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RESPONSE OF PEANUT TO NITROGEN AND MINOR ELEMENT FERTILIZATION ON A NEWLY TERRACED ULTISOL IN JAMAICA

V. A. Campbell
Agricultural Chemistry Division, Ministry of Agriculture, Jamaica

A. H. Wahab
Inter-American Institute of Agricultural Sciences – Jamaica Office

H. Murray and M. Ramsay
Soil Conservation Unit, Ministry of Agriculture, Jamaica.

INTRODUCCION.

Eighty percent (80%) of Jamaica is mountainous with slopes ranging from 5 to over 30°. Most of the food consumed locally is produced on these hillsides by small farmers having 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 foraign exchange for food imports, hilly lands are now heavily relied upon for increased productivity. To sustain high productivity of hillsides it is a **sine qua non** that appropriate soil control measures be practised. For instance, in Jamaica, studies on soil losses by Sheng and Michaelsen of unprotected yam plots having a 17 degree slope showed that as much as 114 tons of soil were lost/hectare/year. Further when plots of the same gradient were bench-terraced and cropped to yams, soil losses were reduced to 18 tons/hectare/year (1973). 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 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 must be corrected to obtain satisfactory 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 two trials were conducted on the same soil but newly terraced, to test the response of peanut *(Arachis hypoguea* L.) to different levels of N. This paper presents the results of these studies.

MATERIALS AND METHODS

Site

The trials were conducted at Allsides, Trelawny, having an elevation of 800 m, on newly constructed bench terraces. The slope of the trial site varied from 10^{o} to 25^{o} prior to terracing. Mean annual rainfall is about 2000 mm. There are two distinct rainy seasons from April through June and from Septe mber through October. The latter period is the more intense. Also, the intervening months are frequently accompanied by periods of sustained droughts. Mean annual maximun and minimun temperatures are 26.5C and 18.0C respectively.

The test soil, deep Ultisol (Dystropeptic Tropudults) and locally classified by Vernon and Jones (1958) as Wiregence Clay Loam Map No.32, is derived from tuffs (igneous materials). The top soil (0–45 cm) is a dark brown clay loam of crumb structure tonguing into the B. horizon. The B horizon (45–90 cm) is a reddish brown clay ot 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 (1/3 bar) of 50% and a cation exchange capacity of 14.0 meg/100 g.

Treatments and Design

Thial 1 was started in May 1978 and lasted 105 days. A randomized block design was used with five replicates to test nitrogen (N) at 10, to and 100 kg/ha as urea applied at planting. In addition 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 $Mn\ C1_2$; 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_20_5 and K_20 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 poltry manure, respectively, five months prior to planting.

Trial 2 was established in the same plots as Trial 1 in September (two weeks following the harst of Trial a) and lasted until December (113 days). This trial was done to test 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 increased availability of space, one control plot was included in each replicate, and treated with lime and poultry manure only.

For both trials seeds of peanut *(Arachis hypogaea* L.) of the Valencia cultivar were sown at 5 cm intervals in rows 60 cm apart giving a density of 400,000 plants/ha. Plots, 2.0 m x 3.0 m were weeded manually and pests and diseases were controlled by alternate applications of Diazinon[1] (Baudin) at 0.67 kg A.I/ha or Carbaryl (Sevin) at 1.91 kg A. I/ha with Cupric hydroxide (Kocide) at 1.86 kg A.I/ha.

Measurements of plant height and nodulation score were taken at the 50% flowering stage (6 weeks) and at 14 weeks (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 sun drying, shelling percentage, moisture content and seed size determinations were made.

Weather Data

The daily rainfall, evaporation from a class A pan and sunshine hours over the trial period were recorded at the Weather Station situated 200 m from the trial site. During Trial 1, total rainfall amounted to 815 mm, 50% of which was recorded from sowing to flowering. Rainy days constituted 45% 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 840 mm recorded), and the pattern was of such that at periods of crop development and pod filling when water requirement is greatest, according to Salter and Goode (1967), the a.w.b. was always positive. Total sunshine hours decreased fromt 784.0 in Trial 1 to 706.2 and averaged 6.2 hours/day.

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 both Trial are presented in Table 2. 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,

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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 appropriate method of application.

Studies to test the residual efects 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 1.13 t/ha for those plots been fertilized at the rate of 10 kg/ha of N to 1.50 t/ha for those plots which had received a similar level of N with a foliar application of M.E.

Also yields of the control plots were markedly low and in fact the lowest for all the treatments (0.52 t/ha). In general, there was a 70% decline in yields from Trial 2 versus Trial 1. Indicative of these results is that nitrogen rates approximating 10 kg/ha plus a blanket application of P and K will need to be employed for satisfactory peanut yields on this soil type (Ultisol locally classified as Wirefence Clay Loam No.32). This finding agrees with recommendation of light dressing of N at 20-30 kg/ha by De Geus (1973). 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 1.14 t/ha presently obtained by Jamaica farmers as estimated by Guthrie, (1978).

