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RESPONSE OF PEANUT (*Arachis hypogaea* L.) TO NITROGEN, MINOR ELEMENTS AND PHOSPHORUS FERTILIZATION ON A NEWLY TERRACED ULTISOL IN JAMAICA

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RESPONSE OF PEANUT (*Arachis hypogaea* L.) TO NITROGEN, MINOR ELEMENTS AND PHOSPHORUS FERTILIZATION ON A NEWLY TERRACED ULTISOL IN JAMAICA 1/

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No. IV- 3 Vincent A. Campbell, Abdul Wahab, Howard Murray, "Response of Peanut (Arachis hypogaea L.) to Nitrogen, Minor Elements and Phosphorus fertilization on a Newly Terraced Ultisol in Jamaica", January 1980.

FOREWORD

It has been shown that the peanut can perform well under Jamaica conditions. Over the years, this crop has been produced by small farmers on the low-lands using low levels of technology. This has resulted in low productivity per acre. Additionally, this has led to a situation in which the demand of peanut and peanut products is much greater than the local supply.

There has been little documentary evidence on the performance of this crop on hillside farms. Further, there has been no structured and continuing research of this crop, which would assist in development of its potential.

In a previous publication (No. III-7 of the IICA/Jamaica Office) evidence was presented which supports the research findings of the GOJ/IICA Allsides Project in relation to the profitable production of peanut grown on selected hilly lands of Jamaica.

It is clear that much greater applied research needs to be focussed on this crop in order to achieve its potential, and the necessary supportive extension facilities should be provided for the transfer of this technology when it becomes available to the hillside farmer.

This latest paper titled: "Response of Peanut to Nitrogen, Minor Elements and Phosphorus Fertilization on a Newly Terraced Ultisol in Jamaica" is intended to further contribute new technical information for the production of peanuts on terraced lands. The paper has been a joint effort between the Ministry of Agriculture and IICA/Jamaica. In this context, the Ministry of Agriculture was represented by Messrs. Vincent Campbell and Howard Murray, and IICA by Dr. Abdul H. Wahab. Editing was done by Dr. Irving E. Johnson of this Office.

It is with distinct pleasure that I write this Foreword for this paper which is the latest release in the collection of papers "Agriculture in Jamaica". I hope it will lead to a greater development of the industry, not only for food but for agro-industrial purposes, and will stimulate further studies towards the solution of technical problems related to the production of this crop on the hillsides of Jamaica.

Dr. Percy Aitken-Soux, Ph.D.
Director
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ABSTRACT

Studies were conducted to determine the response of peanuts to nitrogen at levels of 10, 50 and 100 kg/ha respectively and minor elements (M.E.) on a newly terraced Ultisol. Two other trials tested residual effects of applied fertilizers (Trial 2) and response of peanuts to phosphorus (Trial 3) at levels of 0, 75, 150, 225 and 300 kg/ha P_2O_5 respectively. Whole kernel yields ranged from 2.12 t/ha for 50 kg/ha N and M.E. treated plots to 4.20 t/ha for 10 kg/ha N plots. In Trial 2 whole kernel yields declined significantly and ranged from 1.13 t/ha for 10 kg/ha N plots to 1.50 t/ha for 10 kg/ha N + M.E. treated plots. Control plots receiving no fertilizer produced 0.5 t/ha or 12% of highest yields. Yields declined further in Trial 3 to 0.82 t/ha for 75 kg/ha P_2O_5 treated plots and 1.01 t/ha for 150 kg/ha P_2O_5 plots. Beyond this level of applied P_2O_5 yields declined to essentially those obtained from 0 t/ha P plots (0.62 t/ha). Dry stover yield, number of pods/plant and seed size decreased significantly in Trials 2 and 3. However, shelling percentage was excellent ($>$ 71%) for all three experiments and harvest index values were highest for treatments which produced the best yields. In Trial 1 the N treated plants were more vigorous than the N + M.E. treated ones. However, plant height did not differ significantly in Trials 2 and 3. The number of actual nodules/plant differed significantly between treatments only at six weeks in Trials 1 and 2 but not in Trial 3. Soil N and P levels were essentially unchanged at the end of Trials 1 and 2. In Trial 3 available phosphorus increased with applied P. Ca levels were high in all three trials, but levels of minor elements decreased with the exception of Cu. Nutrient levels of plant tissues were adequate in Trials 1 and 2 although a marked decline was recorded in Trial 2. In Trial 3, N and Ca contents of plant tissues were below the adequacy level for satisfactory crop growth.

