MARDI Res. Bull. 5, 2: (47 – 55)

MAJOR NUTRIENT REQUIREMENT OF ENGLISH CABBAGE *(BRASSICA OLERACEA, VAR. CAPITATA)*

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Accepted for publication on 10 May, 1977

RINGKASAN

Contoh-contoh kobis yang dipungut dari beberapa tempat dijajahan Cameron Highlands telah menunjukkan perhubungan positif diantara pengambilan zat-zat makanan dan beratnya. Garis regressi yang didapati boleh digunakan untuk meramalkan pengambilan zat-zat makanan pada pelbagai peringkat pengeluaran. Bagi anggaran 60 tan/ha penggunaan baja sebanyak 200 kg K/ha, 170 kg N/ha, 90 kg Ca/ha, 30 kg P/ha dan 20 kg Mg/ha adalah disyurkan.

INTRODUCTION

Fertiliser application on vegetables in Malaysia is, at present, purely practised on an adhoc basis. The traditional, excessive applications of organics are observed both in the lowlands and in the highlands (PURUSHOTHAMAN, 1976).

This is not surprising as little work has been done on the nutritional requirement of Malaysian horticultural crops, except for rambutans and durians (NG and THAMBOO, 1967) and bananas (JOSEPH, 1971).

With the present 'green-book' emphasis in the country for the planting of vegetable crops, the need for data on the quantities of nutrients required by croppings of various vegetables is particularly urgent. Reasonable predictions of the nutrients required for optimum growth could be made from the amounts removed by the crops, as has been used in studies for a range of crops e.g. oil palm (NG and THAMBOO, 1967).

There is a dearth of information on the major and minor nutrients required for maximum economical yields of vegetables, in this part of the world (UNDP, 1971).

This paper therefore, sets out some data on the major nutrient contents and their removal by English cabbage *(Brassica oleracea var. capitata),* the most widely grown of all the highland vegetables (FAMA, 1974). Presently, heat tolerant varieties are being grown in the lowlands as well. The successful cultivation of these heat resistant varieties on peat, an excellent media for vegetables, could lead to greater production in the country.

The data presented in this paper is a valuable guide for purposes of fertiliser recommendation. However, it should be emphasised that field response studies to determine an economic optimum for the major and minor nutrients should also be carried out, using bench mark data from the results obtained in this and such like studies.

MATERIALS AND METHODS

Collection of samples

Mature, disease-free samples were collected from various localities, extending from Ringlet to Blue Valley, in the Cameron Highlands district (PURUSHOTHAMAN, 1976). The stem of

each head was cut above the soil surface and the plant shaken free of adhering soil particles. The harvested heads were placed in ventilated plastic bags. Care was taken not to lose any of the outer leaves. Decayed, lower-most leaves were discarded.

Treatment of sample

In the laboratory the heads were cleaned of soil still sticking to the base by wiping with a clean damp cloth. The fresh weight of each cabbage head was obtained, and the heads were then separated into the non-edible outer leaves and the edible inner portion. The individual leaves, particularly the outer leaves, were cleaned carefully with a damp cloth to avoid any contamination of the sample by soil. Fresh weights of the outer leaves and the edible portion were obtained.

Each portion was then chopped up separately, mixed thoroughly and approximately 200 gram samples obtained. These samples were placed in cardboard trays, labelled and dried overnight in a hot air oven at 70°C to constant weight. The dry weight of each sample was obtained.

The dried samples were ground using a Glen Creston grinder.

Chemical Analysis

All the samples were analysed for nitrogen, phosphorus, potassium, calcium and magnesium.

Nitrogen was determined by the micro-Kjeldahl method.

For the other elements 1–2 g of sample was weighed into a silica basin and dry-ashed in a muffle furnace at 500°C (for 4–5 hours) until ashing was complete. The ash was digested with a mixture of nitric and hydrochloric acids and allowed to evaporate on a water-bath. The residue was then washed with warm distilled water into a 100 ml volumetric flask.

P in the digest solution was determined colorimetrically by the vanadate method, potassium by flame photometry using a Corning-Eel flame photometer. Calcium and magnesium by titration with EDTA, after removal of the phosphate ion by an anion-exchange resin.

