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ASSOCIATION INTER-CARAÏBE DES PLANTES ALIMENTAIRES
CARIBBEAN FOOD CROPS SOCIETY

COMPTES RENDUS – SEPTIÈME CONGRÈS ANNUEL
PROCEEDINGS – SEVENTH ANNUAL MEETING

Martinique — Guadeloupe

1969

VOLUME VII

EFFECT OF FERTILIZER NITROGEN, PHOSPHORUS AND POTASSIUM ON YIELD OF CORN, *ZEA MAYS* VAR. « PIONEER 306 »

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Although corn has been grown in Guyana for many years, the use of fertilizers was not a common practice. As a result there is little, if any, information on their effects. However, with the introduction of the hybrid variety of corn, Pioneer 306, the use of fertilizers has gained importance. Studies were conducted during the long rainy season of 1968 on Pioneer 306 to determine the yield response of N, P and K and the fate of these nutrients in the soil.

Experimental materials and methods

Soil. The experiment was carried out on the soil, Onverwagt Silty clay, at the Central Agricultural Station, Mon Repos.

(Ramdin, 1966). Some of the chemical and physical features of the top 15 cm (six inches) are given in Table I.

Table I

Chemical and mechanical analysis of the top 15 cm (six inches) onverwagt silty clay

pH	Truog P (p. p. m.)	P. B. S.	Meq./100 g			C. E. C.	Sand %	Silt %	Clay %
			Exch. K	Exhc. Ca	Exhc. Mg				
5.6	2.5	96	0.47	6.2	10.7	18.08	15	44	41

Experimental design and procedures. The experiment was of a 3^3 factorial design replicated twice. Each replicate was divided into three blocks of nine plots each so that the (W) and (X) components of the N, P, K interaction were confounded in replications one and two respectively. The treatments were randomised within

Central Agricultural Station, Guyana.

each block. The three levels of N, P and K applied are given in Table 2. These levels were chosen in relation to the rates that were arbitrarily used at the station ; these were N, 67.2 kg/ha (69 lbs/acre) ; P, 22 kg/ha (20 lbs/acre) ; and K, 112 kg/ha (100 lbs/acre).

TABLE 2

Levels of N, P *and* K *used in the experiment*

Levels	kg/ha		
	N	P	K
0	0	0	0
1	51	13	56
2	100	26	112

Plots were 6.7 × 3.9 m (22 × 13 ft) The rows were 60 cm (two feet) apart and the plants 22.5 cm (nine inches) within the row. Two to three seeds were planted by hand to each hole, and after germination the seedlings were thinned out to one plant per hole.

N was applied as urea, P as triple superphosphate and K as muriate of potash. All the P was applied five days after germination along with half of the N and K ; the other half of the N and K was applied 40 days after germination. This procedure of splitting N and K followed normal local practice. The fertilizers were weighed and band applied to the rows.

Cobs were harvested when they were reasonably dry. The husked cobs of each plot were weighed in the field.

Soil sampling and analysis. Soil samples were taken from the top 15 cm of each plot of the first replication before application of fertilizers, at 40 days after germination, and again immediately after harvesting was completed. Samples were taken to the laboratory and a portion immediately extracted with N-K_2SO_4 to remove mineral-N. The extract which was kept frozen, was allowed to thaw out just before distillation for mineral-N by the MgO/Titanous sulphate method (BREMNER and SHAW, 1958). The remainder of the sample was air-dried and passed through a two mm sieve. Available P was then determined according to Truog, and K flame photometrically (JACKSON, 1958). Each determination was done in duplicate.

RESULTS AND DISCUSSIONS

Yield : Table 3 presents the yields as two-way tables. The analysis of variance, Tables 4 (*a*) and 4 (*b*) show the significant effects. Fig. 1 illustrates the overall effects of nitrogen, phosphorus and potassium on yields. The average yields are somewhat lower than those normally obtained. This was probably due to water-logged conditions which resulted from the heavy rainfall that occurred during the two weeks immediately after germination.