INTRODUCTION

Eighty percent of Jamaica is hilly with slopes ranging from 5 to over 30°. Soils occurring on slopes exceeding 20° constitute about 60% of all the land.

Most of the food consumed locally is produced on these hillsides by small farmers having farms of less than 2 hectares, and who to a large extent do not practise any form of soil erosion control. Due to Jamaica's acute shortage of foreign exchange for food imports, hilly lands are now heavily relied upon for increased productivity. To sustain high productivity of hillsides it is a <u>sine qua non</u> that appropriate soil control measures be practiced. For instance, in Jamaica, studies on soil losses by Sheng and Michaelsen (1973) of unprotected yam plots having a 17 degree slope showed that as much as 114 tons of soil were lost/hactare/year. Further, when plots of the same gradient were bench-terraced and cropped to yams, soil losses were reduced to 18 tons/hectare/year.

To conserve these hilly soils, the Government of Jamaica has embarked on an ambitious programme of soil erosion control. Due to its ease of cultivation and the potential for intensive agriculture, bench terracing is the favoured erosion control measure for slopes ranging from 10 - 25°. However, during construction of bench terraces large quantities of top and subsoil are moved and later mixed. This can result in serious soil fertility problems which unless corrected can lead to unacceptable crop yields. It is important, therefore, to ascertain the best approach to amending recently terraced soils for improved crop production. To this end Harrison and Wahab (1977) showed that a newly terraced Ultisol responded significantly to applications of N, P_2O_5, and K_2O at rates of 150, 200 and 100 kg/ha respectively using corn as the test crop. Following this study three trials were conducted on the same soil but newly terraced, to test the response of peanut (Arachis hypogaea L.) to different levels of nitrogen, phosphorus and minor elements. This paper presents the results of these studies.

MATERIALS AND METHODS

Site

The trials were conducted at Allsides, Trelawny, having an elevation of 800m, on newly constructed bench terraces. The slope of the trial site varied from 10° to 25° prior to terracing. Mean annual rainfall is about 2000mm. There are two distinct rainy seasons from April through June and from September through October. The latter period is the more intense. Also, the intervening months are frequently accompanied by periods of sustained droughts as evidenced by negative atmospheric water balances. Mean annual maximum and minimum temperatures are 26.5C and 18.0C respectively.

The test soil, deep Ultisol (Dystropeptic Tropudults) and locally classified by Vernon and Jones (1958) as Wirefence Clay Loam Map No. 32, is derived from tuffs (igneous materials). The top soil (0-45cm) is dark brown clay loam of crumb structure tonguing into the B horizon. The B horizon (45-90cm) is a reddish brown clay of angular blocky structure with the presence of cutans. As presented in Table 1, the soil reaction is very strongly acidic (pH of 4.9) and exchangeable Al is high. Levels of available P (measured by the Truog's method) Mg and Zn were low while those of N and K were low to medium low. The plough layer has a bulk density of 1.2 g/cc, a field capacity ($\frac{1}{3}$ bar) of 32% and a cation exchange capacity of 14.0 meq/100g.

Treatments and Design

Trial 1 was started in May 1978 and lasted 105 days. A randomized block design was used with five replicates to test nitrogen (N) at levels of 10, 50 and 100 kg/ha as urea applied at planting. Additionally there were two treatments of 10 and 50 kg/ha N with trace elements which consisted of: 1 ppm B as boric acid; 10 ppm Cu as $CuSO_4$; 5 ppm Fe as iron chelate; 25 ppm Mg as kieserite; 20 ppm Mn as $Mn Cl_2$; and 0.02 ppm Mo as ammonium molybdate. Trace elements were applied as a foliar spray at four weeks from sowing. Also applied at planting was a blanket application of P_2O_5 and K_2O at 300 and 150 kg/ha respectively. To ameliorate soil acidity and low organic matter content, all plots received 3 t/ha $Ca(OH)_2$ and poultry manure respectively, five months prior to planting.

Trial 2 was established in the same plots as Trial 1 in September (two weeks following the harvest of Trial 1) and lasted until December (113 days). This trial was aimed at measuring the yield response of peanut to residual effects of N, P_2O_5, K_2O and trace elements following the harvest of Trial 1 and subsequent incorporation of the stover. Due to availability of space, one control plot was included in each block, and treated with lime and poultry manure only.

Trial 3 was aimed at ascertaining the optimum economic level of phosphorus for peanut growers on newly terraced soils. It consisted of five levels of P_2O_5 i.e. 0, 75, 150, 225 and 300 kg/ha, applied as triple super-phosphate.

