UNIVERSITI PUTRA MALAYSIA

THE EFFECTS OF NITROGEN, POTASSIUM AND CHICKEN DUNG ON YIELD AND QUALITY OF CHILLI (Capsicum annuum L.) GROWN ON A BRIS SOIL

ZAHARAH BT. ARIFFIN

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By

Zaharah bt. Ariffin

Thesis Submitted in Partial Fulfilment of the Requirements
for the Degree of Master of Agricultural Science
Universiti Pertanian Malaysia

November 1989

ACKNOWLEDGEMENTS

The author wishes to express her sincere thanks and gratitude to her supervisors, Associate Professor Dr. Mohammad Md. Ali and Associate Professor Abdul Jabar Mohd. Kamal for their guidance and encouragement throughout her course of study and the preparation of this thesis. Their availability, patience and readiness in the preparation of this thesis are invaluable and greatly appreciated.

Special appreciation is expressed to Mr. Zulkifly Mohd Zain, the Director of Tobacco Research Division, Malaysian Agricultural Research and Development Institute (MARDI) for his permission and co-operation in identifying the experimental plots in Central Tobacco Research Station, Telong, Bachok, Kelantan. The author would also like to extend her appreciation to Mr. Ahmad Wahab and the staff of the Central Analytical Laboratory MARDI for their assistance in the analyses of plant and soil samples. The assistance given by Ms. Salbiah Husin and Dr. Lee Choon Soon in the statistical analyses of the data are also greatly appreciated. Appreciation is also extended to Mr. Mat Ti Othman for the field work.

The author is most grateful to MARDI for sponsoring her graduate studies at the Universiti Pertanian Malaysia.

Finally, the author would like to express her appreciation to her husband and children for their patience and understanding during her graduate studies.

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Supervisor : Assoc. Prof. Dr. Mohammad Md.Ali
Co-Supervisor : Assoc. Prof. Abdul Jabar Mohd. Kamal
Faculty : Agriculture

Field experiments were conducted to determine the requirements of N, K and chicken dung for chilli (*Capsicum annuum* L.) grown on a bris sandy soil. The treatments that were evaluated comprised three levels of N (100, 200 and 300 kg N/ha), three levels of K (100, 200 and 300 kg K/ha) and two levels of chicken dung (0 and 10 t/ha). The study was conducted for two consecutive cropping seasons.

There were differences in crop response pattern for the two cropping seasons. In the first crop, response to N was linearly significant only for fruit number and N, P and K contents in the leaf and P contents in the fruit. In contrast, response to N in the second crop was obtained for yield, fruit number, fruit weight, N and Ca contents in the fruit and N, K,

Ca and Mg in the leaf. Only fruit Ca content had a significant quadratic response to N whilst others had linear response to N fertilizer application. Between levels of applied N fertilizer in the second crop, the second and third level of application provided higher yield, yield attributes and fruit quality parameters. The differences in response to N for the two cropping seasons are attributed to the soil and weather conditions.

Application of K fertilizer beyond 100 kg K/ha had no favourable influence on yield, growth parameters and fruit quality. It only increased leaf K content and decreased leaf Ca and Mg contents.

Application of chicken dung at 10 t/ha increased the yield, fruit number, plant height, fruit diameter, fruit weight, Ca and Mg contents of the leaf and fruit Ca content. Unlike the other parameters, chicken dung application reduced the number of days to flowering by as much as ten days.

