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PROCEEDINGS

ELEVENTH ANNUAL MEETING

THE EFFECT OF LOCAL CLIMATE AND SOIL FACTORS ON IRISH POTATO *(Solanum tuberosum)* YIELDS IN ST. LUCIA

by

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INTRODUCTION

The importation of Irish potatoes into St. Lucia had increased steadily during the 1960's. In 1964, St. Lucia imported 620,000 pounds of potatoes valued at $47,531.00 EC. In 1965 the Agricultural Department decided to embark upon a programme of investigations directed at determining the feasibility of producing Irish potato locally.

A temperate climate is generally considered to be more favourable for the production of the potato. Attempts to grow this crop commercially in the tropics have resulted in varying degrees of success (GOODING, 1961; CHAPMAN, 1965).

Under the climatic conditions of the Tropics, the Irish potato completes its growth period in a relatively short time. Thus climatic and soil conditions must facilitate the rapid growth and tuberization required to produce tuber yields at economic levels.

The soils of St. Lucia vary rather widely in physical and chemical characteristics. (STARK *et al,* 1966). On the low coastal lands the average daily mean temperature is about 25°C and varies by about 2°C between the coldest and the warmest months of the year. Temperature records for the higher altitudes are inadequate but it is known that temperature

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decreases with increase in altitude. Annual rainfall varies from about 127 cm at coastal locations in the North and South to 406 cm in the mountainous south-centre of the island (STARK *et al*, 1966). It was anticipated that such climatic and edaphic variation would provide agronomic conditions of varying degrees of suitability for the production of this crop.

Accordingly a number of field experiments were conducted with the following objectives:

(1) In 1966 – To relate the performance of five cultivars of this crop to the climate and soil properties at 10 sites.

(2) In 1967 – To evaluate the influence of various fertilizer treatments on the yields of two cultivars at two sites with marked ecological differences.

This paper discribes these experiments and summarises the major findings.

METHOD

The potato crops were grown during the dry season period, extending from January to May.

1966 Experiment:

The five potato cultivars were Arran Consul, Green Mountain, Sebago, Kennebec and Red La Soda. The location of the sites and the properties of the soils are given in Table 1.

Rainfall during crop growth was recorded for the various sites.

The experimental plots varied in size from about 0. 05 to 0. 10 hectares. The experimental designs consisted of randomized complete blocks with 3 to 5 replications.

The plots were tilled, ridged and whole 'seeds' planted in the ridges at a spacing of 30 cm within the row and 90 cm between the rows and at a planting rate of about two tons per hectare. An 8:12:25 ($N:P_2O_5:K_2O$) complete fertiliser (widely used for bananas then) was applied at the rate of 1,100 kg per hectare by hand 10 cm to the side of the plant row about two weeks after the plants had emerged.

Crop protection measures consisted of spraying Peronox or Dithane mixed with Sevin at 10 day intervals. Hand weeding was carried out as required and the plots were each moulded once.

The two experimental sites in the Delcer area (No. 6 and 7) were attached to the open drain irrigation system which was operational in this area. Once a week water was allowed to flow through the open channels which crossed each plot in amounts sufficient to provide a wet soil surface throughout the plot. The Desruisseaux plot was watered once weekly through sprinkler irrigation.

Tubers were harvested shortly after the foliage showed the first signs of senescence and this was generally about 12 weeks after planting.

1967 Experiments:

Two of the most successful cultivars of the 1966 trials, Green Mountain and Kennebec were used for these experiments.

The location and soil properties of the two sites are given in Table 2. The crops were planted on the 17th and 18th of January at Belle Plaine and Balembouche respectively.

The experimental plot in both areas was about 0. 10 hectare in size and the plots were similar in geometry. The experimental layout was a split-plot design with cultivar as main plot with four replications. Six fertilizer treatments made up the sub-plot units. The levels of NPK and S in the fertilizer treatments are given in Table 4. The compositions of the

fertilizer treatments were obtained by mixing the required supplements of ammonium sulphate, triple superphosphate and muriate of potash with the 'complete' 8:12:25 fertilizer. This high analysis 'complete' fertilizer was known to contain a negligible amount of sulphur and was used alone in treatment No. 4.

