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Effects of mulching and nitrogen fertilization on "Sugarloaf" Pineapple, Ananas comosus (L) Merr.

Wirkung von Mulchen und Stickstoffdüngung auf Ananas (Ananas comosus (L) Merr, Sorte Sugarloaf

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1. Introduction

Mulching in one of the several cultural practises employed on pineapple fields. Numerous types of mulches including paper mulch, dry grass and black polyethylene sheet have been used (Collins, 1960).

Nightingale (1942) showed that nitrogen was the most limiting nutrient in pineapple cultivation. Dodson (1968) found in Swaziland that nitrogen increased fruit size and reduced fruit acidity in "Smooth Cayenne" pineapple. Singh, Dass, Ganapathy and Subramannian (1977) found in India that nitrogen increased the number of leaves per plant and weight of dry leaves, slip yields, average fruit weight, fruit size and yield. Both total soluble solids and % acidity decreased with rising nitrogen level. The optimum nitrogen level for rain–fed plants was 16 g N per plant.

In Ghana pineapple crops are grown without any mulching. Black polyethylene mulch is, however, used in commercial pineapple production in the neighbouring Ivory Coast (personal communication).
Even though commercial pineapple growers in Ghana apply fertilizers to their crops there is no firm recommendation from official circles, thus nitrogen deficiency symptoms are rampant. The present study was therefore undertaken to determine the possibility of mulching pineapple crops in Ghana and to establish the optimum level of nitrogen for side–dressing.

2. Materials and Methods

The study was conducted on the research plots of the Department of Horticulture, University of Science and Technology, Kumasi, Ghana.

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The soil of the area was of the Akroso series of the forest ochrosol (Brammer, 1960). A 3 x 3 factorial design replicated four times was used. There were three mulching and three nitrogen treatments. For mulching the treatments were black polyethylene sheet, dry grass (Panicum maximum) and bare soil (no mulch). The nitrogen levels were 0, 360 and 540 kg N per ha, i.e., 12 g per plant and and 18 g per plant respectively, applied in split applications as sulphate of ammonia.

Uniform crowns of "Sugarloaf" pineapple were planted manually on 1 September 1979 on raised beds. Each bed contained a double row spaced 0,45 y 0,40 cm with 1,20 m spacing between beds. Each plot consisted of 30 plants and was provided with interplot guard rows.
Prior to planting black polyethylene sheets (gauge 150) were spread on the appropriate plots. Holes (10 x 10 cm) were then made on the sheets according to the spacing. Sides of the sheets were covered with soil in the furrows. 5 cm thick dry grass was spread appropriate plots immediately after planting.

All plots were fertilized with 90 kg N, 90 kg P_2O_5 and 90 kg K_2O per hectare as 15–15–15 compound fertilizer at 5 weeks after planting. Nitrogen side-dressing of 360 and 540 kg N/ha were applied in split applications at 6 and 13 months after planting.

Plants were grown under rain-fed conditions (Table 1) and control plots (no mulch applied) were hoed as and when necessary. The soil test values at the start of the experiment were: pH, 5,4; organic matter, 3,1%; total N 0,22%; available P. 60 ppm; exchangable K; 116 ppm; carbon, 2,3% and C.E.C., 5,0 me/100 g. Records taken included plant height and leaf number at flowering; number, weight and length of slips; crown length and weight; number of hapas produced; peduncle length and thickness; date of flowering and harvesting, fruit size and fruit weight.

Table 1: Rainfall data (in mm) during the experimental period

Month	1979	1980	1981
January	--	5.1	1.7
February	--	100.9	48.0
March	--	49.0	77.2
April	--	53.8	--
May	--	120.0	--
June	--	286.5	--
July	--	129.9	--
August	--	38.4	--
September	331.3	170.8	--
October	103.7	117.4	--
November	21.6	67.7	--
December	8.4	21.6	--

Ten harvested ripe fruits from each plot were peeled and juice was stained through a layer of cheese cloth and analysed for titratable acidity and % total soluble solids (TSS). Acidity was determined by titrating 20 cm^3 of the juice with 0,1 N NaOH using phenolphthalein as an indicator. A Zeiss hand refractometer was used in determining the % TSS of the juice. The experiment was terminated on 31 March 1981.

3. Results and Discussion

Vegetative Growth: It was evident that maximum vegetative growth (leaf number and plant height) was obtained from plants on mulched plots, with higher vegetative growth on black polyethylene–mulched plots (Table 2).Visually plants from mulched plots were vigorous in growth and darker green in colour than the control plants. The response of plants from mulched plots can be attributed to conservation of moisture, prevention of leaching of nutrients and elimination of weed competition and disturbance associated with the removal of weeds by hoeing (Quinn, 1973).

Table 2: Mean effects of mulching and nitrogen application on leaf number, plant height, hapa production and peduncle size of pineapples.