The nutrient percentages were calculated and the uptake per plant and per hectare determined. Data from 30 cabbage plants are presented.

RESULTS AND DISCUSSIONS

Percentage of component in head

The average percentages of the components of the cabbage i.e the non-edible outer leaves and the edible inner portion are presented in *Table 1.*

TABLE 1. PERCENTAGE COMPONENT OF CABBAGE

	Fresh Basis		Dry Basis	
	Outer leaves	Edible portion	Outer leaves	Edible portion
Mean	36.1	63.7	42.7	57.1
S.E.	±11.8	±11.6	±12.0	±11.8

It is seen that on a dry basis almost half (43%) of the harvested cabbage-head consists of non-edible fibrous outer-leaves. These can however be returned to the soil as source of organic matter and nutrients on decomposition.

No trend between percentage component and weight of heads are observed *(Fig. 1)*.

Percentage dry matter

Table 2 presents the dry matter percentages of the cabbage samples. Only 7% of the edible portion is dry matter. The non-edible outer leaves have a slightly higher dry matter content.

TABLE 2. PERCENTAGE OF DRY-MATTER IN COMPONENT OF CABBAGE

Component	Mean	S.E.
Outer leaves	9.47	±1.96
Edible portion	7.02	±1.46

Nutrient Composition

The percentages of major-nutrients of the outer leaves and edible portion are given in *Table 3* below:–

TABLE 3. NUTRIENT COMPOSITION – % DRY MATTER

Nutrient	Composition as percent of dry matter	
	Outer leaves	Edible portion
Nitrogen Av.	3.23	2.90
S.E.	0.60	0.57
Phosphorus Av.	0.33	0.45
S.E.	0.16	0.14
Potassium Av.	3.71	3.09
S.E.	0.66	0.52
Calcium Av.	2.12	0.78
S.E.	0.87	0.31
Magnesium Av.	0.35	0.23
S.E.	0.12	0.05

The nutrient composition in the outer leaves in order of decreasing percentages is K>N>Ca>Mg>P. In the edible portion K, N and Ca follow the same decreasing order, while P is higher than Mg. The relatively high Ca content, perhaps, partially accounts for the success of prawn-dust and chicken dung as a fertiliser source for this vegetable (PURUSHOTHAMAN, 1976).

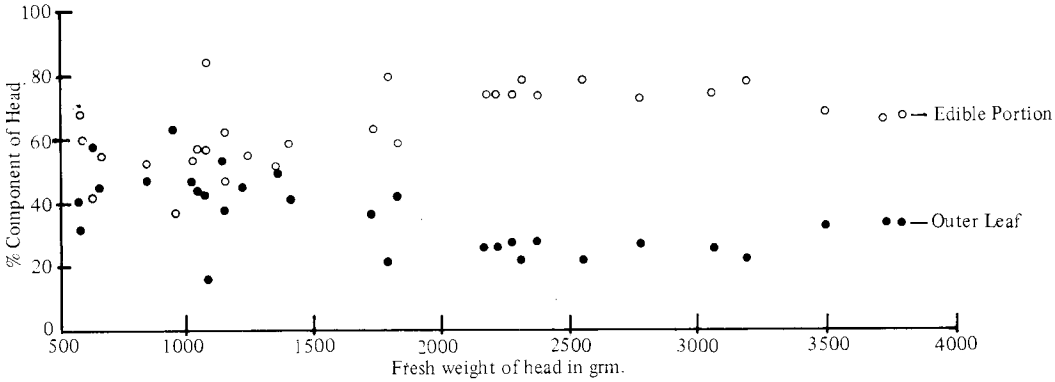

Figure 1. Variation of component (%) with fresh weight of whole cabbage.