The trial was established in plots other than those used in the previous trials. A randomized block design was used having three replicates. The variable levels of P_2O_5 as well as N as urea and K_2O as muriate of potash, at rates of 10 kg and 150 kg/ha respectively were applied in the furrows at planting. Placement was effected 5cm below the sowing depth. The trial commenced on November 8, 1978 and harvesting took place on March 21, 1979 (133-days).

Crop Management

For all trials seeds of peanut (Arachis hypogaea L.) of the Valencia cultivar were sown at 5cm intervals in rows 60cm apart, giving a density of 400,000 plants/ha. Plots 10.0m x 2.5m were weeded once manually. Beginning shortly before the onset of flowering and continuing to crop maturity, preventive disease and insect control was achieved by fortnightly applications of a mixture of Cupric hydroxide 1/ (Kocide at 1.86 kg a.i./ha) and Diazinon (Basudin at 0.67 kg a.i./ha) or Carbaryl (Sevin at 1.91 kg a.i./ha.)

Data Collection

Measurements of plant height and nodulation scores were recorded at the 50% flowering stage (6 weeks) and at crop maturity. Plants (upper stems and leaves) were sampled for tissue analyses at 50% flowering and thereafter at harvest. Following harvest, stover weight, pod yield, whole kernel weight and number of fully developed pods per plant were recorded. Following solar drying, shelling percentage, moisture content and seed size determinations were made.

The daily rainfall, evaporation from a class A pan and sunshine hours over the trial period were recorded at the Weather Station situated 200m from the trial site. During Trial 1, total rainfall amounted to 815mm, 50% of which was recorded during the period from sowing to flowering. Rainy days constituted 45%

1/ Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of material by the authors or an endorsement over other materials not mentioned.

of the trial period (105 days). In 47 days of the 105 day crop cycle there was an excess of moisture in the soil (positive atmospheric water balance (a.w.b.)) as calculated from the rainfall and evaporation data. Sunshine hours totalled 784.0 and ranged from an average of 8.2 hours/day in May to 7.0 hours/day in August.

As in Trial 1, Trial 2 benefited from adequate rainfall (total of 840mm recorded), and the pattern was of such that at periods of crop development and pod filling when water requirement is greatest (Salter and Goode (1967)), a.w.b. was consistently positive. Total sunshine hours decreased from 784.0 in Trial 1 to 706.2 and averaged 6.2 hours/day during Trial 2.

Unlike Trials 1 and 2, Trial 3 suffered from severe moisture stress during the critical stages of crop development. For example, total rainfall amounted to 165mm compared to 815 and 840mm for Trials 1 and 2 respectively. The a.w.b. was consistently negative throughout the trial period. Total sunshine hours increased from 784.0 and 706.2 in Trials 1 and 2 respectively to 894.6 and averaged 6.7 hours/day. The mean maximum temperature during the trial period was 25.9°C.

RESULTS AND DISCUSSION

Yield and Yield Components

Whole kernel yields, stover weight, number of pods per plant, shelling percentage, harvest index (H.I.) and seed size for the trials are presented in Tables 2 and 3. In Trial 1, yield of whole kernels were lowest (2.12 t/ha) for plots which received nitrogen (N) and minor elements (M.E.) and highest (4.20 t/ha) for plots which received 10 kg/ha N alone. There was no significant difference in kernel yield from plots which received 10, 50 and 100 kg/ha N respectively, indicating that there is an economic disadvantage from increasing N levels beyond 10 kg/ha. The significant decline in yield recorded from those plots which received M.E. could be attributed to a depression in growth resulting from the foliar application of these elements as burning was observed following what appeared to be too high a concentration. In future studies it will be necessary to employ different concentrations of M.E. and an appropriate method of application. Studies to test the residual effects of N and M.E. applied in Trial 1, (Trial 2) showed that there was a highly significant decline in yields from those obtained in Trial 1. Yields ranged from 1.50 t/ha for plots which had been fertilized at the rate of 10 kg/ha of N plus M.E. to 1.13 t/ha for those plots which had received a similar level of N with no foliar application of M.E. Also yields of the control plots (0.52 t/ha) were markedly low and the lowest for all the treatments. In general there was a 70% decline in yields from Trial 1, as compared with those from Trial 2. These results indicate that rational fertilization is a sine qua non for economic yields of peanut on this Ultisol.

The yield results of Trials 1 and 2 suggest that nitrogen rates approximating 10 kg/ha plus a blanket application of P and K are essential for satisfactory peanut yields on this soil type - (Ultisol locally classified as Wirefence Clay Loam map No. 32). This finding is consistent with the recommendation of De Geus (1973) that a light dressing of N at 20 - 30 kg/ha be employed for successive planting of this crop. Further, the yield data obtained from the 10 kg/ha N plots (4.20 t/ha) is very promising when compared to the average yield of 1.1 t/ha presently obtained by Jamaican farmers as estimated by the Ministry of Agriculture (1979).