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia bagi memenuhi sebahagian daripada syarat-syarat untuk ijazah Master Sains Pertanian

KESAN NITROGEN, KALIUM DAN TAHI AYAM KE ATAS HASIL DAN MUTU CILI (*Capsicum annuum* L.) YANG DITANAM DI TANAH BRIS

Oleh

Zaharah bt. Ariffin

November 1989

Penyelia : Prof. Madya Dr. Mohammad Md. Ali
Penyelia bersama : Prof. Madya Abdul Jabar Mohd. Kamal
Fakulti : Pertanian

Percubaan di peringkat ladang telah dijalankan untuk menentukan keperluan N, K dan tahi ayam ke atas cili (*Capsicum annuum* L.) yang ditanam di tanah bris berpasir. Rawatan-rawatan yang diuji mengandungi tiga paras N (100, 200 dan 300 kg N/ha), tiga paras K (100, 200 dan 300 kg K/ha) dan dua paras tahi ayam (0 dan 10 t/ha). Kajian ini telah dijalankan bagi dua musim tanaman berturut-turut.

Terdapat perbezaan di dalam pola gerak balas di antara dua musim tanaman. Bagi tanaman pertama, gerak balas terhadap N adalah bererti secara linear hanya untuk bilangan buah dan kandungan unsur N, P dan K di dalam daun dan P di dalam buah. Di sebaliknya, gerak balas terhadap N dari tanaman kedua diperolehi untuk hasil, bilangan buah, berat buah, kandungan N

dan Ca di dalam buah dan kandungan N, K, Ca dan Mg di dalam daun. Hanya kandungan Ca di dalam buah yang menunjukkan gerak balas bererti secara kuadratik terhadap N manakala parameter lain mempunyai gerak balas linear. Di antara paras-paras baja N yang digunakan bagi tanaman kedua, penggunaan baja pada paras kedua dan ketiga mengeluarkan hasil, ciri-ciri hasil dan mutu buah yang tinggi. Perbezaan gerak balas terhadap N di antara dua musim tanaman adalah disebabkan oleh perbezaan keadaan-keadaan tanah dan cuaca.

Penggunaan baja K melebihi 100 kg K/ha tidak mempunyai kesan yang baik ke atas hasil, parameter-parameter tumbesaran dan mutu buah. Baja K hanya menambahkan kandungan K dan mengurangkan kandungan Ca dan Mg di dalam daun.

Penggunaan baja tahi ayam pada kadar 10 t/ha meningkatkan hasil, bilangan buah, tinggi pokok, garispusat buah, berat buah, kandungan Ca dan Mg di dalam daun dan kandungan Ca di dalam buah. Penggunaan tahi ayam juga mengurangkan bilangan hari berbunga sehingga sepuluh hari, tidak seperti parameter lain.

CHAPTER I

INTRODUCTION

Chilli (*Capsicum annuum* L.) belongs to the family Solanaceae. The chilli plant is a perennial, but often grown as an annual. The production period ranges from 2-12 months, depending on the variety, management and occurrence of diseases. The pungency nature of chilli is due to the presence of the alkaloid capsaicin. The fruit is rich in vitamins such as vitamins A and C and minerals such as K and P.

Chilli is a popular ingredient in Malaysian cuisine. The domestic consumption of fresh chillies in 1985 was estimated to be 26,600 tonnes (Malaysia, 1987). However, this does not project the real situation of domestic demand for it does not take into consideration the institutional demands of hotels and restaurants. About 20% of the domestic demand was imported in 1985 (Malaysia, 1985).

The extent of chilli cultivation in Peninsular Malaysia (1985) is estimated to be about 1000 hectares. The major growing areas are distributed in the states of Kelantan (230 ha), Perak (203 ha), Pahang (126 ha), Johore (97 ha) and

Terengganu (93 ha) (Malaysia, 1981). In Kelantan, it is mainly grown on sandy bris (Beach Ridge Interspersed With Swales) and riverine alluvium soils.

Bris is a type of soil developed on sandy coastal deposits and hence the characteristic feature is its sandy texture. Bris soils are estimated to be about 162,000 hectares exclusively occurring in the east coast of Peninsular Malaysia (Yeoh, 1986). The hectarage for Kelantan is approximately 17,813 hectares. Bris soil is generally considered as a problem soil because of its poor physical and chemical properties. It has poor water holding capacity, high nutrient losses due to leaching, high surface temperature, low nutrient reserve and low organic matter content.

