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RESEARCH PAPER

ASSESSMENT OF THE IMPACT OF SOME COMMON WEED MANAGEMENT METHODS ON THE GROWTH AND YIELD OF PINEAPPLES IN GHANA

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ABSTRACT
A 5X5 Latin Square experiment was conducted in a farmer's field in the Ga East Municipality of the Greater Accra Region to evaluate the efficacies of different weed management systems and their effect on pineapple production. The different weed management systems evaluated were T1 - weedy check, T2- manual weed control (hoeing) only, T3- synthetic herbicide alone, T4- manual weed control and plastic mulch and T5- herbicide and plastic mulch. Treatments were replicated five times. Suckers were planted at a spacing of 90cm X 60cm X 25cm on 27 August 2010. Appropriate cultural practices were done at the right times. The results indicated that in all the growth parameters, the two plastic mulched treatments showed the greatest effect, followed by the herbicide-applied only treatment over that of the manual weeding treatment. Weed re-emergence was almost nil on the plastic mulched plots. Fruit weight of the two plastic mulched treatments was similar, but was significantly higher than all other treatment effects. However, percentage exportable fruits were similar among the synthetic and plastic mulch treatments. The results showed that farmers are better off if they add plastic mulch to the application of herbicides for more effective weed control and quality fruit yield.

Keywords: *Weed management, pineapple, plastic mulch, herbicide, forcing*

INTRODUCTION

Pineapple (*Ananas comosus* Merr. L.) by reason of its inherent slow growth rate and the wider spacing between rows is prone to continual weed seed germination, growth and weed attack (Chadha *et al*., 1997; Maia *et al*., 2012). Competition for nutrients, water and sunlight severely affects its growth and yield and can lead to up to over 80% yield loss (Sipes, 2000). This makes weed management in pineapples very important to ensure high productivity. Weed management in pineapple fields constitute, perhaps, the most difficult and expensive practice in the cultivation of the crop in Ghana due to the persistence of the weeds and their impact on the crop. The huge cost associated with weed management makes it very necessary to ensure that whichever method is used effectively controls the weeds and ensures good growth and yield of the fruit. Rohrbach and Johnson (2003) reported that each production area has its own spectrum of weeds sometimes determined by the historical weed control practices.

Weed management in pineapple fields comes in various forms in Ghana, depending on the area of cultivation, kinds of weeds found in the area, the funds available and the access to farm machinery for weed control. Thus, several methods are employed by different farmers and it is important to assess the relative efficiencies of the various methods to identify and recommend the ones which effectively and economically control weeds to enhance crop growth and yield.

The study therefore was conducted to determine the effect of five weed management methods on the growth and yield of pineapples in Ghana.

MATERIALS AND METHODS

Study Area

The experiment was carried out on-farm at Bomart Farms located in the northern part of the Ga East Municipality of the Greater Accra Region. The field lies in the Coastal savannah agro-ecological zone, with the natural vegetation made up mainly of shrubs and grasses. The area has a total annual rainfall of between 1200mm and 1400mm in two rainy seasons starting from April and July (major season) and September and late October (minor season). Temperatures of the area are high and uniform. Mean monthly temperature hovers around 20^{0}C. Relative humidity figures are around 90% during the mornings between July and September, but figures are lower between December and March. A soil analysis conducted at the beginning of the experiment described the soil as mainly sandy loam with pH of 5.0, bulk density of 1.37 and organic matter content 0.37%. The soil has been classified as Eutric Plinthosol (FAO, 1990).