Yield response to applied phosphorus was disappointingly poor, ranging from 0.82 t/ha for plots receiving 75 kg/ha P_2O_5 to 1.01 t/ha for those plots which had received 150 kg/ha P_2O_5 (Table 3). Beyond this level yields declined to essentially those obtained when no phosphorus was applied.

The extremely low yield response to phosphorus could be attributed to a combination of factors such as: (1) inadequate soil moisture during the critical stages of crop growth and development, which resulted in poorly developed plants and early flowering at 28 days compared with 45 days for Trials 1 and 2; and (2) a high degree of phosphate fixation (94 percent) occurring on the test soil. 1/

Yields of dry stover were highest (2.69 t/ha) from plots treated with N alone, with no significant difference recorded between N treatments; and lower (1.59 t/ha)in those plots which had received 50 kg/ha N and M.E. (Trial 1.) In the trial to test the residual effects of N and M.E. stover weights showed a general decline from Trial 1 but to a lesser extent. As in the case of kernel yield, stover yield was lowest (0.83 t/ha) in the control plots. A highly significant relationship was obtained between whole kernel yield and stover weight in Trials 1 and 2 (r = 0.97). In the phosphorus experiment (Table 3) yields of dry stover were very poor (0.84 - 1.24 t/ha) with no significant difference between treatments.

There was no significant difference between treatments in the number of fully developed pods per plant at the end of Trial 1 (Table 2). However, as in the case of kernel and stover yields, number of pods per plant declined sharply in Trial 2, averaging five as compared with nine in Trial 1. In the phosphorus experiment (Trial 3) the number of pods per plant further declined to three.

Shelling percentages (Tables 2 and 3) were excellent in all three trials with plots receiving N alone in Trial 1 giving a significantly higher shelling rate (76%) than those receiving N and M.E. (72%). Shelling percentage was essentially the same for Trials 2 and 3 and averaged 76% and 72% respectively.

Harvest index values for all three trials were highest for those treatments which produced the best yields whereas low values corresponded to those producing lower yields. Values ranged from 0.42 to 0.53, 0.33 to 0.56 and 0.35 to 0.43 in Trials 1, 2 and 3 respectively. Seed weights declined from 48.20 grams/100 seeds in Trial 1 to 41.63 grams in Trial 2. In the phosphorus experiment 100 seeds weighed 46.81 grams.

1/ Personal communication, R.J. Baker, Agricultural Chemistry Division, Ministry of Agriculture, Jamaica, 1979.

Plant height and nodulation scores at flowering and harvest are presented in Tables 4 and 5. Plots in which M.E. were withheld out-performed those receiving both N and M.E. At six weeks severe stunting was observed in M.E. treated plots which had an average height of 4.4cm as compared with 16.0cm for the others. However, at harvest (14 weeks), the N and M.E. plots had increased to a height of 21cm whereas the N alone plots had attained a height of 31cm or 50% taller. In the second trial plant heights did not differ significantly at six and fourteen weeks irrespective of treatment. For both Trials 1 and 2 kernel yields were highly correlated with plant height (r = 0.96 and 0.96). In the phosphorus experiment plant height remained essentially unchanged following the onset of flowering (four weeks). Further, irrespective of the level of phosphorus applied, there was no significant difference in plant height.

The number of active nodules per plant in Trial 1 differed significantly at six weeks between the plots which received 50 kg/ha N (47 nodules/plant) and the other plots (mean 36 nodules/plant). However, despite an overall increase in nodulation at 14 weeks, there was no significant difference between treatments. This trend persisted in Trial 2 but the significant difference observed at six weeks occurred only between the control plots and those which had received both N and trace elements during Trial 1. In the phosphorus experiment plants nodulated poorly at flowering and showed a slight increase at harvest. No significant difference was observed between treatments, irrespective of sampling dates.

Data on nutrient levels of the test plots at the end of each experiment are summarised in Tables 6 and 7. Comparing these results with the inherent nutrient status of the test soil (Table 1) it is apparent that soil acidity was considerably ameliorated and level of exchangeable Aluminium decreased significantly at the end of the trial period. Nitrogen levels remained essentially unchanged in all three trials. In the phosphorus experiment, the P level increased slightly with increasing amounts of applied phosphorus, but remained essentially unchanged at the end of Trials 1 and 2. The K level declined significantly from 168 ppm at the onset of the trials to 23 ppm at the end of Trial 2. However, in the phosphorus experiment potassium levels showed a lower rate of decline from 168 ppm to 129 ppm following harvest of the crop. Calcium levels were consistently high in all three experiments. Levels of trace elements decreased with the exception of Copper for which an actual increase was recorded. This increase can be attributed to regular applications of a copper fungicide to control against rust and web blotch diseases. Also apparent from these results is that the lower yields obtained in Trial 2 coincided with lower levels of P and K in the soil. These data indicate that peanuts grown on an Ultisol respond better to direct fertilization than to residual fertility.

