Pertanika 5(1), 30–33 (1982)

Nitrogen Economy of a Sandy Soil under Groundnut — Maize Cropping Sequence at Kuala Brang, Trengganu[1]

OTHMAN YAACOB[2]
Soil Science Department, Faculty of Agriculture, Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia.

Key words: **N economy, grain legume, sandy tropical soil.**

RINGKASAN

Tanaman kacang tanah yang diusahakan oleh penaman-penaman padi di kawasan tanah lanar berpasir, seluas 900 ha. di Kuala Brang, semenjak tahun 1971; ditanam bergilir-gilir dengan padi atau jagung tanpa penggunaan teknologi yang moden. Jabatan Sains Tanah di UPM dengan kerjasama Lembaga Persatuan Peladang tempatan telah mengadakan projek perintis untuk mengikuti kadar keluar-masuk zat makan nitrogen (N) dalam sistem tanaman tersebut. Anggaran banyaknya N dikeluarkan oleh hasil kacang tanah dan rumput-rumpai, dan juga perubahan taraf N dalam tanah selepas sesuatu musim tananam tersebut dibuat diatas petak ditanam dan tanpa tanaman. Di dalam kajian ini, terdapat 130 kg N.ha^{-1} dikeluarkan oleh batang-batal kacang tanah, 60 kg N.ha^{-1} oleh kacang tanah belum dikupas dan 46 kg N.ha^{-1} oleh rumput-rumpai, manakala cuma 12 kg N.ha^{-1} sahaja oleh rumput-rumpai daripada petak tanpa tanaman. Jumlah N dalam tanah (0-15 cm) ditanam dengan kacang tanah ialah 1080 kg N.ha^{-1} dan 1480 kg N.ha^{-1} di petak tanpa tanaman. Kepentingan data terdapat daripada kajian ini telah dibincangkan dengan menyentuh edaran dan ekonomi N dalam sistem tanaman tersebut yang diamalkan oleh penanam-penanam padi di peringkat teknologi kampung di Malaysia.

SUMMARY

Groundnut crops have been cultivated on sandy alluvial soil (> 900ha) in Kuala Brang, Malaysia since 1971. They are grown in rotation with rice or maize under village level technology, using a minimum amount of fertilizer nitrogen. To monitor changes in total soil N and the amount of N removed by crop and weeds, the Soil Science Department, Universiti Pertanian Malaysia in collaboration with the local Farmers Organisation Authority, set up a small pilot research project The amount of N removed by groundnuts and weeds and the level of soil N at the end of one cropping phase were estimated from cropped and uncropped control plots. Any average of 130, 60 and 46 kg N.ha^{-1} and crop^{-1} was removed from plots sown to groundnuts as stubbles, unshelled nuts and weeds respectively, while 12 kg N.ha^{-1} crop^{-1} was obtained from weeds in control plots. The total soil N (0-15 cm) was estimated to be 1080 kg N.ha^{-1} for groundnut plots and 1480 kg N.ha^{-1} for control plot. The significance of these data is discussed in relation to the overall N economy of the system operating at the village level technology in Malaysia.

INTRODUCTION

The acreage under groundnut *(Arachis hypogaea)* in Malaysia was approximately 9720 ha in 1974 (Kanapathy, 1976), but this has increased recently with additional acreage planted on the east coast (Nasruddin *et al.*, 1979). In the Kuala Brang district, on the east coast state of Trengganu, groundnuts have been grown in rotation with dryland rice *(Oryza sativa)* and maize *(Zea mays)* mainly on flat, sandy alluvial soils since 1971. It has become a major source of income for 20000 small farmers in that district, which is made up of approximately 300 km^2 of undulating terrain with flood-prone sandy soils. The crop is usually grown for three to four months followed later by maize or rice, depending on the prevailing market price. The acreage planted and production from this area as a whole is given in Table 1.

[1] Revised paper read at the Workshop on N Cycling in South-East Asian wet Monsoonal Ecosystems, Chianmai, Thailand, 5-10 Nov. 1979.

[2] Key to Author's name: O. Yaacob.

TABLE 1
The total area and production of groundnut at Kuala Brang district, Malaysia, since 1971

Season (Year)	Area planted (ha)	Production ($kg\ ha^{-1}$)
1971	204	2900
1972	722	3600
1973	715	3500
1974	695	4000
1975	933	3300
1976	770	2200
1977	699	1600
1978	919	1100
1979	459	3200

From 1976-1979, all acreage and production figures are based on general F.O.A. estimates (Nasruddin *et al.*, 1979).