Treatments and Experimental Design

The treatments used were T1-weedy check (no weed control), T2-manual weeding (only), T3-synthetic herbicide (bromacil + diuron), T4-plastic mulch + manual weeding and T5-plastic mulch + synthetic herbicide. The experiment was arranged in a 5 x 5 Latin square design with 5 replications. Each of the 25 experimental plots measured 2.7m x 2m. Three ridges, each of width 90cm and length 175cm, were constructed and covered with plastic film for Treatments 4 and 5. Pineapple suckers each weighing about 400 g obtained from the sucker plots of Bomarts Farms were used. These were planted in three double rows on each plot, with seven plants per row to give a total of 42 plants per plot at a spacing of 90cm X 60cm X 25cm. Planting was done on 27th August 2010. Data was collected on the inner 20 plants.

Ridomil Gold (fungicide) at 0.4kg dissolved in 200l of water and Dursban (insecticide) at 360ml in 200l of water were applied 58 days after planting. Fertilizer application was carried out six times before floral induction (forcing) and once after forcing.

The respective weed management practices (treatments for the experiments) were first imposed eight weeks after planting. Subsequently, weed control was carried out on a monitored regime. The weedy checks were never weeded until floral induction when the weeds were slashed to facilitate forcing. Treatments 2 and 4 were weeded four times before floral induction and twice after with a long hoe due to frequent re-emergence of weeds. Treatments 3 and 5 were sprayed with 500g of diuron + 500g of Bromacil dissolved in 200l of water with a knapsack sprayer once, since the weeds did not re-emerge to warrant re-application.

Data Collection and Analysis

It is a common practice to index the growth of pineapple with an easily identified standard leaf known as the D-leaf (Malézieux and Bartholomew 2003), which is defined as the youngest physiologically mature leaf on the plant (Bartholomew, 2008). It also happens to be the tallest leaf on the plant.

Data collected were: plant height, D-leaf weight, D-leaf length, D-leaf width and plant weight at forcing. Yield data taken were fruit weight and percentage of marketable fruits. For all these, except the plant weight (which required destructive sampling) five plants of intermediate sizes were sampled (Rebolledo-Martinez *et al.*, 2005) from the inner 20 plants at random and the data taken on them. This was done bi-monthly. Plant height was measured as height from the ground to the highest point of the plant in its natural orientation. The mean of the five plants heights was determined for each experimental plot.

D-leaves were picked and sent to the Crop Science Laboratory of the University of Cape Coast for the various parameters to be measured. They were weighed with a top pan balance and their lengths and width measured with a meter rule. The D-leaf width was taken as the width of the leaf bases which were virtually uniform (Bartholomew, 2008) in size. For all these, the mean weight, length and width per plot were determined.

Before floral induction, five plants of intermediate sizes from each plot were selected at random, uprooted, cleaned of soil debris and weighed with a balance. The means for five plants were taken as the mean plant weight for each plot. At harvest, the fruits from 15 plants fom the inner rows of each plot were harvested and weighed. The mean fruit weight was calculated.

The percentage marketable fruits was calculated by first counting the number of fruits which met the criteria for marketing as listed below and expressed as a percentage of the total number of fruits per plot. The criteria were: not diseased or rotten, no missing eyes, fruit not deformed, crowns neither too short nor long (should be about 1/3 of the fruit length), no sunburns and fruit weight not less than 900 g.

The data collected were subjected to ANOVA using the Genstat statistical package (Genstat version 9) and the means compared using the Duncan Multiple Range Test (DMRT) at 5% probability level.

RESULTS

Efficiency of various weed management methods

Table 1 shows the efficiency of the weed management methods over the weedy check. The results show that Plastic mulch + synthetic herbicide achieved the highest efficiency of 90.6%. This was followed by the Plastic mulch + manual weeding with 80.2%, synthetic herbicide with 73.4% and the manual weeding in that order.

Effect of weed management on plant height

Table 2 shows the effect of the weed management methods on the height of the pineapple plants. The treatments did not have any effect on the height of pineapple plants until eight months after planting. Plants from the plastic mulch + herbicide recorded the greatest plant height at forcing, but were not Effect of weed management on plant height at forcing, but were not significantly different from Plastic mulch + manual weeding and synthetic herbicide treatments.

