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EFFECTS OF FERTILIZER PLACEMENT AND TIME OF APPLICATION ON CORN (ZEA MAYS L) YIELDS ON SOME SOILS IN THE EASTERN CARIBBEAN

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INTRODUCTION

It is well known that maize responds well to applications of chemical fertilizers. Recent work in the Eastern Caribbean confirmed this, and suggested that grain yield enhancement could be expected on a number of soils, particularly from the use of nitrogenous and phosphatic fertilizers (Baynes 1969).

Robinson (1950) reported that there was economic benefit to be had with the use in Barbados, of two hundred weights per acre (250 kg/ha) of sulphate of ammonia applied to three week old sweet corn in surface bands. For Jamaica, Hewitt (1954) suggested that fertilizers should not be applied until the maize plants were about 6 inches (15 cm) tall and that fertilizers should be applied as surface bands 4 inches (10 cm) from the seed row. He further warned that there was no advantage in applying fertilizers in dry years, in cases of heavy insect pest infestation or where germination was poor. Sehgal & Brown (1968) however, in making a general recommendation for Jamaica, suggested the following split applications for successful grain corn production:-

(a) 62 lbs. of N per acre (69 kg/ha), 40 lbs. of phosphate per acre (45 kg/ha, Potash 40 lbs. per acre (45 kg/ha). Broadcast before planting.

(b) 14 lbs. N per acre (16 kg/ha), 20 lbs. phosphate per acre (22 kg/ha), and 20 lbs. potash per acre (22 kg/ha) applied at planting time 3 inches (7.6 cm) below and to the side of the seed.

(c) 45 lbs. nitrogen per acre (50 kg/ha) applied as a side dressing when plants are about 2 feet (60 cm) tall.

Cross (1969), recommended for general use in corn, under Trinidad conditions, the N.P.K. mixture 20:10:10 at the rate of 5 cwts. per acre (630 kg/ha) rotavated in, before planting, or applied in split application; two thirds before rotavation, and one third at seeding.

It is important that fertilizers be efficiently used, particularly by a crop like corn which is considered by many to be economically marginal. A strategy of application is therefore required which will ensure optimized returns on the fertilizer investment. This problem is being investigated wherever corn is grown, and it is obvious from reports that it would be unwise to extrapolate from one area to another. Clearly, fertilizer policy, including the time and method of application will depend on a number of factors, which vary with ecological conditions. In effect then, it is important that techniques should be developed which reflect the local situation.

Caja (1967), working in Peru reported that time of application of N was more important than method of application. He concluded that a single application at seeding time; in broadcast or in bands, provided the largest increase in yield, when compared with later treatments.

Payne (1969) in reviewing work done in Jamaica, recorded that while split applications of Sulphate of Ammonia were beneficial on Newall Loam, this practice did not lead to improved yields on St. Ann Clay Loam or on Caymans Sandy Loam.

Work in both Indian (Shulka & Wassey 1970) and Nigeria (Agboola 1970) demonstrated the benefit of split applications of N. In both cases, method of application did not appear to be important, however, good grain yield increases were observed from the application of N at seeding, at about six weeks of age and at tasselling.

Information on time and method of application of fertilizers in maize in the Eastern Caribbean is not generally available. This paper describes some thirteen field experiments conducted over a three year period in Barbados, St. Lucia, St. Vincent and Grenada, in which different methods and times of fertilizer application were studied.

MATERIALS AND METHODS

The experiments were conducted in Barbados on a Black Association Soil, during 1969, 1970 and 1971. In 1971 the identical experiment was repeated on a Yellow Brown Association Soil at Groves. Balembouche Gritty Clay Loam, and Capitol Clay Loam were used in

St. Lucia and Grenada, respectively, for the duration. In St. Vincent, Akers Sandy Clay Loam was tested in 1969 and 1971, while Bellevue Sandy Loam was used for the 1970 experiment there. (Stark et al 1966; Vernon & Carroll 1965; Vernon et al 1959; Watson et al 1958). A generalized description of the six soils involved in the study is given in Table I. The data has been reproduced from unpublished reports on chemical and physical analysis done by the Central Analytical Laboratory at the St. Augustine Campus of the U. W.I.