Nutrient levels of plant tissues at the flowering stage are shown in Tables 8 and 9. For Trials 1 and 2 levels of nutrients were within the sufficiency range as reported by Walsh and Beaton (1973). There was a noticeable decline in most of the plant elements in Trial 2. This is consistent with the lower yields obtained in the second crop which did not benefit from direct fertilization.
In the phosphorus trial, with the exception of N and Ca, levels of the other major elements were adequate for crop growth. In comparison with Trial 1, levels of minor elements were lower but adequate for crop growth.

SUMMARY

Peanut yield response and other agronomic parameters were studied using three levels of nitrogen viz. 10, 50 and 100 kg/ha respectively with and without minor elements (M.E.) and with a blanket application of P and K, lime and organic matter on a newly terraced Ultisol. Further studies were conducted to test the residual effects of N, P and K and M.E. applied in the first crop. A third experiment was conducted to test the yield response of peanuts to 0, 75, 150, 225 and 300 kg/ha P_2O_5. Whole kernel yield was lowest (2.12 t/ha) for plots treated with 50 kg/ha N and M.E. and highest (4.20 t/ha) for plots which received 10 kg/ha N. No significant difference in kernel yield was recorded for plots which received 10, 50 and 100 kg/ha respectively, indicating that there is an economic disadvantage from increasing N rates beyond 10 kg/ha. In the second trial to test the residual effects of treatment applied in Trial 1, whole kernel yield declined significantly ranging from 1.13 t/ha for plots that had been treated with 10 kg/ha N to 1.50 kg/ha in those that originally received 10 kg/ha + M.E. Control plots receiving no fertilizer whatever produced yields of 0.52 t/ha or 12% of plots receiving 10, 300 and 150 kg/ha respectively of N, P_2O_5 and K_2O. Yield response to applied P was disappointingly poor, ranging from 0.82 t/ha for plots that received 75 kg/ha P_2O_5 to 1.01 t/ha for those which were treated with 150 kg/ha P_2O_5. Beyond this level, yields declined to essentially those obtained when no P was applied (0.62 t/ha). Poor yield response could be attributed to inadequate moisture during crop growth and development.

Dry stover yields ranged from 1.59 t/ha to 2.69 t/ha for 50 kg/ha N + M.E. and 50 kg/ha N treated plots respectively. In Trial 2 stover yields declined as in the case of the whole kernel yields but to a lesser extent. In the P trial stover yields were low and ranged from 0.84 to 1.24 t/ha.

Shelling percentage was excellent for all three experiments (> 71%) and harvest index values were highest for treatments which produced the best yields. Seed size was highest (48.20 grams per 100 seeds) in Trial 1 and lowest (41.63 grams per 100 seeds) in the residual effect of fertilizer trial.

The N treated plants grew taller than the N + M.E. treated ones which showed severe stunting at six weeks. This could have been attributed to method of application and concentration level of foliar spray. This pattern continued through crop maturity. In the second trial plant height did not differ significantly. Plant heights were lowest in the phosphorus experiment and unlike the two previous trials, there was no appreciable increase in plant height following flowering. A significant difference in the number of active nodules per plant was recorded only on the 50 kg/ha N treated plots at 6 weeks. However, despite an overall increase in nodulation, there was no significant difference between treatments at 14 weeks. This trend persisted in Trial 2. Nodulation was observed to be poorest in the P trial. Data on nutrient status at the end of the trials indicate that soil pH increased from 4.9 to 5.6. Exchangeable Al decreased substantially from 6.7 to 1.80 ppm. N and P levels were essentially unchanged at the end of Trials 1 and 2. In the phosphorus experiment soil phosphorus increased with applied P. Ca level was persistently

high in all three trials, but levels of minor elements decreased with the exception of Cu. Nutrient levels of plant tissues were adequate in Trials 1 and 2 although a marked decline was measured in Trial 2. In the phosphorus trial N and Ca levels of plant tissues were below the adequacy levels for satisfactory crop growth.