The effects of the two plastic mulched treatments were, however, significantly higher than those from the weedy check and manual weeding treatments. The effect of the synthetic herbicide alone was significantly higher than the weedy check.

Effect of weed management on length of 'D' leaf

Table 3 shows the effect of weed management on the length of the 'D' leaf. The treatment differences on the length of 'D' leaf was not significant at 2 and 4 MAP. Significant differences were observed at both 6 and 8 MAP samplings. On both occasions, 'D' leaves length

Table 1: Efficiency of weed management methods over control

TREATMENTS	Weed control efficiency over weedy check (%)
Weedy Check	-
Manual Weed	69.2
Synthetic herbicide	73.4
Plastic mulch + Manual Weeding	80.2
Plastic Mulch + Synthetic herbicide	90.6

Table 2: Effect of weed management methods on height of pineapple plants

TREATMENTS	Mean plant height			
	2MAP	4MAP	6MAP	8MAP
Weedy Check	57.2a	57.3a	75.1a	76.7a
Manual Weed	54.5a	60.3a	75.4a	82.5ab
Synthetic herbicide	59.1a	59.4a	78.0a	89.0bc
Plastic mulch + Manual Weeding	56.6a	60.1a	82.7a	90.5c
Plastic Mulch + Synthetic herbicide	58.2a	60.3a	80.3a	91.5c
s. e. d	**1.85**	**1.89**	**2.92**	**3.77**
CV (%)	**6.72**	**5.92**	**7.35**	**8.81**

Means followed by the different letters within a column in all tables are significantly different at the 5 %

from plastic mulch + herbicide treatment was significantly higher than the weedy check and the manual weeding treatment effects. All other treatment means were similar.

Effect of weed management on width of 'D' leaf

The results of the width of 'D' leaves presented in Table 4 shows that significant differences were observed from the second month after planting with plastic mulch + herbicide recording the greatest 'D' leaf width, throughout the sampling period. This was followed by the plastic mulch + manual weeding whilst effect of the weedy check was the lowest. With the exception of sampling at 4 MAP, treatment

Table 3: Effect of weed management methods on 'D' leaf length of pineapple plants

TREATMENTS	Mean 'D' leaf length (cm)			
	2MAP	**4MAP**	**6MAP**	**8MAP**
Weedy Check	59.5a	68.0a	70.6a	87.4a
Manual Weed	59.9a	67.0a	73.3ab	92.3ab
Synthetic herbicide	60.7a	74.2a	74.9ab	96.7bc
Plastic mulch + Manual Weeding	60.4a	72.7a	76.8bc	98.9bc
Plastic Mulch + Synthetic herbicide	61.2a	74.2a	79.0c	101.8c
s.e.d	**1.81**	**3.03**	**1.88**	**3.33**
CV (%)	**5.35**	**8.49**	**6.53**	**7.55**

Table 4: Effect of weed management methods on 'D' leaf width of pineapple plants

TREATMENTS	Mean 'D' leaf width (cm)			
	2MAP	**4MAP**	**6MAP**	**8MAP**
Weedy Check	3.6a	3.6a	5.4a	6.2a
Manual Weed	3.8ab	4.0b	5.6a	6.5a
Synthetic herbicide	3.7ab	4.3c	6.7b	7.3c
Plastic mulch + Manual Weeding	3. 8b	4.5cd	6.9b	7.7c
Plastic Mulch + Synthetic herbicide	3.9b	4.6d	6.9b	7.9c
s.e.d	**0.08**	**0.14**	**0.43**	**0.46**
CV (%)	**4.91**	**10.10**	**14.1**	**10.63**

differences between the weedy check and manual weed treatments were not significant. At forcing (8 MAP) the plastic mulch and the herbicide treatment effects were similar, but their effects were greater than those of the weedy check and manual weeding treatments.