The thirteen experiments reported were all seeded at the beginning of the rainy season in each year in each island. No supplemental irrigation was done and the actual dates of seeding were:-

Islands	Years		
	1969	1970	1971
Barbados	August	June	August
St. Lucia	July	July	July
St. Vincent	May	May	June
Grenada	July	July	July

Rainfall was recorded daily on or near each site from which weekly totals were computed and presented in Table 2.

The cultivar used was Tropical Hybrid X304 produced by Pioneer Hi-Bred Seed Co., in Jamaica. The seed rate was standardized over all experiments to about 35,000 plants per hectare and the plot size employed was 1/373.59 hectares. The general management of the experiments were the same on all four islands over the three year period. Insect pests were controlled by the use of Sevin (Carbaryl) at the rate of 2.24 kg/ha, and weed control was adequate with a pre-emergence spraying of Gesaprim 80 (Atrazine) at the rate of 2.8 kg/ha and hand weeding.

Methods and time of application were as follows:-

1969: These treatments were arranged in a simple randomized complete block design of three replicates, and one experiment on each of the four islands was conducted (Table 2).

1970: Four experiments were established on the soils and islands as indicated in Table 2 and each consisted of four replicates of a split plot, with time of application in the main plot and placement method in the subplot.

1971: Five experiments were conducted during this year on the islands and soils as indicated in Table 2.

Four replicates of a randomized complete block design were placed on each site.

The 1969 series of experiments received a standard dressing of N.P.K. fertilizer as follows:-

Source	Nutrient	Rate/ha
Sulphate of Ammonia	N	120
Triple Superphosphate	P_2O_5	120
Muriate of Potash	K_2O	120

Work done by Baynes (1969) suggested that these levels were excessive for the soils under study, and so an attempt was made to use optimum levels for each island projected to meet the requirements needed for good responses. These were as follows for the 1970 and 1971 series:-

Nutrient	N	Kg/ha P_2O_5	K_2O
Source	as Sulphate of Ammonia	as Triple Superphosphate	as Muriate of Potash
Island			
Barbados	63	30	69
St. Vincent	100	58	69
St. Lucia	100	58	69
Grenada	90	86	69

RESULTS

1969 Experiments

The 1969 series did not permit the identification of a distinctly superior time or method of fertilizer application (Table 3). In Barbados on a Black Association soil, yields ranged from 1.20 T/ha in respect of surface bands 7.6 cm from seed row at seeding time, to 1.73 T/ha for broadcasting at seeding. No statistical significance could be established from the data.

In Grenada on Capitol Clay Loam, the grain production ranged from 3.00 T/ha in respect of broadcast application 30 days after seeding, to 4.50 T/ha for fertilizer placement 7.6 cm below and to the side of the seed row 30 days after seeding.

In St. Lucia, on Balembouche Gritty Clay Loam, grain yields recorded were a low of 5.33 T/ha from surface bands 7.6 cm from seed row 30 days after seeding, to a high of 6.57 T/ha in respect of the same method of application done at seeding time.

The range on Akers Sandy Clay Loam in St. Vincent was from 3.80 T/ha from broadcasting at seeding, to 4.60 T/ha from surface bands 7.6 cm from the seed row at seeding time.

Statistically significant differences were not demonstrated on any of the sites studied and variations due to treatment were not really large. Rainfall appeared to be adequate on all sites except at Husbands in Barbados where the 12, 13 and 14 weeks appeared to have been sub-optimal. In any event, the comparatively low grain yields experienced in Barbados were probably further influenced by ineffectual insecticidal treatment which resulted in serious damage by insect pests - probably Spodoptera. Across the four soils there were no clear advantages in delaying fertilizer application up to 30 days after seeding and neither broadcasting nor placement appeared to offer any enhancement in yield over the standard method of surface bands. However, early fertilizer application appeared to have produced good early growth, which was not reflected in grain yield out-turn.