Whole 'seeds' were planted in furrows at a spacing of 31 cm within the rows and 76 cm between rows and at a rate of about two tons per hectare. Pre-emergence herbicides Lorox and T.C.A. were applied immediately after planting. The fertilizer treatments were side handed about one week after plant emergence. Crop protection measures consisted of fortnightly spraying with a cocktail of Peronox and Sevin. Hand weeding and moulding were carried out once at each site.

A sprinkler irrigation system was installed at the drier, low altitude site at Balembouche. Water was supplied whenever plant moisture stress was indicated through the plants developing a temporary state of wilt.

Time to harvest was determined as described for 1966 experiments.

RESULTS

1966 Experiments:

Relatively good yields were obtained for at least some cultivars at Belle Plaine (sites No. 1, 2 and 3) and at Giraud (site No. 4) (Table 3). Green Mountain was generally the highest yielding cultivar, producing yields of about 20 tons per hectare in the Belle Plaine (average over the three sites) and Giraud areas. The altitude of these two areas ranged from about 360 to 200 m and so the sites are referred to as 'middle' attitude sites. The weather was relatively cool during the experimental period. Rainfall during the crop growth period was well distributed and ranged from about 322 mm to 178 mm at the four sites (Table 3). The soil at each site was a sandy clay loam and was quite suitable for the required tillage practices.

Poor yields were obtained from sites No. 5, 6, 7, 8 and 9 which were located at altitudes below about 12 m. At Site No. 10 (near Quilesse) which was located at the highest altitide (550 m), the crop was completely devastated by disease symptomatic of 'late blight'.

Measured rainfall was quite low for sites No. 6 and 7, at Delcer. Rainfall for site No. 8 – Desruisseaux, was also apparently inadequate. At these sites, plants were often observed to be in an apparent state of physiological wilt during the day and the foliage of many plants dried up relatively early. Wilting was generally more evident after the flowering stage. Marble sized tubers formed most of the culls recorded for these sites in Table 3. Normal size tubers were obtained only from plants which were in wetter portions of the fields. A fungus whose white mycellium surrounded the base of the stem and the roots was associated with many plants which died at site No. 8 at Desruisseaux.

At site No. 5 (at Palmiste), mainly small sized tubers were produced by the Arran Consul cultivar and many of the larger tubers of this and other cultivars were knobby in shape. Although no rainfall data were available for this site, no dry spell was known to have existed in this area during the crop growth period. Mechanical analysis of soil samples taken during the experiment indicated that the soil type was clay loam (Table 1). STARK *et al* (1966) classified the site as having a loamy sand with fair water holding capacity and free to rapid drainage. Observations made during the study, support the drainage characteristics described by these authors.

At site No. 9, Union, disease and insect pest problems contributed to the low yields. The clay loam soil was heavy to work and the associated high water content under the high rainfall (Table 3) may have promoted the tuber rots and root diseases observed. It was noted that two of the blocks which were most severely affected by wilt problems coincided in location with a former tomato growing site.

The failure to carry out regular spraying for crop protection allowed the foliage disease to get out of control at site No. 10 near Quilesse. This is one of the wettest areas in St. Lucia.

1967 Experiments:

Measured rainfall at the 'middle' altitude site at Belle Plaine was about 620 mm (Table 2) and there was no indication of water stress at any time during the crop growth. Although the measured rainfall at the 'low' altitude site at Balembouche was as high as about 400 mm, it was still necessary to irrigate on two separate occasions. The lower values for rainfall and total number of rain days reflect the more sunny conditions observed at Balembouche than Belle Plaine during that period (Table 2). Measured maximum and minimum temperature were also higher at Balembouche than at Belle Plaine.