Effect of weed management on weight of 'D' leaf

Significant differences were observed in the weight of 'D' leaves from the sixth month after planting (Table 5). At 6 MAP sampling, the two mulched treatments recorded similar effects, which was significantly higher than the other treatment effects. Sampling at 8 MAP showed that the plastic mulch + herbicide treatment effect was significantly higher than the weedy check and manual weeding treatment effects. The weedy check also produced effect significantly lower than the herbicide alone

Table 5: Effect of weed management methods on 'D' leaf weight of pineapple plants

TREATMENTS	Mean 'D' leaf weight (g)			
	2MAP	**4MAP**	**6MAP**	**8MAP**
Weedy Check	28.25a	28.59a	38.38a	40.63a
Manual Weed	28.71a	29.42a	39.43a	43.11ab
Synthetic herbicide	29.03a	29.38a	40.67a	46.34bc
Plastic mulch + Manual Weeding	28.03a	31.92a	46.38b	47.52bc
Plastic Mulch + Synthetic herbicide	29.52a	32.73a	46.78b	49.15c
s. e. d.	**1.21**	**2.50**	**2.17**	**2.58**
CV (%)	**10.08**	**15.01**	**11.78**	**11.49**

and plastic mulch + manual weeding treatments.

Effect of weed management on weight of plants and fruits

Plant and fruit weight results are shown in Table 6. Plant weight was not different among the herbicide and plastic mulch treatments, but the effect of each plastic mulch treatment was significantly higher than those of the manual weeding and weedy check treatments.

Mean fruit weight results showed that the greatest yield was recorded from the plastic mulch + herbicide though it was again not significantly different from the effect of the plastic mulch + manual weeding. Weedy check and the manual weeding treatment effects did not show significant difference. The fruit yield from the herbicide only treatment was significantly higher than that of the weedy check, but was significantly lower than the two plastic mulch treatment effects.

Effect of weed management on marketability of fruits

Table 7 shows the mean percentage marketable fruits recorded from various treatments. It indicates that the least percentage marketable fruits were recorded in the weedy check treatment and this was significantly lower than in all other treatments. The treatment effect of the manual weeding control was also significantly lower than the synthetic herbicide and the plastic mulched treatments. Percentage marketable fruits was greatest in the plastic mulch + herbicide treatment, whilst the difference between the plastic mulch + manual weeding and herbicide only treatments was not significant.

DISCUSSION

The desire of every farmer is to produce crops that will grow well and produce a good harvest. Thus, in choosing a weed management system, the growth and yield of the pineapple is of prime importance. The results presented in this study show that growth occurred in three phases. Rate of growth was generally slow until the fourth month, after which it rose sharply through the sixth month and then reduced afterwards. The initial slow growth may have occurred because the first few months were used for root initiation and development, thus above ground growth was minimal. Catunda *et al.*

Table 6: Effect of weed management methods on weight of pineapple plants and fruits

TREATMENTS	Mean plant weight at forcing (kg)	mean fruit weight (g)
Weedy Check	2.25a	1.40a
Manual Weed	2.51a	1.56ab
Synthetic herbicide	2.84ab	1.61b
Plastic mulch + Manual Weeding	3.08b	1.82c
Plastic Mulch + Synthetic herbicide	3.45b	1.95c
s. e. d	**0.31**	**0.09**
CV (%)	**18.42**	**14.78**

Table 7: Effect of weed management methods on percentage exportable pineapple fruits

TREATMENTS	Percentage marketable fruits	
Weedy Check	35.02a	(32.90)
Manual Weed	44.2b	(48.56)
Synthetic herbicide	60.82c	(76.18)
Plastic mulch + Manual Weeding	62.48c	(78.60)
Plastic Mulch + Synthetic herbicide	66.49d	(84.04)
s. e. d	**1.36**	
CV (%)	**23.26**	

(2005) indicated that the fact that the crop is small and grows slowly initially may favour weeds taking advantage to grow faster in pineapple fields. The rapid increase in growth rate was as a result of increase in the amount of dry matter partition allocated to the above ground portion of the plant after the initial root development, whiles the slowdown in the latter months represents the transition from the vegetative growth to the reproductive stage (Gardner *et al*., 1985; Evans 1996).