1970 Experiments

The series conducted during 1970 wet season was perhaps more comprehensive in design. The four placement methods produced essentially the same grain yield within each set of comparisons (Table 4). The best grain yield on the Black Association soil in Barbados was 3.56 T/ha from broadcasting and the lowest 3.26 T/ha from placement 7.6 cm below and 20.3 cm to the side of the seed row. The effects of treatment were consistently small on all sites, the ranges being 5.94 T/ha and 6.04 T/ha, 4.49 T/ha, and 5.08 T/ha, and 5.02 T/ha, for St. Lucia, Grenada and St. Vincent, respectively.

Time of fertilizer applications was not demostrated to be of greater benefit than placement method on the soils studied, in this series (Table 5). In Barbados, fertilizer application at 14 days after seeding showed a small yield increase over the other methods, and delay in application until 30 days after seeding produced very modest grain increases in St. Vincent and St. Lucia. Seeding time applications, however, tended to be associated with small increment in grain yield in Grenada (Table 5).

None of the mean differences were statistically significant, nor were they large enough to be considered of economic interest. There was no measurable interaction between method of application and time of application.

1971 Experiments

Grain yields in the 1971 series were generally higher on the Barbados sites than on the other three sites studied. This stems, most probably, from the very unusually erratic rainfall distribution experienced, especially in St. Vincent and St. Lucia (Table 2).

The effects of treatments on all five soils studied were small and non significant (Table 6). While the highest grain yield on the Black Association was 5.65 T/ha from fertilizer in surface bands 7.6 cm from seed row at seeding time, the highest grain yield on the Yellow Brown Association soil in Barbados was 5.06 T/ha from fertilizer in surface bands in two applications, one at seeding and the other 4 weeks after seeding. This same treatment (No. 5) was associated with the highest yield 4.10 T/ha in St. Vincent on Akers Sandy Clay Loam, but it was associated with the lowest grain yield 2.40 T/ha on Capitol Clay Loam in Grenada. Treatment (4) involving four fertilizer applications produced the best (4.00 T/ha) grain yield in St. Lucia but treatment 3, fertilizer applied as surface bands 4 weeks after seeding was best in Grenada with a mean yield of 3.43 T/ha (Table 6).

DISCUSSION

The absence of clear evidence, that fertilizer placement is important in yield improvement on the soils studied, over the three seasons is most useful. The implications are, that placement is not critical and that the farmer may employ the cheapest and most convenient method and time of applications without the hazard of grain yield depression. Placement of fertilizers, particularly N with P, have been demonstrated to increase corn yield (Miller & Ohlrogge 1958) in Purdue. Shrotriya et al (1970), working with wheat in India, found that although N was required for yield increases, broadcast N was not materially different from side banded N in grain yield enhancement.

Time of application was not demonstrated to be of significance under the conditions studied, nor was split applications found to increase yields.

This seems to be consistent with Hewitt's (1954) recommendations. It conflicts with work by Shulka and Wassay (1970) in India and Agboola (1970), working Nigeria, who showed yield increases from split application of fertilizers. Times of application in this study might have shown benefit from treatments at tasselling time. The Indian, Nigerian and Jamaican observations all included a treatment at tasselling time. It is probable that the full benefits of placement and time of application could not be fully exploited by the plants because of serious vicissitudes in soil moisture caused by suboptimal rainfall distribution. This could explain the inconsistent yields of plants which having received early applications of fertilizers had clearly responded by appearing to grow at a faster rate than plants with late application. This was particularly obvious in the St. Lucia and Grenada experiments, but the effects of rainfall distribution could have been equally operative in Barbados and St. Vincent.

It would be reasonable to conclude that corn will not benefit from split applications, from delayed application or from placed fertilizers on the soils studied. When the extra cost and hazards of plant damage are considered, in the absence of clear yield elevation, split and delayed applications appear to have little to offer. Early applications of fertilizer was often associated with good plant stands which gave early ground cover, and tended, therefore, to offer better opportunity for more effective weed control.

SUMMARY

Split applications of fertilizer as well as a range of times of application, from seeding time to six weeks after seeding, and a variety of placement methods were tested in a number of field experiments, using hybrid corn cultivar X304, on six different soils in the Eastern Caribbean, over a three year period.