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 wich had received 50 kg/ha N and M.E. (Trial 2). In the trial to test the residual effects of N and M..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 both trial ($r = 0.97$ and 0.97)

There was no significant difference between treatments i n 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/plant declined sharply in Trial 2, averaging five versus nine in Trial 1.

Shelling percentage (Table 2) was excellent in both 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 Trial 2 and averaged 76%

Harvest index values from both trials were highest for those treatments which produced the best yields whereas low values corresponded to those plots producing lowest yields. Values ranged from 0.42 to 0.53, and 0.33 to 0.56 in Trials 1 and 2 respectively (Table 2).

Seed weights declined from 48.20 to 41.63 grams per 100 seeds in Trials 1 and 2. In neither trial was there any significant difference in seed size between treatments.

Plant height and nodulation scores at six and fourteen weeks from sowing are presented in Table 3. Plots in which M.E. were witheld outperformed 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 4.4 cm versus 16.0 cm for the others. However, by the fourteenth week, the N and M.E. plots had increased to a height of 21 cm whereas the N alone plots had attained a height of 31 cm or 50% taller. In the second trial plant heights did not differ significantly at six and fourteen weeks irrespective of treatment. These results suggest that the depressed growth experienced by plants treated with trace elements in the first trial was not as apparent in the second trial. Kernel yields were highly correlated with plant height in both trials (r = 0.96 and 0.96)

The number of active nodules/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 fourteen weeks, there was no significant difference between treatments. This trend persisted in Trial 2 but the significant difference obtained at six weeks arose only betwen the control plots and those which had received both N and trace elements during Trial 1.

Data on nutrient levels of the test plots at the end of each experiment are summarized in Table 4. Comparing these results with the inherent nutrient status of the soil (Table 1) it is apparent that soil acidity was considerably ameliorated and level of exchangeable aluminum decreased significantly at the end of the trial period. Also there was a significant decline in potassium from 168 ppm at the onset of the trials to 23 ppm at the end of Trial 2. Further, whereas N and P levels remained essentially unchanged and that of calcium high, those of all trace elements decreased with the exception of copper for which an actual increase was recorded. This increase can be attributed to regular applications of copper fungicide to control rust and web blotch. 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 responds better to direct fertilization than to residual fertility.

Nutrient levels of plant tissues at the flowering stage are shown in Table 5. Overall, levels 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.

SUMARY

Peanut yield response and other agronomic parameters were studied using three levels of nitrogen (N) 10,50 and 100 kg/ha respectively with and without minor elements (M.E.) and with a blanker 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.. 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 residual effects of treatments applied in Trial 1 whole kernel yields declined significantly ranging from 1.13 t/ha for plots that had been treated with 10 kg/ha N to 1.50 t/ha in those that had originally received 10 kg/ha N + M.E. Control plots receiving no applied fertilizer whatever produced yields of 0.52 t/ha or 12% of plots receiving 10, 300, 150 kg/ha respectively of N, P_2O_5, and K_2O.

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. The mean number of pods/plant declined from nine in the first trial to five in Trial 2.

Shelling percentage was excellent (71) for both experiments and harvest index values were highest for treatments which produced the best yields. Seed size decreased from 48.20 to 41.63 g/100 seeds in Trials 1 and 2 respectively.

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 the concentration level of foliar spray. This pattern continued through crop maturity. However, in the second trial plant heights did not differ significantly. A significant difference in the number of active nodules/plant was recorded only between 50 kg/ha N treated plots and others at six weeks. However, despite an overall increase in nodulation, there was no significant diferences at fourteen weeks. This trend persisted in Trial 2. Data on nutrient status at the end of the trials indicate that soil pH increased from 4.9 to 5.5, exchangeable Al decreased N and P levels were essentially unchanged. Ca levels were hight, but levels of minor elements decreased with the exception of Cu. Nutrient levels of plant tissues were adequate in both trials although a marked decline was measured in Trial 2.

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, a blanket application of lime, organic matter, P and K are also essential.

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Table 1
Selected physical and chemical properties of the 0–45 cm soil layer of a newly terraced Ultisol planted to peanut

Physical & Chemical Properties	Value
Clay %	62.78
Silt %	22.01
Sand %	15.21
Organic matter content %	3.05
Field Capacity at 1/3 bar, %	50.00
Bulk density, g/m3	1.20
pH (1:2.5)	4.90
Cation exchange capacity, meq./100g	14.00
Exchangeable Al, meq./100g	6.70
Available Nutrients :	
Nitrogen %	0.15
Phosphours, 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
Manganese, ppm	8.10
Zinc	3.60

1. Ca and Mg were determined

1. Ca and Mg were determined by using N MC1 extract; K was determined by ysing 0.5 NCH_3COOH extract; and P by the Truog's method.

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