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N and K requirements of lowland cabbage (*Brassica oleracea* L. var. capitata) on peat, grown under netted structure

[Keperluan N dan K bagi kubis tanah rendah **(***Brassica oleracea* L. var. capitata) yang ditanam di tanah gambut, di bawah struktur jaring]

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Key words: netted structure, cabbage, N and K rates, peat

Abstract

In the year 2000 Malaysia's net import of cabbage was 22.5 million tonnes worth RM11.6 million. The loss in foreign exchange can be reduced by planting heat tolerant cabbage varieties in the lowlands under netted structures. The netted structure can prevent the entry of most of the common lepidopteran pests of cabbage, thus reducing the frequency of insecticide application.

The current recommended fertilizer rate is meant for cabbage in open field planting. This rate may not be applicable for cabbage under netted structure. Therefore different rates of N and K were evaluated, to further improve the nutrient uptake efficiency of cabbage grown under netted structure. Four rates of N and K were investigated, using the cabbage variety KK Cross. The 4 x 4 factorial experiment was laid out in a RCB design replicated four times and repeated over three crop cycles.

N and K can be reduced from 240 kg/ha to 120 kg/ha with no detrimental effect on cabbage yield. Doubling the N rate had increased the average yield by only 9%. The foliar analysis of %K in the composite samples of the cabbage heads reconfirmed the yield results obtained. %N was higher in the highest N rate compared to the lowest N rate. This was reflected in the yield obtained. The rates of 120 kg N/ha and 120 kg K/ha can be recommended for cabbage on peat under netted structure. However more split application of N fertilizer should be advocated during the rainy season, to minimize leaching of the highly soluble N fertilizer.

Introduction

Malaysia imported 22.5 million tonnes of cabbage worth RM11.6 million in 2000. The loss in foreign exchange can be reduced by planting suitable heat tolerant cabbage varieties, as a crop substitute, under netted structures in the lowlands. Planting cabbage in open fields often require frequent spraying against the common lepidopteran pests. Netted structures prevent the entry of these lepidopteran pests, thereby reducing the frequency of insecticide application.

The currently recommended fertilizer rate at 240 N and 240 K in kg/ha (Vimala and Chan 1997) is meant for cabbage in open field planting and may not be

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applicable under netted structures. It had been shown that this fertilizer rate could support either a legume or a leafy vegetable, as an intercrop, with no detrimental effect on cabbage yield (Leong and Lee 1993; Leong et al. 1996). Currently there is no information on the fertilizer requirement of cabbage under netted structures. Thus a study was conducted to determine the optimum N and K rate for cabbage grown under netted structure on peat.

Materials and methods

The trial was conducted on drained peat in Kelang, Selangor over three crops. Each crop cycle was carried out on a new site. Soil analysis for the 1st, 2nd and 3rd crop was carried out respectively in June 1996, April 1997 and November 1997. The average soil N, soluble P and K cation were 1.41% N, 90.5 ppm P, 0.47 meq K/100 g; 1.26% N, 50.3 ppm P, 0.40 meq K/100 g; and 1.1% N, 25.7 ppm P, 0.31 meq K/100 g; for the 1st, 2nd and 3rd crop respectively.

Cabbage**,** *Brassica oleracea* L. var. capitata (KK Cross) seeds were sown in nursery trays and transplanted into open field, one month later. The seedlings were planted in two rows on 20 cm high beds measuring 0.9 m x 4.5 m. The planting distance used was 45 cm x 45 cm.

Four rates of N and K were investigated. The 4 x 4 factorial experiment was arranged in one block. A randomised complete block design with four replicates was used. Four rates of N and K in kg/ha were used:

- 120, 160, 200 and 240 N
- 120, 160, 200 and 240 K

The control treatment is the currently recommended rate of 240 N and 240 K in kg/ha. The fertilizers used were ammonium sulphate, triple super phosphate (TSP) and muriate of potash to supply N, P and K respectively. The fertilizers were split applied equally at basal, 3 weeks and 6 weeks after transplanting of the seedlings. TSP at 40 kg P/ha was applied in the first application only.

The soil pH was raised to 5.5 using ground magnesium limestone at 2.5 t/ha for every 0.15 pH unit increase (Chew et al. 1986). Liming was carried out 2 weeks before transplanting of cabbage seedlings. Common trace elements were applied as basal dressing together with the major fertilizers, one day before planting in accordance with Leong et al. (1985).