No single method or time of application produced a statistically superior grain yield. It is, therefore, suggested that fertilizer time and method of application might best be dictated by cost considerations and convenience, up to six weeks after seeding on the soils studied.

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TABLE 1.- Generalized Description* of Six Eastern Caribbean Soils (Depth 0-15mm)

Soil Type	pH	Mechanical Analyses % oven dry soil				% m.e. per 100 gm oven dry soil						% Base Sat.	% Oven dry soil		p.p.m.
		Coarse Sand	Fine Sand	Silt	Clay	C.E.C.	T.E.B.	Ca	Mg	K	Na		C	N	P_2O_5
Barbados															
(1) Black Association #30	7.5	7	16	8	73	34.4	-	-	3.7	0.76	1.62	100	1.9	0.18	110
(2) Yellow Brown Ass.#50	7.4	7	10	13	72	27.0	-	-	1.57	0.50	0.62	100	2.2	0.21	93
St. Lucia															
(3) Balembouche Gritty Clay Loam #38	6.5	56	18	14	13	10.6	(8.3)	5.8	2.0	0.21	0.17	78	2.3	0.23	6
St. Vincent															
(4) Akers Sandy Clay Loam #15	6.5	42	29	15	14	9.5	8.3	5.4	2.2	0.45	0.20	87	1.6	0.15	24
(5) Bellevue Sandy Loam #19	6.4	42	30	11	18	10.0	(7.1)	4.8	1.5	0.54	0.22	71	1.3	0.14	11
Grenada															
(6) Capitol Clay Loam #30	5.3	5	10	26	60	18.8	(10.7)	6.6	3.6	0.36	0.20	57	3.7	0.34	4

* (From unpublished data - Central Analytical Lab. U.W.I. St. Augustine, Trinidad)

TABLE 2.- Weekly Rainfall (mm) recorded at or near Experimental Sites, 1969, 1970, 1971

	Barbados				St.Lucia			St. Vincent			Grenada		
Weeks	Black Assoc. Husbands		Black Assoc. Graeme Hall	Yellow Brown Assoc. Groves	Balembouche Gritty Clay Loam Balembouche			Akers Sandy Clay Loam Bon Homme	Bellevue Sandy Loam Colonaire	Akers Sandy Clay Loam Carapan	Capitol Clay Loam Mirabeau	Capitol Clay Loam(dry) Telescope	Capitol Clay Loam Mirabeau
	1969	1970	1971	1971	1969	1970	1971	1969	1970	1971	1969	1970	1971
0	45	112	110	69	36	77	32	N.A.	39	28	55	62	8
1	16	21	52	168	76	124	8		17	5	10	57	26
2	58	27	26	36	36	42	9		26	2	73	46	98
3	41	78	8	20	14	43	24		20	12	69	13	71
4	10	33	17	19	53	34	3		14	6	49	61	37
5	15	19	5	61	88	120	10		106	12	57	57	34
6	30	94	32	8	75	20	35		47	12	17	66	30
7	32	38	36	19	39	0	133		76	30	22	16	49
8	29	8	40	29	13	11	64		95	85	44	87	41
9	37	1	9	48	41	21	18		12	23	61	47	60
10	50	20	50	0	166	15	22		43	49	71	14	54
11	30	74	50	38	23	195	41		222	30	57	58	188
12	24	5	16	72	37	82	3		43	73	162	19	36
13	1	2	57	5	57	0	43		16	99	72	33	36
14	3	54	48	127	21	84	35		74	9	23	100	140
15	39	35	7	20	98	44	-		20	62	61	16	46
16	27	556	6	2	15	38	-		48	44	60	22	9
17	44	8	-	64	-	110	-		42	-	5	17	112
18	-	-	-	-	-	48	-		-	-	-	-	-
Total	531	1185	569	805	888	1108	480	N.A.	960	581 (Argyle)	1168	791	1075

TABLE 3.- Maize Grain Yields (T/ha 15.5% moisture) on Four Soils, with Two Times and Three Methods of Fertilizer Application 1969

* Treat. Code	Barbados Black Association Husbands	Grenada Capitol Clay Loam Mirabeau	St.Lucia Balembouche Gritty Clay Loam Balembouche	St. Vincent Akers Sandy Clay Loam Bon homme
1	1.73	3.83	5.17	3.80
2	1.33	3.00	6.50	4.30
3	1.20	3.40	6.57	4.60
4	1.53	4.30	5.33	4.40
5	1.33	3.97	6.23	3.93
6	1.43	4.50	6.13	4.03
	N.S.D.	N.S.D.	N.S.D.	N.S.D.