Traditionally, bris soils have been cultivated with cashew and coconut. Cultivation of miscellaneous fruit tree crops have been attempted previously but with limited success. However, currently, with proper soil management techniques, high value crops such as chilli, cabbage and mustard can be successfully grown.

Meticulous fertilizer management techniques are required for producing high yield and good quality chilli on bris soils. This is true for N and K which directly influence growth,

maturity, yield and fruit quality. The use of chicken dung is also important since it can improve the physical and chemical properties of the soil. Climatic conditions particularly rainfall during the growing period also influence the crop growth.

Numerous studies on the nutritional requirements of chilli grown on various other soil types have been reported (Ng, 1978 and Stroehlein and Oebker, 1979). However, there is a lack of knowledge on the nutrient requirements of chilli grown on bris soil with high leaching losses of N and K. The use of organic manures such as chicken dung would serve to ameliorate the poor physical conditions of bris soils and to complement as a fertilizer.

This thesis was confined to a study using N, K and chicken dung for chilli production in a bris soil. The objectives of the study were to determine the effect of N, K and chicken dung on:

1. Yield and crop growth parameters such as plant height and number of days to flowering of chilli.
2. Fruit quality of chilli, and
3. Nutrient uptake by chilli.

CHAPTER II

LITERATURE REVIEW

Bris Soil

Bris is a type of soil developed on sandy coastal deposits and it is characterized by its sandy texture. The parent materials are made up of marine sand deposits. It can be divided into seven series based on their texture and drainage class, namely; Baging, Rompin, Rudua, Jambu, Melawi, Rusila and Rhu Tapai (Yeoh, 1986). The percentage of coarse and medium sands for Baging, Rudua and Rhu Tapai is 90.7, 86.2 and 20.0%, respectively (Yeoh, 1986). Spodic horizons were not found in Baging, Rompin and Rusila series. The depth of spodic horizons from the soil surface for Rhu Tapai, Rudua and Jambu were less than 50 cm, 50 to 100 cm and greater than 150 cm, respectively. The spodic horizon is an alluvial horizon in which active organic matter and amorphous oxides of aluminium and iron have precipitated. The depth of the spodic horizons are directly related to the depth of water table from the soil surface.

Physical Properties

Bris soil normally has very low silt and clay contents. This makes bris soil very infertile both in terms of nutrients and water-holding capacity. The mean capillary rise for bris soil ranges from 8 cm for Baging series to 25 cm in Rhu Tapai (Yeoh, 1986). These values largely depend on the percentage of the coarse, medium and fine sand.

The surface temperature recorded by Abdul Wahab (1984) was about 45°C during the dry months of February and March.

Chemical Properties

The cation exchange capacity for bris soil is generally low (less than 5 meq/100 g soil) compared to normal soil (5 to 20 meq/100 g soil). This indicates that bris soil has a very poor nutrient holding capacity. As a result, the applied nutrients to the soil are easily leached. Studies showed that application of organic matter such as POME (Palm Oil Mill Effluent) increased the C.E.C. of the soil (Abdullah *et al.*, 1988). Exchangeable bases were found to be less than 1 meq/100 g soil for most of the cations.

Bris soil has low nutrient reserve and high leaching rate of nutrients. Depending on the soil series, Biot et al. (1982) reported that the percentages of C, N and free Fe from the top soil (0-15 cm) ranged from 1.08 to 8.71, 0.06 to 0.30 and 0.16 to 0.18, respectively. The C.E.C., Ca, Mg, Na and K ranged from 0.56 to 3.60, 0.03 to 0.73, 0.03 to 0.39, 0.02 to 0.07 and 0.02 to 0.05 meq/100g soil, respectively. The soil was neither acid nor alkaline and the pH values ranged from 4.5 to 5.4.