Composite samples of cabbage heads were collected for foliar nutrient analysis. Cabbage head was harvested at about 62 days after transplanting.

Results and discussion

Yield

From the results obtained over three crops (*Table 1*), it was found that the K rate could be reduced from the current recommended level of 240 kg/ha to 120 kg/ha, with no detrimental effect on the cabbage yield.

However in the case of N, the response to different rates was variable in the three crops. No difference in the relationship between different rates of N was noted in the 1st and 2nd crop. Linear response to N was significant only in the 3rd crop. However the absolute yields obtained in the 1st and 2nd crop were higher than the yield from the 3rd crop (*Table 1*).

Total rainfall obtained, for the duration of cabbage growth from transplanting to first harvest, were 305, 265 and 676 mm respectively for the 1st, 2nd and 3rd crop. The amount of rainfall received in the 3rd crop was double and almost triple the amount received in the 1st and 2nd crop respectively. The total rainfall received, for the whole duration of cabbage growth, had definitely affected the cabbage yield. The linear response to N in the 3rd crop could be attributed to the weather condition, especially the rainfall, rather than the different N rates per se. Excessive moisture could have caused indirect stress to the plants due to nutrients leached off.

Table 1. Effects of different N and K rates on the yield of cabbage (kg/plot) over three crop cycles

Treatment	1st crop	2nd crop	3rd crop
N rate (kg/ha)			
120	17.71 (23.15)	15.98 (20.88)	13.70 (17.91)
160	18.04 (23.58)	16.14 (21.09)	13.59 (17.76)
200	18.58 (24.28)	15.16 (19.81)	14.22 (18.58)
240	19.79 (25.86)	16.42 (21.46)	15.59 (20.37)
F test	ns	ns	*
Linear N	4.78 ns	0.01 ns	7.56*
Quadratic N	0.40 ns	0.48 ns	2.11 ns
K rate (kg/ha)			
120	18.73 (24.48)	15.81 (20.66)	14.19 (18.54)
160	18.60 (24.31)	15.93 (20.82)	14.05 (18.36)
200	18.80 (24.57)	16.71 (21.84)	13.78 (18.01)
240	17.98 (23.50)	15.25 (19.93)	15.08 (19.71)
F test	ns	ns	ns
Linear K	0.44 ns	0.06 ns	1.09 ns
Mean	18.53	15.92	14.27
S.E.	2.78	2.71	1.76
C.V. (%)	15.0	17.0	12.4

ns = Non-significance at 5% probability
*Significance at 5% probability
Figures in parenthesis are extrapolated values in t/ha

Therefore, split application of N should be advocated when growing cabbage during the rainy season. This is to prevent or minimize excessive leaching of the highly soluble N fertilizer applied. This confirmed Kleinhenz et al. (1997) finding that high soil moisture induces water stress in vegetables with shallow rooted system, preventing them from effectively absorbing available $NO_{3,}$ consequently more NO_3 will be leached.

In addition, doubling the N rate from 120 kg/ha to 240 kg/ha had increased the yield in these three crops by an average of 9.4% only. This small increase in yield may not justify the increase in application of N rate up to 240 kg N/ha, as it incurs additional fertilizer and labour cost. Hence lower rate of N at 120 kg/ha should be recommended for cabbage production on peat under netted structure. *Plate 1* gives general view of the cabbage grown under netted structure. *Plate 2* shows no visual differences of the cabbage treatment at the lowest (11) and highest rate (44) of N and K.

Mohanty and Hossain (1998) similarly found that the highest cabbage yield is obtained at 120 kg N/ha, with addition of manure, in Orissa, India. Mallik et al. (1996) reconfirmed that the highest net profit and cost benefit ratio are obtained at 120 kg N/ha at the closer spacing. Elsewhere, Verbotskii et al. (1984) obtained best yields at 120 kg N/ha, over a 3-year trial period. Riley and Guttormsen (1993) found there was hardly any yield increase for summer cabbage above 100 kg N/ha on a morainic loam soil. In fact many studies indicated otherwise. In a 2-year study conducted by Samant et al. (1981) they found the economically best fertilizer combination is at 75:80:150 kg/ha of N: P_2O_5: K_2O. From the results of the trial conducted over three locations in Indonesia, Nunung (1980) found that 90 kg N/ha to 135 kg N/ha, depending on locality, give the highest cabbage yield.