Being essentially a legume-based cropping system, fertiliser N is used by the farmers in small quantities only. The cultural practices in this system include land preparation with light tractors and manual sowing of seed in rows as close as possible to prevent heavy weed infestation. Upon maturity, the plants are pulled out of the ground and the nuts separated by hand. The plant residues or haulm are left on the ground along with other vegetative materials until the next crop (Nasruddin *et al.*, 1979). Since this system appears to depend on the legume as an additional source of N in addition to the inherent soil N, a pilot project was initiated by the Soil Science Department of the Universiti Pertanian Malaysia, in collaboration with the local Farmers Organisation Authority of Kuala Brang, to estimate the amount of N cycling within this crop-soil system which is operated at the village level in Malaysia. Some preliminary results of this project are reported in this paper.

MATERIALS AND METHODS

Sampling plot

The area chosen was a new one where one crop of groundnut was planted, followed later by either maize or rice. Another area very close to the first, but under natural riverine vegetation made up of sedges and related grasses, was also chosen to serve as control plot from which changes in the N content of soil and weeds under one groundnut crop could be compared. This control area was sown with uninoculated groundnut when the first area was planted with rice or maize.

The area planted with groundnut was divided into four plots, each 10 m x 10 m. Five cores (0-15 cm) were taken from each plot; these were bulked into two composite sub-samples. The control area was also divided into four plots with the same dimensions. Soil samples similar to those in the cropped plot were also taken.

The physical and chemical characteristics of soil at Kuala Brang are given in Table 2.

Plot yield

Groundnuts which were sown in March on all four plots were harvested by hand in June 1979 and unshelled nuts were separated from haulm. Weeds from all groundnut and control plots were also harvested manually, weighed, sub-sampled and brought back to the laboratory. Soil samples (105°C) and plant samples (65°C) were oven dried prior to reweighing. The total N content of soil (< 2 mm) was determined by a semi-micro Kjeldahl method (Bremner, 1965), while that of the plant material (< 1 mm) was obtained by the wet ashing method of Thomas *et al.*, (1967).

TABLE 2
Physical and chemical composition of fine textured flood plain soil at Kuala Brang, Trengganu

Horizon	Mechanical composition			Chemical composition							
	Sand %	Silt %	Clay %	pH H_2O	N %	C %	Org. matter %	K	Ca (meq/100g)	Mg (meq/100g)	CEC
A_1	37	21	38	4.4	0.04	0.85	1.46	0.14	0.16	0.42	9.6
B_{21}	36	18	40	4.2	0.03	0.42	0.72	0.02	0.05	0.31	6.1
B_{22}	33	23	42	4.2	0.03	0.38	0.65	0.01	0.05	0.23	5.2
C	43	19	35	4.3	0.02	0.33	0.58	0.01	0.03	0.10	3.6

All weights were expressed on kg ha^{-1} basis. Appropriate statistical analysis was made on relevant data.

RESULTS AND DISCUSSION

The yield of unshelled groundnut was not comparable to the yield recorded during previous years for the Kuala Brang area as a whole (compare Table 1 with Table 3a). However, the yield was slightly lower than that obtained in other groundnut areas within Malaysia where higher fertilizer rates were used in addition to weeding and spraying (Ti and Chan, 1972), or in the same area during earlier years (Table 1).

TABLE 3
The total herbage yield of groundnut, weeds and their nitrogen content, for April-June (1979) season at Kuala Brang

(a) Herbage yield (kg ha^{-1})

Plot A				Plot B
Unshelled nuts	Haulm	Weeds	Total	Weeds
1020	4765	2405[a]	7903	1100[a]

(b) Nitrogen concentration (%)

4.6	2.1	1.5[p]	–	1.1[q]

(c) Plant N (kg ha^{-1})

46.9	167.0	36.5[y]	250.4	11.9[y]

*In this Table, mean values for weeds only within the row followed by the same letters are not significantly different at $P < 0.1$ according to the paired T-test.

In terms of total dry matter, approximately 8000 kg ha^{-1} was obtained from the plot sown with groundnut for the first time. However, weeds from a substantial part of total yield (Table 3a). The dry matter yield was rather lower than expected of a humid tropical region (Stewart, 1970). The distribution of rainfall and minimum management input for the period may have influenced this yield. For the same reason, the herbage yield from the control plot was also low, being slightly more than 1000 kg ha^{-1} for that season (Table 3a).

For the March-June season (1979) a total of 250.4 kg N ha^{-1} was removed as plant nitrogen from the plot under groundnuts. This amount of N was assumed to have come from the grain legume and soil. From this 47 kg N ha^{-1} was completely removed in unshelled nuts, leaving a total of 204 kg N ha^{-1}, 167 kg N ha^{-1} from haulm and 37 kg N ha^{-1} from weeds (Table 3c) which could have returned to the soil. According to Firth *et al.*, (1973) this amount of nitrogen is sufficient to supply the N requirement of a rice crop in a rice-legume rotation. At Kuala Brang, Malaysia, 167 kg N ha^{-1} was obtained from legume haulm, and another 37 kg N ha^{-1} from weeds. This nitrogen, or a portion of it, would have been released after decomposition to the succeeding cereal crop. The plant N from control plots which was not in association with groundnut and estimated at 12 kg N ha^{-1} also supported the assumption that weeds also benefited from the legume association (Yaacob *et al.*, 1979).