Growth and fruit yield results in the present studies is different from the report of Maia *et* *al*. (2012) who reported that herbicide application did not have significant effects on growth and yield measurements in pineapple. In all the growth parameters measured, the two plastic mulched treatments showed the greatest effect. This confirms earlier findings (Py *et al.*, 1984) that the plastic mulch improves the conditions for plant development especially by providing a better conservation of soil moisture (Dole and Dole, 1991; Rebolledo-Martinez *et al.*, 1997). The herbicide only treated plots followed the two plastic mulched treatments in all the growth parameters measured. This was expected because the growth on these plots was not limited by competition from weeds, compared to the manual weeding and the weedy check, despite the fact that its growth was not enhanced by plastic mulch. The manually weeded plot could not perform, as the synthetic herbicide because it was faced with weed competitions intermittently, since weed control was done on monitored bases. Thus, intermittent weed competition, coupled with the lack of enhancement by plastic mulch may have stressed the growth of the crops, though they seemed to have performed better than the weedy check.

Estimates of growth made before forcing provide information on the progress of growth which also determines when to force the plants and, as well, give an idea on the yield at harvest. Many studies have shown that fruit weight at harvest is highly correlated with growth measured at the time of forcing (Py, 1953; Py and Lossois, 1962; Wee *et al.*, 1979). Consequently, the differences in yield from the various treatments appeared to follow the same pattern in the growth; the two plastic mulched treatments recording the greatest yield, significantly different from the weedy check and the manual weeding treatments, with the herbicide only plot recording yields between the two groups. As indicated by Paulle and Duarte (2011), plastic mulch helped to prevent rapid escape of fumigants, maintained warmer soil temperatures during the cool season, retained moisture at the soil surface, reduced fertilizer leaching during rainy periods, controlled weed growth in the beds and thereby increased the yields for the plastic mulched plots. The others did not have the enhancement by the plastic mulch and hence could not yield as much as them. The lower yields recorded by the weedy check and manually weeded plots could also have resulted from the competition for nutrient, light and space from the weeds.

In spite of the insignificant differences in the weight of fruits, plastic mulch + herbicide recorded significantly higher percentage marketability than plastic mulch + manual weeding. This difference may have resulted from insect damage caused to the fruits in the periods of high weed populations in the plastic mulch + manually weeded plots, reducing the percentage marketability of the yield from the plots. The herbicide only treated plot recorded lower percentage marketability than the two plastic mulched treatments basically because of lower yields (fruit weight) as indicated earlier. Insect attacks could not have accounted for this since the plot had reduced weed populations. The weedy check recorded the lowest percentage marketability mainly due to lower yields (fruit weight) and high amount of insect damage caused by insect pests which were harboured by the weeds. The manually weeded plot also recorded low percentage marketability, possibly for similar reasons as the weedy check. The severity of damage by the insect pests and the low yields, however, were not as much as that of the weedy check and this made percentage marketability for the manual weeding significantly higher than that of the weedy check.

CONCLUSION

The efficiencies of the weed management methods evaluated over the weedy check showed that the best method was the plastic mulch + herbicide, followed by the plastic mulch + manual weeding, the herbicide only and then the manual weeding. The plastic mulch treatment promoted growth better than the manual weeding and herbicide only treatments. Fruit yield in the plastic mulch treatments were also similar, but were both greater than other treatment effects. However, percentage exportable fruits in the plastic mulch + herbicide treatment were significantly higher than all other treatment effects, including the plastic mulch + manual weeding treatment. Since pineapples are mainly cultivated for export, under the conditions of this study, the plastic mulch + herbicide method is recommended to farmers.

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