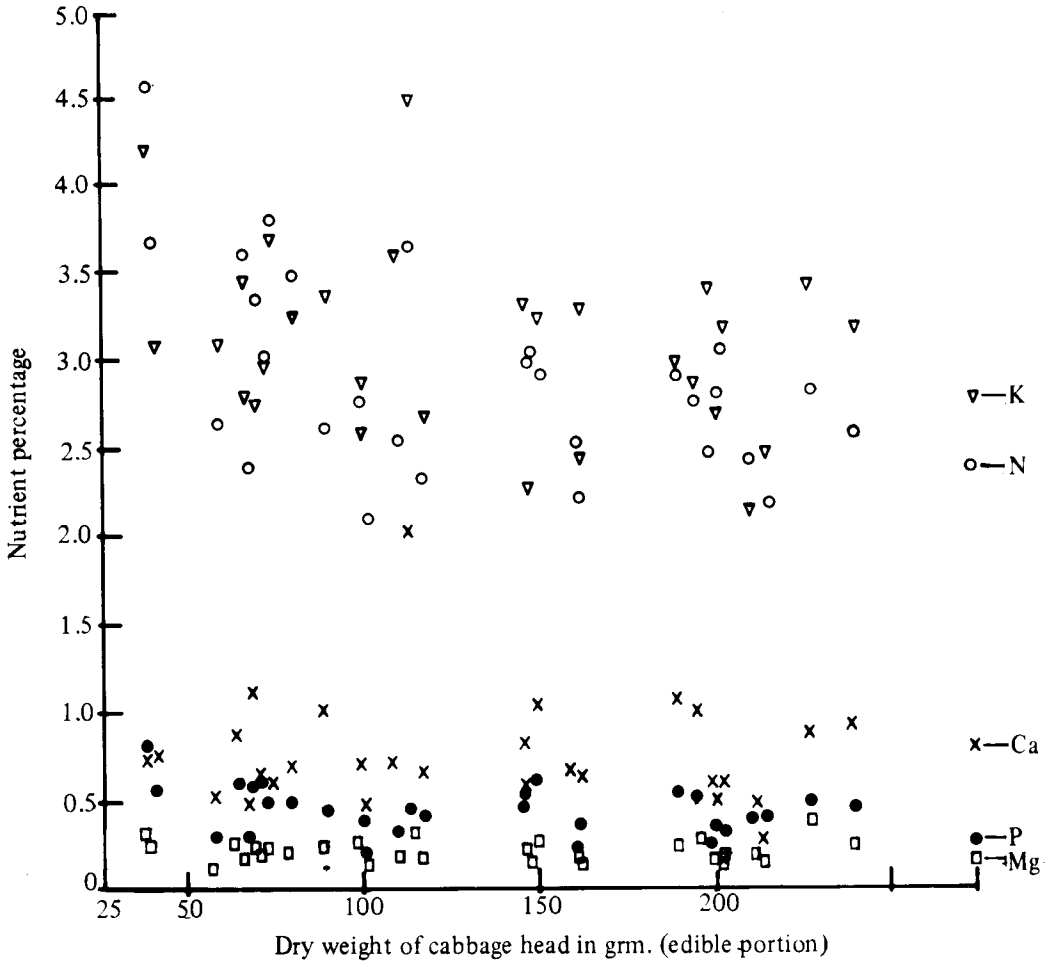

Figure 2. Variation of Nutrient Composition with weight of Head (Edible Portion).

No significant relationship between percentage nutrient in the cabbage components and dry-weights were obtained *(Fig. 2).*

Total Nutrient Content

The quantities of nutrients in the components of each sample were calculated from the percentage nutrient composition and their dry-weights *(Table 4)*.

TABLE 4. TOTAL NUTRIENT CONTENT PER PLANT

Component	Nutrients (Grams)				
	N	P	K	Ca	Mg
Outer leaves					
Average	1.72	0.18	1.96	1.23	0.20
S.E.	0.67	0.10	0.76	0.82	0.12
Edible portion					
Average	2.27	0.34	2.50	0.70	0.18
S.E.	1.24	0.20	1.44	0.49	0.12

N, P and K are higher in the edible portion than in the outer leaves, while Ca and Mg are higher in the outer leaves.