Treatment	Leaf Number at Flowering	Plant Height at Flowering (cm)	Hapa Number per Plant	Peduncle Length (cm)	Peduncle Diameter (cm)
Mulching					
Bare Soil	49.8	113.8	0.9	35.8	2.5
Dry Grass	51.5	116.2	1.1	35.9	2.8
Black Polyethylene	54.5	118.3	1.2	35.3	2.9
H.S.D. 5%	2.6	2.0	0.2	N.S.	0.3
Nitrogen (kg ha^{-1})					
0	50.1	113.3	0.6	36.4	2.5
360	53.2	118.3	1.4	35.3	2.8
540	52.6	116.8	1.3	35.3	2.8
H.S.D. 5%	2.1	2.9	0.3	1.1	0.3
Interaction	N.S.	N.S.	--	N.S.	N.S.

* Significant at P=0.05
N.S.= Not Significant.

Nitrogen fertilization increased significantly vegetative growth, agreeing with Sing et al. (1977). The treated plants were also more vigorous and darker than control plants.

Hapa Production: Both mulching and nitrogen side–dressing increased hapa production. There was a significant interaction between mulching and nitrogen treatments (Table 2). In all mulching treatments, nitrogen significantly increased hapa production. This increased hapa production was the result of the greater vegetative growth of plants from mulched– and nitrogen–treated plots as there was a positive correlation between leaf number and hapa production (Table 6).

Slip Production: Mulching and nitrogen increased slips produced per plant, total slips' weight and slip length. Also there was a significant interaction between mulching and nitrogen application (Table 3). It is evident that the increased number and size of slips produced was the result of increased vegetative growth caused by mulching and nitrogen. There was a positve correlation between leaf number and slip number (Table 6). Sing et al. (1977) observed that nitrogen increased slip yield in the "Smooth Cayenne" pineapple.

Crown Size: Crown size, as reflected by crown length and weight (Table 3), was not influenced by mulching. It would appear the greater vegetative growth of plants from mulched plots influenced fruit size (Table 4) at the expense of crown size. Nitrogen application, on the other hand, significantly increased crown size.

Table 3: Mean effects of mulching and nitrogen application on slip production and crown size of pineapples.

Treatment	Slip Number per plant	Slip Length (cm)	Crown Length (cm)	Crown Weight (g)
Mulching				
Bare Soil	8.3	25.1	18.9	114.5
Dry Grass	10.7	27.9	19.1	114.1
Black Poly-ethylene	11.1	28.1	18.8	113.0
H.S.D. 5%	0.8	2.3	N.S.	N.S.
Nitrogen (kg ha^{-1})				
0	8.5	22.1	17.5	109.4
360	10.9	29.1	19.4	117.8
540	10.7	29.9	19.9	114.4
H.S.D. 5%	0.9	3.6	1.5	4.9
Interaction	--	--	N.S.	N.S.

Table 4: Mean effects of mulching and nitrogen application on flowering, fruit maturity and fruit weight, yield andllength of pineapples.

Treatment	Mean days from planting to Flowering	Mean days from planting to Harvest	Fruit Weight (kg)	Total Fruit (t ha^{-1})	Fruit Length (cm)
Mulching					
Bare Soil	423.9	538.5	1.61	48.6	25.5
Dry Grass	395.0	514.1	1.81	53.8	26.9
Black Poly-ethylene	410.2	530.3	1.99	58.8	27.9
H.S.D. 5%	11.7	7.6	0.15	4.3	1.0
Nitrogen (kg ha^{-1})					
0	441.2	548.5	1.61	48.7	25.2
360	394.7	515.4	1.89	57.0	27.8
540	393.3	578.9	1.90	55.6	27.2
H.S.D. 5%	13.9	14.9	0.18	3.9	1.1
Interaction	--	--	--	--	--

Peduncle Size: Peduncle size was measured in terms of peduncle length and diameter, i.e., thickness (Table 2). Peduncle length was not influenced by mulching. Mulching, however, increased peduncle thickness.

Nitrogen application surprisingly decreased peduncle length but increased peduncle thickness. The greater vegetative growth caused by both mulching and nitrogen might have influenced the thickness of the peduncle. There wa a positive correlation between leaf number and peduncle diameter (Table 6).

Table 6: Correlation Coefficients between some parameters and leaf number of pineapples

Parameter	Leaf Number
Fruit Length	0.96*
Fruit Weight	0.98*
Hapa Number	0.96*
Peduncle Diameter	0.97*
Slip Number	0.98*
Total Fruit Yield	1.00**

* Significant difference at P = 0.05
** Significant difference at P = 0.01

Table 5: Mean effect of mulching and nitrogen application on fruit quality of pineapples.

Treatment	% T.S.S.	% Titratable Acidity	T.S.S./Acidity Ration
Mulching			
Bare Soil	14.53	0.71	20.46
Dry Grass	14.62	0.67	21.82
Black Poly-ethylene	14.44	0.67	21.55
H.S.D. 5%	N.S.	N.S.	0.62
Nitrogen ($kg\ ha^{-1}$)			
0	15.16	0.73	20.77
360	14.22	0.66	21.55
540	14.21	0.66	21.53
H.S.D. 5%	0.73	0.06	0.69
Interaction	N.S.	N.S.	N.S.