Conductivity reading of bris soil was extremely low (less than 13.8 umhos/cm) (Yeoh, 1986). This indicates that the soil was severely leached and contained very little amount of soluble ions. This is due to the eluviation of soluble ions and microsize particles of organic matter from the upper horizons.

Nitrogen

Plant Uptake of Nitrogen

In sweet pepper, Thomas and Hielman (1964) reported that the amount of N in the leaf tissue was directly related to the amount of N applied. The critical level of N in the leaf tissue was about 4%. This value was higher than the critical level reported by Miller (1961). He also observed that N deficiency

symptoms occurred in plants having a total N content of less than 1.26%. The percentage of N in the bell pepper fruit was found to be 1.58%. For the low N plants, the fruits were somewhat chlorotic although they would have been salable from the colour stand-point.

The N content in the leaf tissue appeared to increase at the initial growth stage and gradually decreased at fruiting. Miller et al. (1979) reported that the concentration of N in capsicum fruit was highest at fruit set and then declined as it matured. Maximum rate of growth and the uptake rate for total N and fruit N were found to be greatest between 56 and 70 days after transplanting.

Huett (1986) working on tomato reported that application of N increased leaf, stem, and fruit N concentrations and leaf and fruit Mg concentrations but reduced fruit K concentrations. At the time of harvest, N application resulted in a slight decrease in Ca, Mg, P and K concentrations in the vegetative tissues.

Tissue analysis carried out by Vimala et al. (1985) showed that the N concentration in chilli was highest in the leaves (4.66%) followed by fruits (3.14%) and stems and branches (1.67%). On the other hand, the removal of N was

highest from the fruit (9.11 g/plant) followed by stem and petioles (2.90 g/plant) and leaves (1.85 g/plant).

Effect of Nitrogen on Growth and Yield

Nitrogen is one of the most important element required for a normal plant growth. It is important for chlorophyll and protein synthesis. As a result, N deficiency is normally related with pale green colour due to lack of chlorophyll, stunted growth as a result of reduced cell division and cell enlargement due to lack of protein synthesis. Nitrogen deficiency also delayed maturity and caused premature death of lower leaves.

In bell pepper, Miller (1961) pointed out that N deficiency was characterized by stunted, weak growth with necrotic leaves. Visual deficiency symptoms occurred in plants having a total N of 1.26% or less in the vegetative tissue. Similar symptoms were observed by Maynard et al. (1962). Their findings showed that N fertilization increased flower production but did not increase fruit set. With respect to tomato, Huett (1986) observed that N deficiency delayed fruit set and reduced leaf, stem and root development.

On the other hand, excess of N extensively increased plant height and lodging but delayed maturity in some plants. According to Miller (1961), bell pepper fruits produced on the high N plants were short, thick, rounded and glossy dark green in colour. Knavel (1977), reporting on the influence of N on pepper transplant, observed that plants grown on higher N levels showed larger, darker and heavier fresh weight of green leaves and larger fruits but produced fewer number of matured fruits. He further indicated that harvesting was more difficult because of the abundance of foliage and taller plants.

Experiments carried out by Stroehlein and Oebker (1979) indicated that N applied at high rate (280 kg/ha) on chilli grown on loamy soil delayed fruit set. Moderate rates of N (100-150 kg/ha) tended to produce more desirable type of plants and produced the highest yield. Sundstrom et al. (1984) showed that the yield of red pepper grown in sandy olivier silt loam (0.41% organic matter) increased with the increase in N when the rate applied was increased from 0 to 112 kg/ha. On fine sandy loam, Thomas and Heilman (1964) found that the highest pepper yield was obtained at 135 kg/ha N. Locascio et al. (1981) stated that on sandy soils, marketable fruit yield of chilli increased as N was increased from 140 to 220 kg/ha. A further increase to 308 kg N/ha reduced the yield sharply, probably due to the soluble salt injury. Recent studies by