Converted to kg/ha, the total nutrient removed at maturity are as follows: N = 107.2; P = 14.0; K = 119.8; Ca = 51.8; Mg = 10.2. These are however average values. The highest removal data obtained was N = 7.2 g; P = 1.1 g; K = 7.7 g; Ca = 4.5 g; Mg = 0.9 g. In kg/ha a total of 172 kg N, 26.4 kg P, 184.7 kg K, 107.9 kg Ca and 21.6 kg Mg are removed. (Based on a planting distance of 2' x 2')

Thus, the major nutrients must be applied in amounts sufficient to meet the uptake requirements indicated. In addition, some allowance should be made for losses through leaching, volatilisation, wash-off and 'positional unavailability', particularly in the case of inorganic sources of fertilisers.

Calculation of nutrient applied per plant from the farmers organic application rates gave N = 23.9 g; P = 8.8 g; K = 13.0 g; Ca = 99.5 g; Mg = 16.1 g (PURUSHOTHAMAN, 1976). Apparently this is far in excess of even the highest removal data per plant obtained in this investigation. However as there is no information on the rate of decomposition and availability of nutrients in the organic manures it is not clear to what extent these applications are excessive.

The optimum field application rates can only be determined by field trials at each locality. Nevertheless the uptake values obtained present useful basic data for further field trials and for purposes of general recommendation, in the absence of field-data.

It may be noted that the non-edible outer leaves contain relatively large amounts of nutrients *viz.* 46.2 kg/ha N; 4.8 kg/ha P; 52.7 kg/ha K; 33.0 kg/ha Ca; 5.4 kg/ha Mg and these could be returned to the soil probably after composting as a source of organic matter and nutrients.

Relationship between total nutrient content and fresh weight of heads

The relation between total fresh weight and nutrient content was investigated by regression analysis. Fresh weights were used because the cabbage heads are harvested and the fresh weights recorded for sale. Significant linear regressions were established between fresh weights and total nutrient contents as presented in *Figs. 3–Figs. 7.* Theoretically the regression lines should pass through the origin, but due to experimental errors, they deviated slightly. The linear relationship, within the experimental data obtained, indicate that yields can be increased to a large extent with increasing applications and hence uptake of nutrients.

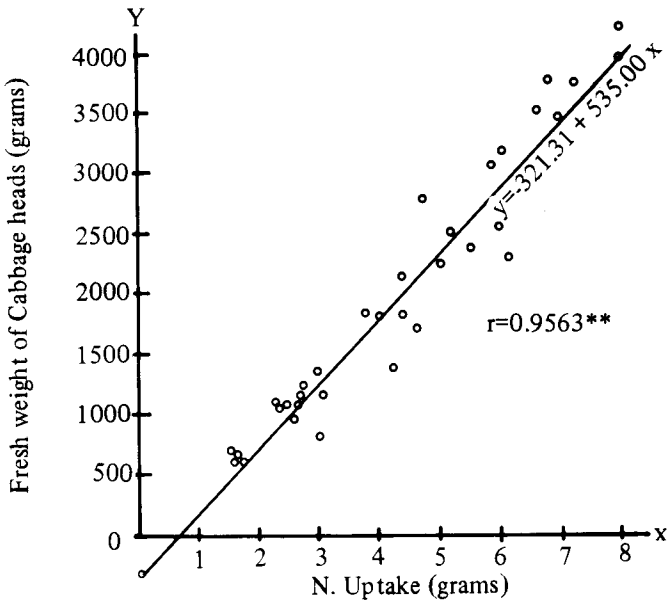

Figure 3. N. removed vs. fresh weight of heads.