Plate 1. General view of cabbage under netted structure

Plate 2. No visual differences were noted in the N and K treatment combination at the lowest (11) and highest (44) fertilizer rate for cabbage on peat

The reduction of N and K rate from 240 kg/ha to 120 kg/ha demonstrated a vast improvement in nutrient uptake efficiency and fertilizer utilization for cabbage on peat grown under netted structure. In addition, the netted structure also gave protection from direct destructive impact of tropical thunderstorms to the crop and soil. The reduction in nutrient application also meant less contamination of the underground water. Excessive applications of nitrogen fertilizer are very common in vegetable production and groundwater pollution with nitrates is of grave concern especially in rural areas

Table 2. Effects of different N and K rates (kg/ha) on the N and K content in composite samples of cabbage heads

	%N		%K	
	1st crop	3rd crop	1st crop	3rd crop
120	3.78a	3.57a	3.90a	5.53a
160	3.96ab	3.61ab	4.11a	5.51a
200	3.95ab	3.69b	4.06a	5.28a
240	4.09b	3.90b	3.99a	5.43a
Mean	3.949	3.696	4.017	5.44
S.E.	0.337	0.307	0.720	0.730
C.V. (%)	8.5	8.3	17.9	13.4

Means with similar letters are not significantly different at 5% level according to DMRT

producing horticultural crops (Anon. 2002). In the same report it was found that a quarter of drinking wells in Malaysia contain higher than accepted levels of nitrates.

No N and K interaction effect was noted in all the three crops.

Nutrient content

From the results of the foliar analysis conducted in the 1st and 3rd crop, no significant differences in %K were noted between all the K rates *(Table 2)*. The result was reflected in the yield obtained, reconfirming that 120 kg K/ha is sufficient for cabbage on peat. Whereas in the %N, significant differences were detected between different N rates in both crops. As expected, higher N rate recorded higher %N content in both the 1st and 3rd crop. Similarly this result was reflected in the absolute yield obtained *(Table 1)*. No deficiency of N and K symptoms were noted in all treatments.

The results were within the adequate nutrient ranges in the most recently matured cabbage leaf at head formation, advocated by Askew and Smith (1995), where nutrient content above or below were associated with lower yields. The adequate ranges were 3.3–4.8 %N and 2.1–4.2 %K

Conclusion

The currently recommended fertilizer rate for cabbage on peat is 240 N and 240 K kg/ha. The N and K rates for lowland cabbage grown on peat under netted structure can be reduced to 120 kg/ha, irrespective of the time of planting. However in the case of N fertilizer, more split applications should be advocated for cabbage grown during the rainy season.

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Abstrak

Dalam tahun 2000 jumlah import kubis adalah sebanyak 22.5 juta tan bernilai RM11.6 juta. Kerugian dalam pertukaran mata wang asing boleh dikurangkan dengan menanam varieti kubis yang tahan panas di kawasan tanah rendah di bawah struktur jaring kalis serangga (SJKS). SJKS boleh menghalang kemasukan kebanyakan serangga perosak kubis jenis lepidoptera, seterusnya mengurangkan kekerapan penyemburan racun serangga perosak.

Kadar baja yang disyorkan pada masa ini adalah sesuai untuk penanaman kubis secara terbuka. Kadar ini mungkin tidak boleh diguna pakai untuk penanaman kubis di bawah SJKS. Oleh itu kadar N dan K yang berbeza telah diuji untuk membaiki kecekapan pengambilan nutrien oleh kubis yang ditanam di bawah SJKS. Empat kadar N dan K telah diuji kaji menggunakan varieti kubis KK Cross. Uji kaji mengikut faktor 4 x 4 telah dijalankan dalam reka bentuk RCB, 4 replikasi dan diulang sebanyak 3 pusingan tanaman.

Kadar N dan K boleh dikurangkan daripada 240 kg/ha kepada 120 kg/ha tanpa menjejaskan hasil kubis. Menggandakan kadar N telah menambahkan hasil purata sekadar 9% sahaja. Analisis daun untuk %K dari campuran sampel kepala kubis, mengesahkan keputusan hasil yang diperoleh. %N adalah lebih tinggi pada kadar N tertinggi berbanding dengan kadar N terendah. Ini ditunjukkan dalam hasil yang diperoleh. Kadar 120 kg N/ha dan 120 kg K/ha sepatutnya disyorkan untuk tanaman kubis di tanah gambut di bawah SJKS. Walau bagaimanapun pemberian baja harus dibuat mengikut bahagian semasa musim hujan untuk mengurangkan kehilangan baja N yang mudah larut.

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