At both sites there was a significant response to fertilizer application and the cultivar Green Mountain produced significantly higher yields than the other cultivar, Kennebec (Table 4). There was no significant cultivar-fertilizer interaction in yield at either site.

According to the Duncan Multiple range test, the mean yields for control and fertilizer treatments fell into three groups (a, b and c) at Balembouche and two groups (a and b) at Belle Plaine. At Belle Plaine, treatment No. 4 which represented the highest levels of P and K, second highest level of N but negligible S did not produce significantly higher yield than Control. The other treatments, including No. 2 which consisted of less P and K, about same amount of N but more S than treatment No. 4, produced significantly higher yields than Control.

At Balembouche all fertilizer treatments produced significantly higher yields than Control. The mean yield from treatment No. 6 was significantly higher than treatments 2, 3 and 4 but not 5. There was no significant difference in yields among treatments 2, 3, 4 and 5. Only treatment No. 6 represented increases in N, P, K and S over treatment No. 2. As treatment No. 6 was also the only fertilizer treatment which

produced significant yield increase over treatment No. 2, the importance of nutrient balance at Balembouche is indicated.

Commercially good yields were obtained for Green Mountain cultivar at both sites for all the fertilizer treatments applied (Nos. 2 to 6). The highest yields obtained for the two cultivars at both sites were associated with the 2:1:2 and 3:2:4 ratios of NPK (Table 4). Treatments 2 and 5 at Belle Plaine and treatment 6 at Balembouche produced yields of just under and above 20 tons per ha respectively for the Green Mountain cultivar.

DISCUSSION

In the 1966 experiments generally good yields were obtained from the Irish potato cultivars only at the four 'middle' altitude sites. These sites were generally cool and rainfall was well distributed during crop growth. The highest average cultivar yield for these sites was obtained from Green Mountain and this was about 20 tons per ha.

Poor yields were obtained for the cultivars at the five 'low' altitude sites. It was evident through soil conditions and wilting characteristics of the plants that water stress contributed to limiting yields at three of the latter sites which were located in the Delcer and Desruisseaux areas. The conditions of low rainfall, prevalence of sunny skies and exposure to blowing winds which characterised these sites would be expected to favour a high level of potential evapotranspiration (VAN BAVEL, 1966; SKIDMORE *et al*, 1969). Under these conditions the water supplied through irrigation as practised proved to be inadequate. The prevalence of moisture stress after the flowering stage as indicated by the wilted condition of the plants may have been responsible for the large percentage of marble sized tubers obtained at these sites. Lack of water after flowering and tuber set is reported to be reflected mainly in the small size of tubers. (SALTER and GOODE, 1967). The 'knobby' shaped tubers obtained at Palmiste, particularly from the cultivar Arran Consul, suggested the existence of an irregular supply of available water during tuber bulking (IVINS and MILTHORPE, 1963; SALTER and GOODE,

1967). The apparent low water holding property of the soil at this site may have been mainly responsible for the suggested periodic low available moisture supply. At the other low altitude site, Union, moisture supply was evidently ample for plant growth but the low yields were at least partly due to the disease and insect problems. The heaviness of this clay loam soil was also clearly unsuitable for the required tillage practices.

Although the four 'middle' altitude sites were cooler than the 'low' altitude sites, the effect of ambient temperature *per se* on yields obtained in 1966 could not be evaluated as the poor yields at the latter sites were also associated with other unfavourable factors discussed above.

In the 1967 experiments both the texture and the water supplying characteristics of the soils at the 'low' and 'middle' altitude sites were considered to be favourable for the production of the potato. Plant water stress was kept to a minimum through the adequacy of rainfall at the 'middle' altitude site and the supplementing of the water supply from rainfall with irrigation at the 'low' altitude site. Both maximum and minimum temperatures were higher at the low altitude site (Table 2). The pattern of yields obtained for the different fertilizer treatments at the lower Balembouche site indicated that when the supply of nutrients was adequate, the yield levels were as high as the highest obtained from the more elevated and cooler Belle Plaine site. Thus yields of about 20 tons per ha were obtained from Green Mountain for treatments representing the more balanced levels of NPK and S applied at both sites. Unlike the Balembouche site, there was no response to the higher levels of N, P, K, S in treatment 6 over treatment 2 at Belle Plaine. This result reflects the higher nutrient status of the Belle Plaine site which was indicated in Table 2.