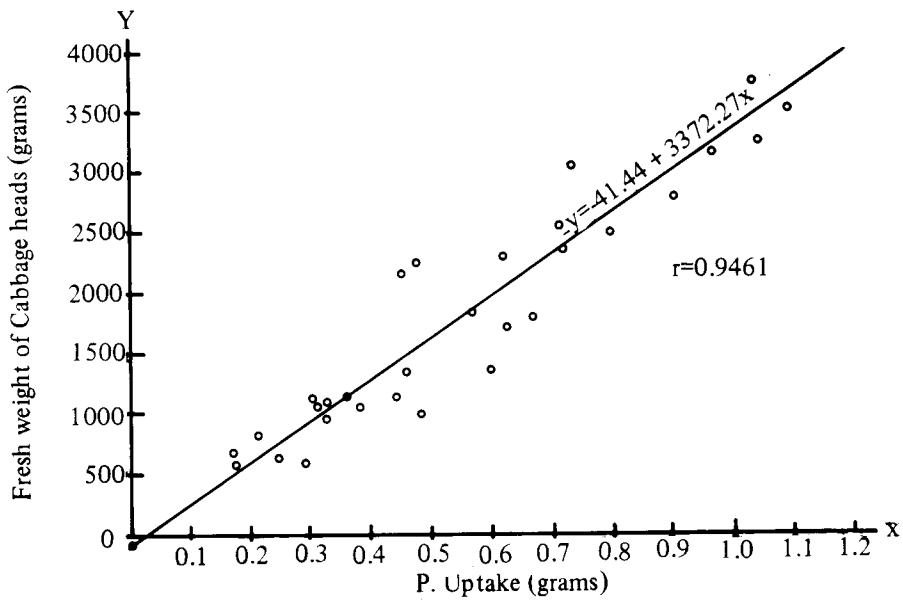

Figure 4. P. removed vs. fresh weight of heads.

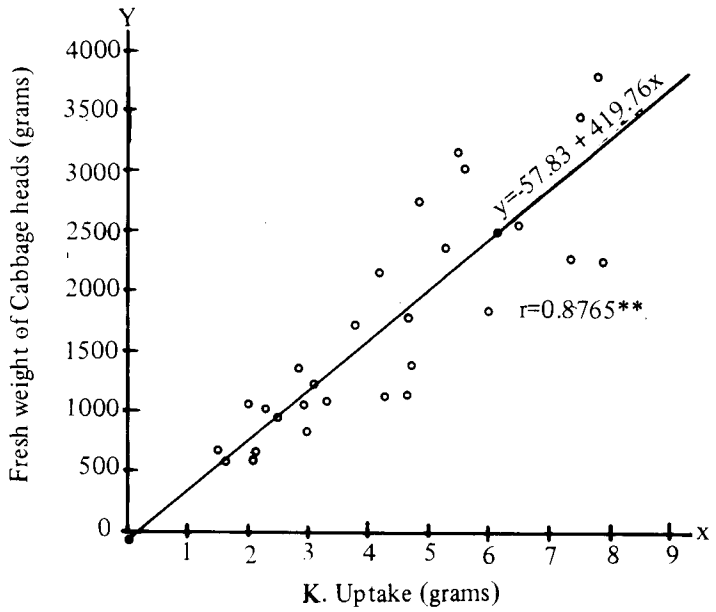

Figure 5. K. removed vs. fresh weight of heads.

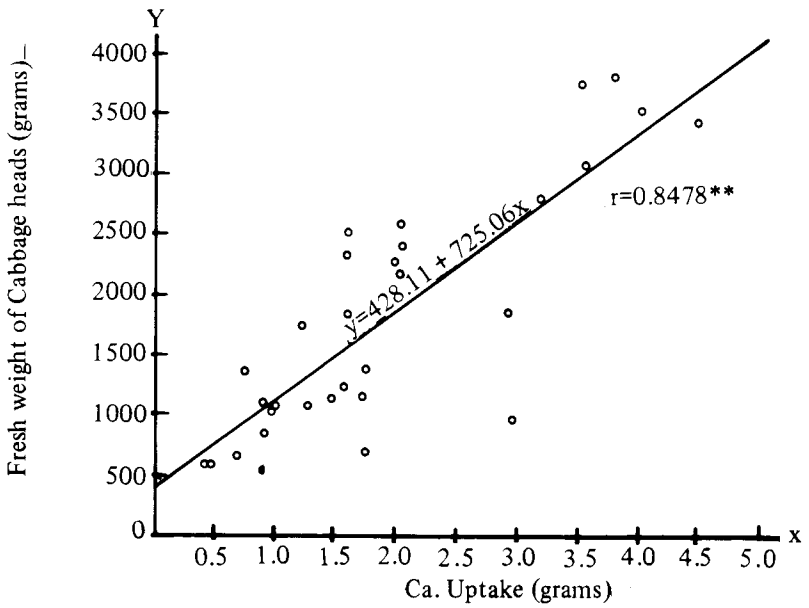

Figure 6. Ca. removed vs. fresh weight of heads.