These data suggest that on a newly terraced Ultisol and specifically on the test soil discussed, N fertilization should not exceed 10 kg/ha per crop for satisfactory peanut yield. Further, soil organic matter and pH should be ameliorated prior to crop establishment. Rational fertilization is a <u>sine qua non</u> for acceptable yields. Results obtained from the P experiment do not provide a basis for making forthright recommendations on optimum P application at the time.

Table 1. - Selected physical and chemical properties of the 0-45cm soil layer of a newly terraced Ultisol at the beginning of the trials.

Physical and Chemical Properties	Value
Clay %	62.78
Silt %	22.01
Sand %	15.21
Organic matter content %	3.05
Field Capacity at 1/3 bar, %	32.00
Bulk density, g/cm^3	1.20
pH (1:2.5)	4.90
Cation exchange capacity, meq./100g	14.00
Exchangeable Al, meq./100g	6.70
Available Nutrients[1]:	
Nitrogen, ppm	15.00
Phosphorus, ppm	13.60
Potassium, ppm	168.00
Calcium meq./100g	5.50
Magnesium meq./100g	1.40
Copper, ppm	1.30
Iron, ppm	92.00
Maganese, ppm	8.10
Zinc, ppm	3.60

1. Ca and Mg were determined by using N KCl extract; K was determined by using 0.5 NCH_3COOH extract; and P by the Truog's method.

Table 2. Whole kernel yield and yield components of peanut grown under three N rates with and without minor elements (Trial 1) and with no additional N and minor elements, i.e. residual effect of Trial 1 (Trial 2) on a newly terraced Ultisol in Jamaica

	Nitrogen rates (kg/ha) & minor elements (M.E.)						Co-efficient	L.S.D.
	0	10	50	100	10 + M.E.	50 + M.E.	of variation(%)	(0.01)
Whole kernel yield at 10% H_2O (t/ha)								
TRIAL 1	-*	4.20	4.04	4.13	2.24	2.12	12.10	0.75
TRIAL 2	0.52	1.13	1.22	1.38	1.50	1.43	13.17	0.69
Stover wt. at 10% H_2O (t/na)								
TRIAL 1	-	2.51	2.64	2.69	1.95	1.59	15.40	0.65
TRIAL 2	0.83	1.49	1.46	1.50	1.48	1.51	29.86	NS
No. of Pods/Plant								
TRIAL 1	-	8	11	9	9	9	17.31	NS
TRIAL 2	3	4	5	5	5	5	14.58	1.21
Shelling %								
TRIAL 1	-	76.4	75.6	75.9	71.1	71.9	1.78	2.43
TRIAL 2	73.8	77.4	75.8	77.7	75.8	76.4	3.0	NS
Harvest Index								
TRIAL 1	-	0.53	0.49	0.51	0.42	0.48	9.32	NS
TRIAL 2	0.33	0.39	0.44	0.46	0.56	0.42	19.50	0.15
Seed size at 10% H_2O (g/100 seeds)								
TRIAL 1	-	46.86	51.40	49.57	45.34	47.85	4.99	4.44
TRIAL 2	41.5	41.5	42.2	41.5	41.0	42.1	2.3	NS

* Not included in Trial 1

Table 3. Whole kernel yield and yield components of peanut grown under five P rates (Trial 3) on a newly terraced Ultisol in Jamaica

	Phosphate rates (kg/ha P_2O_5)					Co-efficient	
	0	75	150	225	300	of variation (%)	L.S.D.
Whole kernel yield at 10% H_2O (t/ha)	0.62	0.82	1.01	0.83	0.71	46.8	NS
Stover wt. at 10% H_2O (t/ha)	0.95	0.84	1.13	1.24	0.87	51.1	NS
No. of pods/plant	3	4	5	3	2	46.9	NS
Shelling %	71.9	72.5	72.8	72.3	72.2	0.73	NS
Harvest Index	0.35	0.43	0.40	0.39	0.40	23.6	NS
Seed size at 10% H_2O (g/100 seeds)	45.67	47.74	48.31	45.85	46.41	2.50	NS

Table 4. Plant height and number of active nodules at 50% flowering stage (6 weeks) and at harvest (14 weeks) from sowing of peanut grown under three levels of Nitrogen with and without minor elements (Trial 1) and with no additional Nitrogen and minor elements i.e. response to residual fertilizers (Trial 2) on a newly terraced Ultisol in Jamaica.

