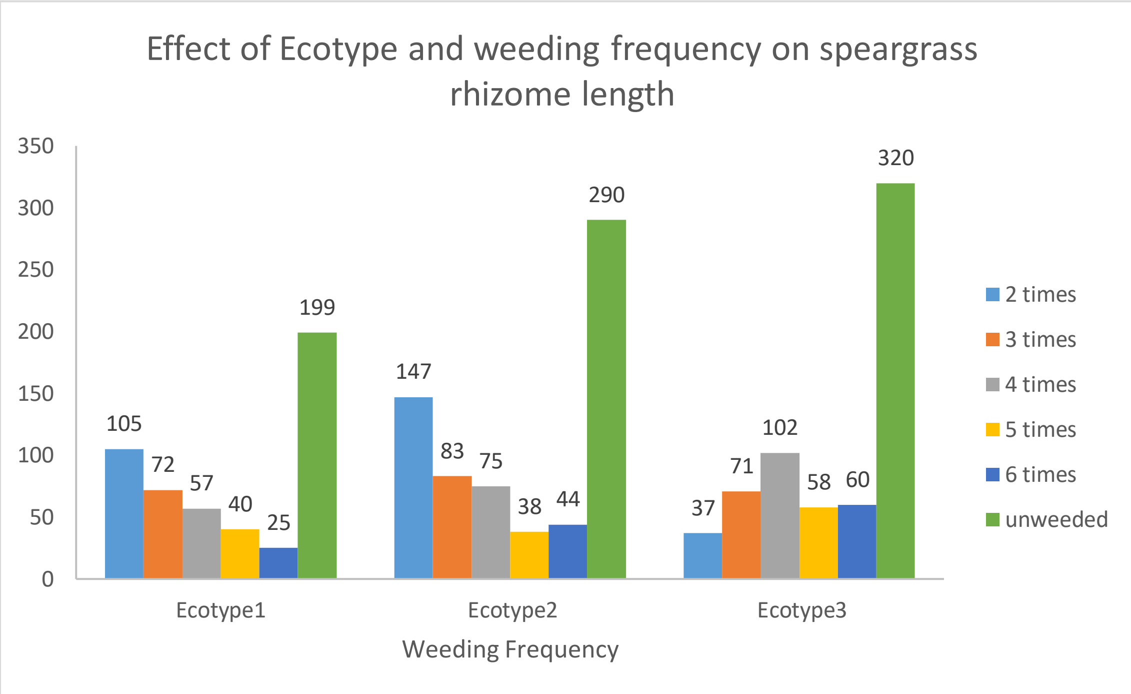


Figure 4.2. The effect of speargrass ecotype and weeding frequency on speargrass shoot density

Effect of Ecotype and weeding frequency on speargrass rhizome length

Figure 4.3 presents the average speargrass rhizome length of the different ecotypes. The rhizome length was significantly different among speargrass ecotypes. Ecotype 1 from Anambra State produced shorter rhizomes, while ecotypes 2 and 3 produced rhizomes of comparable length.The unweeded plots had the highest rhizome lengths in all ecotypes (Figure 4.3). The higher rhizome length observed in the unweeded treatment plot could enhance the competition rate and hence reduce crop yield, as also observed by Eshetu and Addisu (2015).The effect of speargrass ecotype and weeding frequency on speargrass rhizome length revealed that increasing the frequency of weeding significantly decreases speargrass rhizome length. This indicates that frequent weeding practices effectively suppressed the growth and elongation of speargrass rhizomes, leading to shorter rhizomes. While the interaction between ecotype and weeding frequency was not significant, some trends were observed. Ecotypes 1 and 2 tended to have decreasing rhizome lengths with increased weeding frequency, while ecotype 3 showed more fluctuation. Ecotypes 2 and 3 consistently produced rhizomes of comparable length, indicating genetic consistency between these locations. However, ecotypes 2 and 3 had longer rhizomes than ecotype 1 in the absence of weeding. These results also highlight the importance of weed management practices in controlling speargrass rhizome length and suggest that genetic differences between ecotypes may influence rhizome growth under different weeding frequencies.The plots weeded 5 to 6 times had the lowest speargrass rhizome lengths for all the ecotypes. Rhizome lengths in plots that received 5 and 6 weedingsdid not differ significantly (≤ 0.5) in the three ecotypes. This shows weeding 5 times is enough to reduce the rhizome length drastically and there for a very effective control against speargrass.

Figure 4.3. Effect of ecotype and weeding frequency on speargrass rhizome length



Effect of ecotype and weeding frequency on bud density

There were significant differences (≤ 0.5) in bud density among the ecotypes (Figure 4.4).The effect on weeding frequency on rhizome bud density was significant within ecotypes (Figure 4.4).Ecotype 2 (Abia) had the highest number of bud density per meter square among the unweeded plots. This shows that the genetic variations among the ecotypes affected bud production, with ecotype 2 showing higher bud production potentials, especially on the unweeded plot, compared to other ecotypes.The effect of weeding frequency on the rhizome number of buds also provides insight into how weed management practices influence the reproductive capacity of speargrass. The result showed that increasing weeding frequency significantly decreased the number of buds on speargrass rhizomes in all the ecotypes. The highest number of buds was observed in the unweeded plots, indicating that the absence of weeding allowed for the highest reproductive capacity of speargrass. The number of buds on speargrass rhizomes serves as an indicator of its reproductive potential. A higher number of buds means a more significant potential for vegetative spread and proliferation of speargrass. The significant reduction in rhizome number of buds with increased weeding frequency underscores the importance of weed management practices in controlling speargrass populations. Weeding 5 times had the lowest bud density in all the three ecotypes. This shows that frequent weeding effectively suppresses the reproductive capacity of speargrass, limiting its ability to spread and establish new plants.