Flowering and Fruit Maturity: Mulching and nitrogen fertilization delayed flowering and fruit maturity (harvest). There was a significant interaction between mulching and nitrogen treatments, confirming their delay in flowering and fruit maturity (Table 4). Thes responses are attributable to the greater vegetative growth of plants from mulched– and nitrogen–treated plots.

Fruit Weight, Size and Yield: Plants from polyethylene–mulched plots produced the maximum fruit weight and size as well as the total fruit yield followed by those from dry grass–mulched plots and then by plants from unmulched plots. Nitrogen application increased individual fruit weight and size, and consequently increasing the total fruit yield (Table 4). The results are in agreement with those obtained by Dodson (1968) and Singh et al.(1977). There was a significant interaction between mulching and nitrogen treatments, confirming the superiority of fruit of plants from the mulched– and nitrogen–treated plots over those from control plots. These responses are the result of greater vegetative growth caused by mulching and nitrogen application. There was a positive correlation between leaf number and fruit weight, and leaf number and fruit length (Table 6).

Fruit Quality: Fruit quality as measured by % TSS and % titratable acidity of fruit juice was not affected by the mulching treatments. The TSS/acidity ratio of fruit juice from plants of mulched plots, however, was significantly higher than that from plants of bare soil (Table 5). Nitrogen side–dressing decreased % TSS and % titratable acidity, and increased TSS/ acidity ration of the fruit juice. In India, Sing et al. (1977) observed that nitrogen decreased % acidity.

4. Conclusion

The experimental results have alearly shown that it is highly beneficial to mulch pineapple fields and side–dress pineapple plants with nitrogen. Mulching increased vegetative growth, slip and hapa production, peduncle thickness, fruit weight and size, total fruit yield and TSS/acidity ratio of fruit juice. It, however, delayed flowering and fruiting. Mulching did not influence % total soluble solids and % acidity of fruit juice. The type of mulch to use, i.e., whether dry grass or black polyethylene sheet, will depend upon its cost, availability, practicability, etc. It would appear the use of grass mulch does not appear feasible in large scale pineapple production. Use of dry grass mulch where available can therefore be used only on small scale pineapple farms. Black polyethylene mulch may be employed for both small and large scale pineapple production.

Nitrogen increased vegetative growth, peduncle size, slip and hapa production, crown size, fruit weight and size, total fruit yield and TSS/acidity of fruit juice. It, however, deleyed flowering and fruiting, and decreased % total soluble solids and % titratable acidity of the fruit juice. Since there were no significant differences between the medium and high nitrogen levels for all parameters measured the medium nitrogen level 360 kg N/ha may be used a two split applications for side.dressing pineapple plants.

Summary

The response of pineapple plants to black polyethylene and dry grass mulches, and nitrogen levels was investigated. Both mulching and nitrogen increased vegetative growth, slip and hapa production, peduncle thickness, fruit weight and size, total fruit yield and fruit TSS/acidity ratio. Black polyethylene mulch outyielded dry grass mulch. Mulching and nitrogen also delayed flowering and fruit maturity. Mulching did not influence fruit % TSS and % titratable acidity. Nitrogen, on the other hand, decreased fruit % TSS and % titratable acidity. Significant interactions between mulching and nitrogen treatments were obtained for most of parameters recorded.

Black polyethylene mulch was recommended for both small and large scale pineapple production while dry grass mulch was recommended for small scale pineapple farms. Side–dressing with the medium nitrogen level of 360 kg N/ha at two split applications was preferred.

5. Zusammenfassung

Die Reaktion von Ananaspflanzen auf schwarze Polyethylenfolie, trockenem Grasmulch und Stickstoffgaben wurden untersucht.

Beides, Mulchen und Stickstoffdüngung, erhöhten das vegetative Wachstum, Anzahl der Schößlinge des Fruchtstieles und der Fruchtstielbasis, Blütenstieldicke, Fruchtgewicht

und –größe, Gesamtfruchtertrag und das Verhältnis "löslich feste Substanzen" des Fruchtsaftes zu Fruchtsäure. Bodenbedeckung mit schwarzer Folie übertraf im Ertrag trockenen Grasmulch. Mulchen und Stickstoffdüngung verzögerten die Blüte und die Fruchtreife. Mulchen beeinflußte nicht die prozentualen Anteile "feste Bestandteile des Fruchtsaftes" und "titrierbare Säure", während Stickstoffdüngung beides verringerte. Bei den meisten aufgezeichneten Parametern zeigten sich signifikante Wechselwirkungen zwischen Mulchen und Stickstoffbehandlung.

Schwarze Folie wurde für kleine und große Ananasplantagen, während trockener Grasmulch nur für kleine Anlagen empfohlen wurde. Reihendüngung mit mittlerer Stickstoffmenge von 360 kg N/ha in zwei Gaben wurde bevorzugt.

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