	Nitrogen rates (kg/ha) and minor elements (M.E.)						Co-efficient	L.S.D.
	0	10	50	100	10 + M.E.	50 + M.E.	of variation(%)	(0.05)
TRIAL 1								
Plant height (cm:)								
6 weeks	-	15.3	16.3	16.1	4.0	4.8	10.09	1.53
14 weeks	-	31.6	32.8	29.7	21.7	20.1	6.37	2.32
No. of Active Nodules/Plant:								
6 weeks	-	36	47	38	35	35	16.62	8.47
14 weeks	-	89	100	82	96	85	21.99	NS
TRIAL 2								
Plant height (cm):								
6 weeks	12.4	15.8	15.1	16.3	17.3	16.0	14.98	NS
14 weeks	15.9	22.2	21.6	22.5	23.0	21.5	12.76	3.61
No. of Active Nodules/Plant:								
6 weeks	27	40	57	39	51	43	16.82	9.7
14 weeks	33	49	59	45	57	59	31.26	NS

Table 5. Plant height and number of active nodules at 50% flowering stage (4 weeks) and at 19 weeks of peanut plants treated with five levels of phosphorus and grown on a newly terraced Ultisol.

Phosphorus levels (kg/ha P_2O_5)	Plant height (cm)		No. of Active Nodules/Plant	
	4 weeks	19 weeks	4 weeks	19 weeks
0	7.5	8.9	18	34
75	[illegible]	10.4	29	33
150	10.6	11.6	35	36
225	10.1	12.1	16	33
300	7.7	7.9	33	31
Co-efficient of Variation (%)	20.99	33.60	35.54	25.36
L.S.D.	NS	NS	NS	NS

Table 6. Nutrient levels of a newly terraced Ultisol in Jamaica cropped to peanut under three N rates with and without minor elements (M.E.) (Trial 1) and with no additional N and M.E. (Trial 2)

Nutrient	END OF TRIAL 1 Nitrogen rates (kg/ha) and minor elements (ME.) 0	10	50	100	10 + M.E.	50 + M.E.
N %	-	0.12	0.12	0.12	0.12	0.14
P (ppm)	-	17.00	29.00	26.00	17.00	16.00
K (ppm)	-	88.00	87.00	116.00	119.00	116.00
Ca (meq./100g)	-	4.90	8.50	11.00	7.60	8.60
Mg (meq./100g)	-	1.96	1.94	2.24	2.08	2.08
B (ppm)	-	6.00	4.00	7.00	7.00	6.00
Cu (ppm)	-	4.00	3.00	4.00	6.00	7.00
Fe (ppm)	-	67.00	70.00	90.00	77.00	75.00
Mn (ppm)	-	7.00	6.00	9.00	11.00	9.00
Zn (ppm)	-	3.00	4.00	3.00	4.00	4.00
pH (1:2.5)	-	5.3	5.6	5.4	5.3	5.5
Al (meq./100g)	-	4.0	2.0	2.6	1.4	2.3

Nutrient	END OF TRIAL 2 Residual nitrogen rates (kg/ha) and minor elements (M.E.) 0	10	50	100	10 + M.E.	50 + M.E.
N %	0.15	0.16	0.15	0.16	0.17	0.15
P (ppm)	12.00	16.00	16.00	8.00	16.00	21.00
K (ppm)	15.00	22.00	16.00	20.00	22.00	42.00
Ca (meq./100g)	9.40	10.30	7.30	9.40	9.50	6.30
Mg (meq./100g)	0.91	0.92	1.00	0.94	1.11	1.00
B (ppm)	10.00	6.00	5.00	4.00	7.00	4.00
Cu (ppm)	10.00	8.00	5.00	10.00	13.00	13.00
Fe (ppm)	85.00	105.00	100.00	89.00	100.00	98.00
Mn (ppm)	9.00	9.00	9.00	10.00	12.00	9.00
Zn (ppm)	1.00	2.00	1.00	2.00	2.00	3.00
pH (1:2.5)	5.5	5.6	5.3	5.5	5.6	5.2
Al (meq./100g)	3.1	0.5	2.2	1.1	0.6	3.3

Table 7. Nutrient levels of a newly terraced Ultisol in Jamaica following one peanut crop grown under five rates of phosphorus (Trial 3)

Nutrient	RATES OF PHOSPHORUS (kg/ha P_2O_5) 0	75	150	225	300
N %	0.13	0.15	0.13	0.12	0.12
P (ppm)	17.18	18.96	21.03	26.81	26.52
K (ppm)	115.62	136.68	138.34	130.31	122.57
Ca (Meq./100g)	5.99	7.60	8.83	8.27	8.47
Mg (Meq./100g)	1.46	1.61	1.73	1.65	1.55
B (ppm)	6.00	6.67	7.33	5.67	5.67
Cu (ppm)	4.00	6.00	4.67	8.00	6.33
Fe (ppm)	56.67	59.33	57.33	60.67	50.33
Mu (ppm)	9.67	8.33	7.33	10.00	7.33
Zn (ppm)	3.67	3.67	4.00	3.00	4.00
pH (1:2.5)	5.2	5.3	5.1	5.3	5.4
Al (meq./100g)	2.2	2.0	2.3	2.0	1.8