* Treatment Code	Treatment Description
1	Broadcast - at seeding
2	" - 30 days after seeding
3	Surface bands 7.6 cm from seed row - at seeding
4	Surface bands 7.6 cm from seed row - 30 days after seeding
5	Placed 7.6 cm below and to side of seed row - at seeding
6	Placed 7.6 cm below and to side of seed row - 30 days after seeding.

TABLE 4.- Effects of Fertilizer Placement on Maize Grain Yield (T/ha 15.5% Moisture) on Four Soils in the Eastern Caribbean - 1970

Placement* Code	Barbados Black Association Husbands	St. Lucia Balembouche Gritty Clay Loam Balembouche	Grenada Capitol Clay Loam Telescope	St.Vincent Bellevue Sandy Loam Colonaire
1	3.26	6.04	5.08	5.52
2	3.40	5.94	4.78	5.02
3	3.55	5.98	4.89	5.28
4	3.56	5.97	4.49	5.28
	N.S.D.	N.S.D.	N.S.D.	N.S.D.

* Placement Code	Placement
1	7.6 cm below and 20.3 cm to side of seed row.
2	7.6 cm to side and below seed row.
3	Surface band 7.6 cm from side or seed row.
4	Broadcast.

TABLE 5.- Effects of Time of Application of Fertilizer on Maize Grain Yield (T/ha 15.5% moisture) in the Eastern Caribbean - 1970

Time of Application	Barbados Black Association Husbands	St.Lucia Balembouche Gritty Clay Loam Balembouche	St.Vincent Bellevue Sandy Loam Colonaire	Grenada Capitol Clay Loam
At Seeding	3.36	5.89	5.12	5.16
14 days after seeding	3.64	5.74	4.64	5.24
30 days after seeding	3.32	6.31	4.66	5.38
	N.S.D.	N.S.D.	N.S.D.	N.S.D.

TABLE 6.- Influence of Split Application and Placement of Fertilizers on Yields (T/ha 15.5% moisture) of Grain Corn (*Zea Mays* L) on Five Soils in Four Islands - 1971

Treatment* Code	Barbados Graeme Hall Black Association	Barbados Groves Yellow Brown Association	St.Lucia Balembouche Gritty Clay Loam	St.Vincent Carapan Akers Sandy Clay Loam	Grenada Mirabeau Capitol Clay Loam
1	5.65	4.02	3.63	3.20	2.90
2	5.53	4.59	3.50	4.00	2.93
3	5.27	4.61	2.48	4.00	3.43
4	4.90	4.88	4.00	3.15	3.18
5	4.86	5.06	3.88	4.10	2.40
6	5.44	4.13	3.73	3.73	3.00
7	5.16	4.43	2.73	3.18	2.73
	N.S.D.	N.S.D.	N.S.D.	N.S.D.	N.S.D.

* Treatment Number	Treatment
1	Fertilizing in surface bands 7.6 cm from seed row at seeding.
2	Fertilizing in surface bands 7.6 cm from seed row two weeks after seeding.
3	Fertilizer in surface bands 7.6 cm from seed row four weeks after seeding.
4.	Fertilizer in surface bands 7.6 cm from seed row in four applications:(a) at seeding (b) 2 weeks after seeding (c) 4 weeks after seeding (d) 6 weeks after seeding.
5	Fertilizer in surface bands 7.6 cm from seed row in two applications:(a) at seeding (b) 4 weeks after seeding.
6	Fertilizer in surface bands 7.6 cm from seed row in three applications:(a) at seeding (b) 2 weeks after (c) 4 weeks after.
7	Fertilizer placed 7.6 cm at side and 7.6 cm below seed at seeding time.