Nitrogen. Nitrogen fertilization had a very significant effect on yield ; this response was linear (Table 4 (*b*) and Fig. 1). Increasing nitrogen from 0 to 100 kg/ha

caused an increase in yield of 3 115 kg/ha with about 60 per cent of this increase being caused by the first 50 kg/ha of nitrogen.

TABLE 3

Two-way Tables of mean yields of husked cobs (kg/ha) (*)

	N_0	N_1	N_2	Mean
P_0	725	2 724	3 767	2 405
P_1	589	3 465	3 563	2 539
P_2	1 225	2 496	4 554	2 758
K_0	575	2 404	4 036	2 340
K_1	546	2 644	3 898	2 363
K_2	1 418	3 637	3 949	3 005
Mean ..	846	2 895	3 961	

	P_0	P_1	P_2	Mean
K_0	2 305	2 076	2 632	2 338
K_1	2 516	1 982	2 590	2 363
K_2	2 393	3 560	3 054	2 384

S. E. for means of 6 plots ± 0.7
S. E. for means of 18 plots ± 0.5

TABLE 4

(a) *Analysis of Variance*

Factor	*df*	Mean Square
Blocks	5	11.49
N	2	1 550.39**
P	2	19.70**
K	2	82.75**
N × P.....	4	56.53**
N × K	4	28.79**
P × K	4	17.32**
N × P × K unconf.	4	93.99
Part conf.	4	46.37
Error	22	4.52
Total	53	1 941.85

(b) *Subdivision of part of the treatment* SS

Factor	*df*	Mean Square
N : L	1	3 001 21**
Q	1	99.57
P : L	1	38.65**
Q	1	0.77
K : L	1	136.50**
Q	1	39.00**
NP : Q × L	1	26.09*
Q × Q	1	83.30**
Rest.....	2	1.83
NK : L × L	1	24.45*
Q × L	1	25.33*
Rest.....	2	2.41
PK : Q × L	1	51.96**
Q × Q	1	56.29**
Rest.....	2	4.32

Phosphorus. There was a comparatively small but significant response of yields to P fertilization ; this response was linear. These results indicate that further responses may be obtained if a higher rate of fertilizer P is applied.

Forty per cent of this increase was due to the first 13 kg/ha of phosphorus.

Potassium. The application of K had a very significant effect on yields ; both the quadratic and linear components of this response were significant. Increasing K from 0-112 kg/ha caused an increase in yield from 2 340 to 3 005 kg/ha with only three per cent of this increase resulting from the first 56 kg/ha. One possible explana-

(*) 1 kg/ha = 0.89 lbs/acre.

tion for this pattern is that most of the K applied in the first 56 kg/ha may have been fixed in the clay lattice and therefore unavailable to the plant, when more K was added this remained available to the plant, and hence increased yields.

NP interaction. The N_QP_L and the N_QP_Q components of the NP interaction were significant. Examination showed that increasing P from 0 to 26 kg/ha did not cause a significant increase in yield when no N was applied.

NK interaction. The N_LK_L and N_QK_L components of the NK interaction were significant. Examination showed that increasing K from 0-112 kg/ha caused a significant increase at all levels of nitrogen except the highest one, and secondly that increasing N from 0-100 kg/ha caused a comparatively greater increase in yield when no K was applied than when 112 kg/ha was applied.

PK interaction. The P_QK_L and P_QK_Q components of this interaction were significant. Examination showed that increasing K from 0-112 kg/ha, caused a significant increase in yield only at the second level of phosphorus fertilization.

These results indicate that on Onverwagt silty clay, nitrogen is the most important fertilizer nutrient for corn and possibly a rate greater than the highest level used in these studies may prove beneficial. Potassium is also an important nutrient but with low levels e. g. 56 kg/ha no yield response will be obtained. Phosphorus does not cause a very great increase in yield and keeping in mind the PK interaction 13 kg/ha of P seems adequate, however, larger levels of P on corn must be tested. From these results a possible fertilizer recommendation for this soil type is nitrogen 100 kg/ha, phosphorus 13 kg/ha and potassium 112 kg/ha.