The suggestion of response to sulphur by the two Irish potato cultivars in the 1967 experiments was supported by the findings of MESSING (1969). In pot experiments he obtained response to sulphur application by tomatoes grown in some soil types associated with the Balembouche and Belle Plaine sites of the 1967 experiments; viz. Avrogne and Balembouche soil types respectively (STARK *et al* 1966).

CONCLUSIONS

Studies carried out on the production of Irish potatoes in St. Lucia in 1966 and 1967 indicated that yields of about 20 metric tons per hectare (about 9 tons per acre) are obtainable from some potato cultivars, such as Green Mountain, grown on medium textured loam soils.

The main factors which were found to influence yields at the experimental sites representing a wide range of ecological conditions were: potato cultivar; the availability of soil moisture, particularly after the flowering stage; the levels of nutrients NKP and S supplied; and the efficacy of the crop protection measures adopted.

SUMMARY

Five cultivars of Irish potatoes *(Solanum tuberosum)* were grown at ten sites in St. Lucia between January and May, 1966.

Good yields (about 20 metric tons per hectare) were obtained from the cultivar Green Mountain at four sites with medium textured soils and located at altitudes ranging from about 200 to 360 m. At these sites the weather was cool and moist during crop growth.

Poor yields were obtained at the five sites located at 'low' altitudes (120 m and below) and the site at the highest altitude (550 m). Inadequacy of soil moisture appeared to have contributed to the poor yields at four of the lower sites. Disease and insect pests contributed to the poor yield at the other low site. Disease destroyed the crop at the highest site where crop protection measures were not properly carried out.

The studies carried out in 1967 showed that when water and nutrients, N, P, K and S were adequately supplied, yields of about 20 tons per hectare were obtainable from Green Mountain cultivar at both a 'low' and a 'middle' altitude site.

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Table 1

Location and soil properties of the sites for the 1966 Irish Potato experiments

Site					Chemical Analysis of Soil							
						m.e. per 100 gm			%			ppm
No.	Name	Location	Approx* Altitude (in metres)	Soil Type**	pH	Ca	Mg	K	Base Sat.	% N	C/N Ratio	P (Truog)
1	Bath Nursery	Belle Plaine	360	Sandy Clay Loam	5.9	8.9	2.0	0.47	85	0.21	11.4	8
2	Bath Nursery	Belle Plaine	360	Sandy Clay Loam	5.4	7.2	1.2	0.22	86	0.12	10.8	35
3	Beausejour	Belle Plaine	360	Sandy Clay Loam	6.2	6.7	0.2	0.61	100	0.16	9.4	5
4	Giraud	Giraud	200	Sandy Clay Loam	6.7	10.3	2.0	0.67	89	0.17	10.6	10
5	Palmiste	Palmiste (near Soufriere)	10	Clay Loam	6.4	11.6	2.2	0.23	100	0.11	7.3	77
6	Industry	Delcer	100	Sandy Clay Loam	7.3	9.4	3.0	0.34	100	0.08	8.8	144
7	La Pointe	Delcer	90	Sandy Clay	6.7	8.7	2.6	0.30	100	0.07	17.1	3
8	Desruisseaux	Desruisseaux	120	Clay	6.2	5.3	1.4	0.22	67	0.17	11.2	2
9	Union	Union Agric. Station	10	Clay Loam	–	–	–	–	–	–	–	–
10	Savanne Edmund	near Quilesse	550	Clay	5.1	1.7	0.8	0.51	12	0.55	6.5	2

*Determined from map of St. Lucia.