Table 8. Nutrient levels of stems and leaves of peanut grown on a newly terraced Ultisol in Jamaica under three N rates with and without minor elements (M.E.)(Trial 1) and no additional N and M.E. (Trial 2) at the 50% flowering stage (six weeks)

	TRIAL 1							
	Nitrogen rates (kg/ha) and minor elements(M.E.)						C.V.	L.S.D.
Element 1/	0	10	50	100	10 + M.E.	50 + M.E.	%	0.05
N (%)	*	3.6	3.5	4.00	4.2	3.9	12.2	NS
P (%)	-	0.7	0.8	0.8	0.7	0.7	13.7	NS
K (%)	-	5.6	5.2	5.6	5.9	6.6	19.6	NS
Ca (%)	-	1.3	1.3	1.4	1.3	1.2	8.6	NS
Mg (%)	-	0.9	0.8	0.8	0.8	0.8	10.4	NS
B (ppm)	-	25	28	26	37	38	23.2	9.6
Cu (ppm)	-	420	460	500	800	640	24.9	188.0
Fe (ppm)	-	108	115	110	180	110	27.5	46.0
Mn (ppm)	-	32	65	43	104	81	55.2	48.0
Zn (ppm)	-	26	46	28	74	60	49.7	9.9

	TRIAL 2							
	Nitrogen rates (kg/ha) and minor elements(M.E.)						C.V.	L. S. D.
Element	0	10	50	100	10 + M.E.	50 + M.E.	%	0.05
N (%)	3.5	3.6	3.7	4.0	3.5	3.6	3.9	0.18
P (%)	0.2	0.3	0.3	0.3	0.3	0.3	11.7	0.04
K (%)	1.8	2.1	2.1	2.0	2.5	2.6	19.1	0.55
Ca (%)	1.4	1.3	1.3	1.3	1.2	1.1	10.3	0.17
Mg (%)	0.6	0.6	0.6	0.6	0.5	0.5	18.2	NS
B (ppm)	33	32	34	34	34	32	5.8	NS
Cu (ppm)	355	455	370	495	345	360	22.6	NS
Fe (ppm)	136	182	156	168	122	152	15.7	30
Mn (ppm)	55	41	41	47	48	60	23.1	NS
Zn (ppm)	36	37	38	37	38	46	14.7	NS

1/ Sufficiency ranges as given by Walsh and Beaton (1973) for N,P,K, Mg are: 3.5-4.5, 0.25-0.50, 2.00-3.00, 1.25-2.00, 0.30-0.80 % respectively. For B, Cu, Fe, Mn and Zn values they are: 25-60, 6-15, 50-300, 50-350 and 20-50 ppm respectively.

* Not included in Trial 1

Table 9. Nutrient levels of stems and leaves of peanut grown under five rates of phosphorus (Trial 3) at 50% flowering stage (4 weeks).

Element 1/	RATES OF PHOSPHORUS ($kg/ha\ P_2O_5$)					C.V.	L.S.D.
	0	75	150	225	300	(%)	(0.05)
N (%)	3.08	3.30	3.30	3.36	3.14	6.37	NS
P (%)	0.39	0.51	0.47	0.42	0.42	24.11	NS
K (%)	2.24	2.32	2.39	2.41	2.67	5.25	5.0
Ca (%)	0.90	0.98	1.00	0.90	1.03	17.27	NS
Mg (%)	0.65	0.60	0.80	0.73	0.61	10.40	4.0
B (ppm)	29.60	28.10	31.60	30.30	28.20	7.41	NS
Cu (ppm)	160.00	193.33	133.33	160.00	160.00	17.09	NS
Fe (ppm)	73.30	70.00	66.70	73.30	63.30	19.45	NS
Mu (ppm)	46.67	47.67	50.00	53.33	56.57	30.12	NS
Zn (ppm)	54.33	62.00	46.67	57.33	57.33	18.28	NS

1/ Sufficiency ranges as given by Walsh and Beaton (1973) for N,P,K, Mg are: 3.5-4.5, 0.25-0.50, 2.00-3.00, 1.25-2.00, 0.30-0.80 % respectively. For B, Cu, Fe, Mn and Zn values they are: 25-60, 6-15, 50-300, 50-350 and 20-50 ppm respectively.

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