The highland farmers usually talk of an expected stand of 10,000 plants/ac. At a fresh weight of 2.5 kg per head the nutrients removed *(Figs. 3–7)* would be as in *Table 5.*

Similarly from the regression analysis *(Figs. 3–7)* the nutrients removed and hence to be replaced for various levels of production can be predicted.

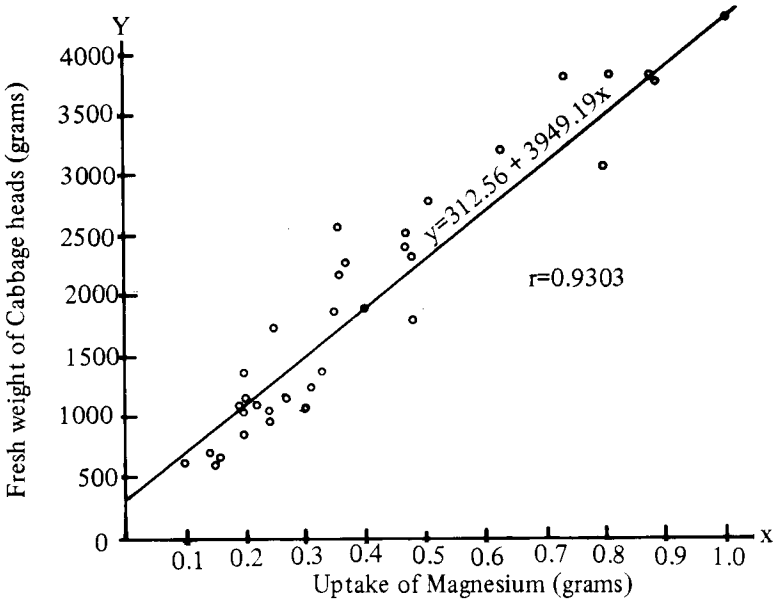

Figure 7. Mg. removed vs. fresh weight of heads.

TABLE 5. TOTAL NUTRIENT REMOVED AT A PRODUCTION OF 60 TONS/HA

	Per plant/(gm)	Per hectare (kg)
N	5.25	129.7
P	0.75	18.5
K	6.10	150.7
Ca	2.90	71.6
Mg	0.55	13.6

HANSEN (1973) obtained an uptake of 28.8 kg N, 4.8 kg P and 25.4 kg K for a production of 12 metric tons heads and leaves. For a production of 60 metric tons/ha this would mean a removal of 144 kg N/ha, 24.0 kg P/ha and 127.0 kg K/ha. The N and P uptake is higher than the values obtained in this study while the K is lower (Refer *Table 5*).

DE GEUS (1973) reports uptake for cabbages as 300 kg N, 85 kg P_2O_5 and 300 kg K_2O. The production level however is not reported.

Assuming a loss of 30% applied nutrients (a figure generally characteristic of the podsolics) the following rates are recommended for a hectare of cabbages producing about 60 tons of head and leaves:

N	=	170 kg/ha
P	=	25 kg/ha
K	=	200 kg/ha
Ca	=	90 kg/ha
Mg	=	20 kg/ha

These values are however general values, to be used as a guideline for purposes of fertiliser recommendation and as a basis for fertiliser studies on the various soil-types. For higher production levels the nutrient uptake rates can be obtained from *Figs. 3–7.*

ACKNOWLEDGEMENTS

The authors thank Encik Ahmad Shokeri for assistance in the statistical analysis and Encik Cheah Jip Hoi for assisting in collecting and preparing samples. Encik S. Thamboo is gratefully acknowledged for his help in the collection and analysis of samples.

SUMMARY

English cabbage heads, collected from various localities in Cameron Highlands district showed positive correlation between nutrient uptake and the fresh weights of heads. Regression lines obtained could be used to predict the nutrient removal at various levels of production. For an estimated yield of 60 tons/ha, from the nutrient results obtained, a fertiliser application of approximately 200 kg K, 170 kg N, 90 kg Ca, 30 kg P and 20 kg Mg is recommended.

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