**Determined through mechanical analysis of soil samples taken during the study.

Table 2

Location and soil properties of the sites for the 1967 Irish Potato experiments and Meteorological data for growth period

Site		Approx.* Altitude (in metres)	Soil Type**	Chemical Analysis of Soil						Climatic Data for Crop Growth Period			
					Me. per 100 gm			%		Ave. Tem.		Rainfall	
No	Name			pH	Ca	Mg	K	Base Sat.	ppm P	C^0 Max	C^0 Min.	Total	No. of days
1	Balembouche	15	Gritty Clay Loam	6.5	6.3	0.9	0.22	81	9	28.9	22.2	400	53
2	Belle Plaine	360	Clay Loam	6.0	8.4	1.4	1.56	76	12	25.6	20.0	620	77

*Determined from map of St. Lucia

**Determined from Soil and Land Use Survey report No. 20 – St. Lucia.

Table 3

Yield of tubers of five potato cultivars grown at 10 sites in St. Lucia – 1966

Site No.	Area Located	Date Planted	Rainfall (mm)	Average tuber yield (Tons/ha) and percentage weight of Culls (in brackets).				
				Arran Consul Yield	Green Mountain Yield	Kennebec Yield	Sebago Yield	Red La Soda Yield
1	Belle Plaine	26/1/66	322	13.3(8)	14.8(8)	9.6(11)	10.6(7)	12.4(10)
2	Belle Plaine	17/2/66	294	20.0(4)	24.5(7)	22.7(8)	8.7(10)	–*
3	Belle Plaine	25/1/66	322	17.3(4)	18.0(4)	10.9(4)	14.3(4)	19.0(10)
4	Giraud	18/2/66	178	13.8(11)	20.5(4)	17.1(4)	16.1(14)	–*
5	Soufriere	25/1/66	–**	4.7(**)	12.4(**)	6.7(**)	6.9(**)	9.6(**)
6	Delcer	26/1/66	53	4.0(24)	6.4(27)	5.4(12)	5.4(25)	5.4(17)
7	Delcer	27/1/66	53	3.5(30)	3.0(25)	3.0(20)	3.0(20)	4.7(23)
8	Desruisseaux	26/1/66	102	0.1 (about 90)	0.1 (about 90)	0.1 (about 90)	0.1 (about 90)	0.1 (about 90)
9	Union Agric. Station	8/2/66	444	3.2(6)	3.0(10)	5.9(9)	4.2(9)	3.0(9)
10	near Quilesse	26/1/66	470	0.0(–)	0.0(–)	0.0(–)	0.0(–)	0.0(–)

*Not Planted

**Not determined

Table 4

The effect of different fertilizer treatments on tuber yields of two potato cultivars at two sites in St. Lucia

Treat No.	Nutrient Level (kg/ha)				Approx. Ratio			Average Tuber Yield (Tons/ha)					
								Balembouche			Belle Plaine		
	N	P	K	S	N	P	K	Green Mtn.	Kennebec	Mean*	Green Mtn.	Kennebec	Mean*
1	0	0	0	0	0	0	0	7.9*	8.8	8.3 c	12.7	8.6	10.6 b
2	83	37	69	68	2	1	2	15.3	11.5	13.4 b	19.3	16.5	17.9a
3	134	29	56	142	5	1	2	16.3	10.8	13.6 b	17.9	14.3	16.1 a
4	90	58	232	neg	3	2	8	16.0	12.5	14.3 b	15.5	11.9	13.7 ab
5	90	58	116	54	3	2	4	18.6	14.4	16.5 ab	19.3	15.3	17.3 a
6	134	58	116	109	2	1	2	22.2	14.6	18.4 a	18.3	15.0	16.6a
								S.E. =± 0.44**			S.E. =± 0.54**		

*Within each experimental site, values for mean yields flanked by a letter in common are not significantly different ($P > 0.05$)

**For fertilizer treatment means of corresponding site.