Soil Analysis. The concentrations of available N, P and K remaining in the soil at 40 days after germination and after harvest are presented in table 5. At 40 days after germination, application of fertilizer phosphorus and potassium had no significant effect on the concentration of available P and K respectively in the soil. The concentration of mineral-N, when 100 kg/ha was applied, was significantly greater than that of the control.

TABLE 5

Concentration of Available N, P and K remaining in the soil 40 days after germination ; and after harvest

	Mineral N (p. p. m.)					Truog — P (p. p. m.)					Exch. K (p. p. m.)				
	N_0	N_1	N_2	S. E.	LSD*	P_0	P_1	P_2	S. E.	LSD*	K_0	K_1	K_2	S. E.	LSD*
40 days	34	35	57	6.7	20.1	2.5	2.9	2.2	0.5	1.6	87	82	92	3.4	10.3
Harvest	12	17	20	2.8	8.5	1.9	2.2	2.6	0.4	1.3	120	118	136	8.0	24.3

* At 5 % Level.

After harvest, there was no significant difference in concentrations of available N, P and K between the fertilized and unfertilized plots. The concentration of available K in all treatments of K however is considerably greater than at 40 days after germination ; this suggests that fixed K in the soil may have been released during that interval.

Summary

Response of corn (Zea mays) Var. Pioneer X-304 to N (0-100 kg/ha), P (0-26 kg/ha) and K (0-112 kg/ha) fertilization was investigated on Onverwagt Silty Clay at the Central Agricultural Station, Guyana. Significant, linear yield responses were obtained by the application of all three fertilizer nutrients. A possible fertilizer recommandation of N (100 kg/ha), P (26 kg/ha) and K (112 kg/ha) was made.

Résumé

Effets sur le maïs (var. Pioneer X-306)
des apports d'azote, phosphore et potasse

La réponse du maïs (Var. Pioneer X-306) à l'azote (0-100 kg/ha), au phosphore (0-26 kg/ha) et au potassium (0-112 kg/ha) a été étudiée sur les sols limono-argileux de la Station Centrale agronomique en Guyane britannique.

Des résultats significatifs et des accroissements linéaires des rendements sont obtenus avec chaque élément fertilisant. On a recommandé la fumure suivante : 100 kg/ha N, 26 kg/ha P et 112 kg/ha K.

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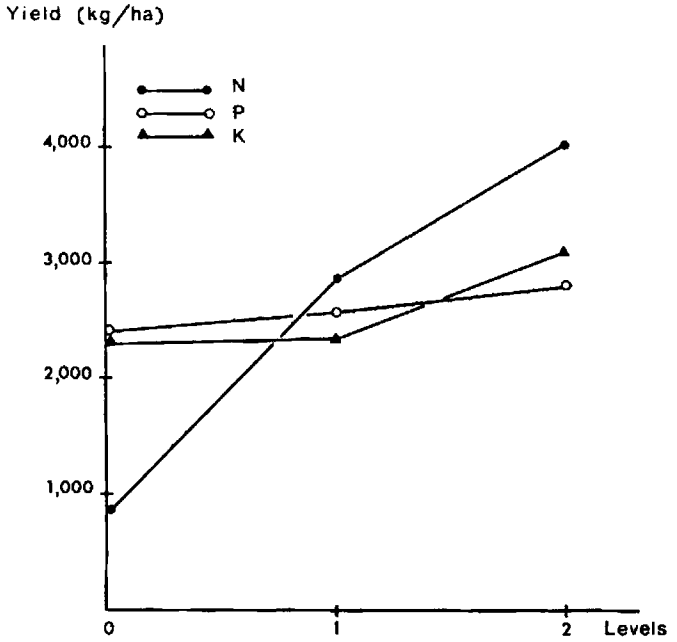

Fig. 1. — Response in yield of corn to increasing levels of N, P and K.