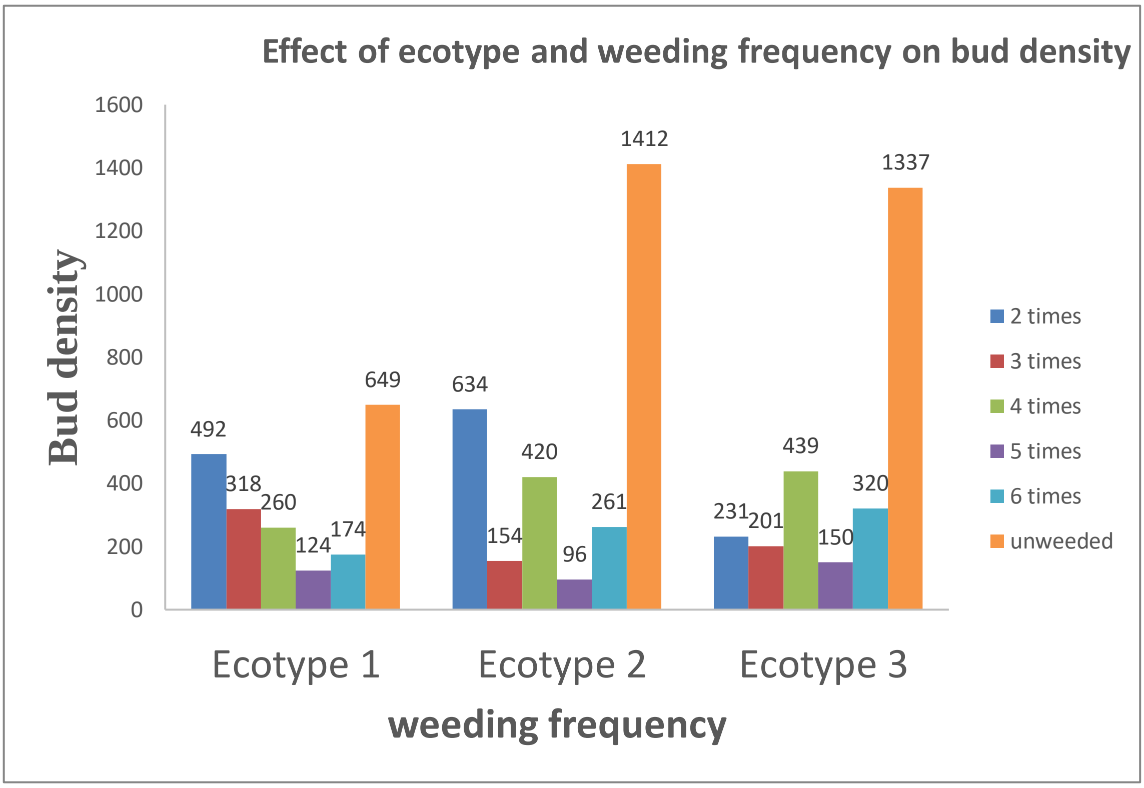


Figure 4.4 Effect of ecotype and weeding frequency on bud density

CONCLUSION AND RECOMMENDATIONS

Speargrass,*Imperata cylindrica* [L.] is a noxious, perennial rhizomatous grass .It produces mainly vegetatively from underground stems called rhizomes which have buds that can grow out even when weeded (Wong,1973).The work studied the growth parameters of *Imperata cylindrica* in relation to ecotypes and weeding frequency.

From the study, it could be deduced that weeding reduced the growth parameters such as the rhizome node and bud number, rhizome length, shoot density, length and dry weight in all the ecotypes. There were no significant differencesin shoot density ($\leq$ 0.5) among the ecotypes based on the weeding frequency. The Ecotype 3 (Ebonyi) had the highest number of shoot density among the three, especially the unweeded plots.There were significant differences ($\leq$ 0.5) in shoot density based on weeding frequency. This shows that the higher the weeding frequency, the lower the shoot density in all the ecotypes.

The ecotype 3 had the highest rhizome length especially for the unweeded plot. The unweeded plots had the highest rhizome lengths in all the ecotypes. There were significant differences ($\leq$ 0.5) among ecotypes. The plots weeded 5 to 6 times had the lowest speargrass rhizome lengths and shoot density.

The study also revealed that ecotype 2 (Abia) had the highest number of rhizome nodes per meter square in the unweeded plot compared to other ecotypes. The unweeded plots had the highest number of rhizome nodes compared to the weeded plots. This indicates that weeding reduced the number of nodes in all the ecotypes. Weeding five times had the lowest number of rhizome nodes in all the ecotypes. Among the unweeded plots, ecotype 2 (Abia) had the highest bud density per meter square .The ecotypes had significant differences (< 0.5) in bud density. Weeding 5 times had the lowest bud density in all the three ecotypes.Even though the genetic variations in the different ecotypes showed significant differences in some growth parameters in relation to weeding frequency, weeding was very effective in controlling speargrass in all the ecotypes. Plots weeded five times showed drastic reductions in all the growth parameters. Therefore, weeding at least four to five times is highly recommended in the control of speargrass in a non-cropsituation. However, it is also recommended that other control methods, such as herbicides, be encouraged to reduce the competitive ability of speargrass. This is very important since weeding seems laborious and may require weeding up to five times for very effective control of speargrass.

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