TABLE 4
Variations in the total N content of soil (0-15 cm) at the groundnut pilot project in Kuala Brang, Malaysia for April – June (1979) season

Replicate	Plot A* with groundnut	Plot B No groundnut
	Nitrogen content (kg N ha^{-1})	
1	1120	1600
2	800	1400
3	1200	1800
4	1200	1120
Mean	1080	1480
SE±	95	145

For one season in 1979, there was no significant difference in the average for total soil-N within top 15 cm depth.
*Taken after one crop of groundnut.

From the soil system, an average total N content at 1080 kg N ha^{-1} was estimated for the groundnut plot, and 1480 kg N ha^{-1} for the control plot. Thus, growing of groundnuts (and weeds) appears to deplete total N from the soil. The difference between the control and cropped plot of 400 kg N ha^{-1} (Table 3) is greater than that removed as plant N from groundnut plot over a period of one crop (compare Tables 3 and 4). After a low yield of groundnut for the 1979 and a return of 204 kg N ha^{-1} in crop residues, there was a decrease of soil-N by 400 kg N ha^{-1} (Table 4). This suggests an apparent net decrease of soil-N of nearly 200 kg ha^{-1}, which could be removed in the form of shelled nuts. Under the Kuala Brang environment, groundnut can be expected to add substantial amounts of N through the return of crop residues, particularly when the same soil is intensively cropped with the legume even under village level technology.

Accepting the variations occurring within the plots, the decrease in total soil N due to grain legume cropping for one season, appears reasonable (Table 3) under actual field situation (Mandal and Murkerjee, 1954). Under simulated field conditions, however, this decrease is not apparent (Yaacob and Blair, 1979).

ACKNOWLEDGEMENTS

The author would like to thank the local Farmers Organization Authority (FOA), officers and farmers at Kuala Brang for assisting and allowing their area to be used for this study, Mr. V. Sockalingam and Mr. Kamaruddin Othman for field and laboratory sampling and analysis. Permission to present this paper by the Vice-Chancellor, Universiti Pertanian Malaysia and the generous financial assistance by the SCOPE/UNEP International Nitrogen Unit (Sweden) in collaboration with Chaing Mai University (Thailand) are gratefully acknowledged.

REFERENCES

BREMNER, J.M. (1965): Total N. In 'Methods of Soil analysis. Pat 2.' Black, C.A. (ed.) *Agron. Mono.* **9.** pp 1179-1237.

KANAPATHY, K. (1976): Guide to fertilizer use in Peninsular Malaysia. – *Bull. 143. Min. Agric. and Rural Development Malaysia.*

NASRUDDIN, A.S. MOHAMAT, M. and YAACOB, O. (1979): A case study on groundnut cultivation at Kuala Brang, Trengganu, Malaysia. – *Proceedings Tropical Legumes Symposium. Universiti Pertanian Malaysia,* p. 465-472.

MANDAL, S.C. and N.H. MURKERJEE (1954): New cropping systems for the maintenance of soil fertility. *Proc. Bihar Acd. Sci.* **2-3:** 49-57.

THOMAS, R.L. SHEARD, R.W. & MOYER, J.R. (1967): Comparison of conventional automated procedures for nitrogen, phosphorus and potassium analysis of plant material using a single digestion. *Agron. J.:* **59:** 240-243.

STEWARD, G.A. (1970): High potential productivity of the tropics for cereal crops, forage crops and beef. *J. Aust. Inst. agric. Sci.* **36:** 85-101.

TI, T.C. and CHAN, A.K. (1972): Growing groundnut. *Extn. Branch, Department, Agric. Malaysia.*

FIRTH, P., THITIPOCA, H., SUTHIPRADIT, S., WETSELAAR, R. and BEECH, D.F. (1973): Nitrogen balance studies in the Central Plain of Thailand. *Soil Biol. Blochem.* **5:** 41-46.

YAACOB, O. and BLAIR, G.J. (1979): Effect of legume species and cropping intensity on the nitrogen status of a granite soil under simulated tropical environment. *Plant Soil,* **52:** 85-97.

YAACOB, O., BLAIR, G.J., CHEE, Y.K. & NOOR, M.Y. (1979): Nitrogen accumulation in soils under legume-based agricultural systems in the tropics. *Proceedings Tropical Legume Symposium, Universiti Pertanian Malaysia,* p. 303-311.

(Received 15 June 1982)