UNIVERSITI PUTRA MALAYSIA

THE PERFORMANCE OF SWEET CORN AND SELECTED LEGUMES IN WEEDED AND NONWEEDED INTERCROPPING SYSTEMS

AHMAD BIN KATANG

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by

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Thesis submitted in partial fulfilment of the requirements for the degree of Master of Agricultural Science in the Faculty of Agriculture, Universiti Pertanian Malaysia.

OCTOBER, 1989

....lovingly dedicated to my wife.....

to my daughter,

to my dear family,

and to cropping system workers, everywhere.

ACKNOWLEDGEMENT

Alhamdu-lillahi-rabbil-'alamin.

All praise be to ALLAH, The Almighty.

I wish to thank my supervisors, Associate Professor Khalip bin Abdul Raffar and Dr. Rosli bin Mohamad for their encouragement and kind assistance which they had rendered me throughout the course of the study.

Support in forms of technical advice, constructive comments and criticisms from the staff of The Agronomy Department and The Faculty of Agriculture, Universiti Pertanian Malaysia, is gratefully acknowledged.

Finally, I wish to thank my wife, Norlia Abdullah, for her continuous encouragement, assistance and tolerance throughout the challenging two years of my study.

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October, 1989

Supervisor : Associate Professor Khalip Abdul Raffar.

Co-supervisor : Dr. Rosli Mohamad.

Faculty : Agriculture.

An intercropping study was conducted at the Agronomy Field Research Station, Universiti Pertanian Malaysia from January to April, 1987 involving sweet corn (Zea mays [L.] var. Thai Super Sweet), mungbean (Phaseolus radiatus [L.] Wilczek var. VC-1163), cowpea (Vigna unguiculata [L.] var. Purple Hull Pink-Eyed Seed) and groundnut (Arachis hypogaea [L.] var. V-13) in weeded and nonweeded sweet corn + legume systems. Sweet corn was the base crop with mungbean, cowpea or groundnut as the intercrop in the

respective weeded and nonweeded treatment combinations. The treatments were replicated four times in a randomised complete block design (RCBD) with factorial arrangements. The objectives of the study were to evaluate crops performance under weeded and nonweeded conditions, compatibility of the legumes with sweet corn, comparative ability of the legumes to smother weeds, and the influence of the cropping system on the N, P and K contents of crops and weeds at harvest.

The results indicated that the performance of sweet corn in the intercropping was not affected. The yield and yield components of sweet corn were not significantly reduced by the presence of the intercrops or weeds. The performance of legumes, however, were affected. Intercropping the legumes with sweet corn in the absence of weeds resulted in lower cowpea, groundnut and mungbean bean yields of 69, 75 and 80 percent compared to the respective monocrops. This was mainly due to reductions in the number of plants per plot, number of seeds per pod and pods per plant. In the presence of weeds in the associated intercroppings, cowpea, groundnut and mungbean bean yields per plot were reduced by 93, 94 and 96 percent compared to the respective monocrops. Apart from the reduction in the number of plants per plot, these were mainly attributed to reductions in plant weight, pod weight and number of pods per plant. Seed weight of legumes were not affected by intercropping or the presence of weeds.

All three legumes showed poor ability to smother weeds as all their yields were adversely affected by the presence of weeds.

Intercropping and/or the presence of weeds had no effect on the assimilation of Nitrogen, Phosphorus and Potassium by sweet corn, mungbean, cowpea or groundnut at harvest, suggesting that nutrients and moisture were nonlimiting. The nutrient contents of the respective plant components of the crops were also not affected by intercropping or presence of weeds.

Land Equivalent Ratio (LER) and Area Time Equivalent Ratio (ATER) values obtained from each weeded intercropping system showed that all three legumes were compatible with sweet corn. However, LER and ATER values from the nonweeded intercropping systems indicated otherwise. The sweet corn + legume systems were only advantageous when weeds were removed. The highest LER (1.32) and ATER (1.45) were obtained from the weeded sweet corn + cowpea system while the lowest LER (0.87) and ATER (0.89) were from the nonweeded sweet corn + groundnut system. Cowpea appeared to be the best choice among the three legumes for intercropping with sweet corn.

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi sebahagian daripada syarat-syarat untuk Ijazah Master Sains Pertanian.

PRESTASI JAGUNG DAN BEBERAPA JENIS KEKACANG DALAM SISTEM PENANAMAN BERSELANG TANPA RUMPAI DAN BERUMPAI

oleh

AHMAD BIN KATANG

Oktober, 1989

Penyelia : Profesor Madya Khalip Abdul Raffar.

Penyelia Bersama : Dr. Rosli Mohamad.

Fakulti : Pertanian.

Satu kajian sistem penanaman berselang telah dijalankan di Stesyen Penyelidikan Agronomi, Universiti Pertanian Malaysia dari Januari, 1987 hingga April, 1987 melibatkan jagung manis (Zea mays [L.] var. Thai Super Sweet), kacang hijau (Phaseolus radiatus [L.] Wilczek var. VC-1163), kacang 'Cowpea' (Vigna unguiculata [L.] var. Purple Hull Pink-Eyed Seed) dan kacang tanah (Arachis hypogaea [L.] var. V-13). Kajian ini juga

melibatkan rawatan pengawalan rumpai dan tanpa pengawalan rumpai dalam sistem penanaman berselang tersebut. Penyelidikan sistem penanaman berselang ini bertujuan menilai prestasi jagung manis dan kekacang di bawah sistem-sistem penanaman tanpa rumpai dan berumpai, keserasian kekacang dengan jagung manis, perbandingan keupayaan kekacang untuk mengawal rumpai, dan kandungan unsur N, P dan K semasa tuai dalam tanaman.

Jagung manis telah ditanam sebagai tanaman asas dan kacang hijau, kacang 'cowpea' atau kacang tanah masing-masingnya sebagai tanaman selang antara baris dalam kombinasi rawatan tanpa rumpai dan berumpai. Rawatan-rawatan dikendalikan di dalam rekabentuk blok penuh berawak dengan susunan faktorial dalam empat replikasi.

Keputusan kajian menunjukkan prestasi jagung, dari sudut hasil dan komponen-komponen hasil, tidak terjejas oleh sistem penanaman berselang atau rumpai. Walau bagaimanapun, sistem penanaman berselang dan rumpai telah menjejaskan prestasi kekacang-kekacang yang digunakan. Hasil biji kacang 'cowpea', kacang tanah dan kacang hijau masing-masingnya berkurangan sebanyak 69, 75 dan 80 peratus dalam sistem penanaman berselang dan seterusnya masing-masing dikurangkan sebanyak 93, 94 dan 96 peratus oleh kehadiran rumpai. Pengurangan hasil kekacang ini berhubung kait dengan pengurangan jumlah pokok sepetak, berat

pokok, hasil lengai dan biji sepokok. Walau bagaimanapun, penanaman berselang atau rumpai tidak menunjukkan kesan bermakna ke atas berat biji kekacang.

Ketiga-tiga jenis kekacang menunjukkan keupayaan yang lemah untuk mengawal rumpai dalam sistem-sistem tanaman berselang yang berkaitan.

Tanaman berselang dan/atau rumpai dalam sistem-sistem jagung manis + kekacang tidak memberi kesan yang bermakna ke atas kandungan Nitrogen, Posforus dan Kalium semasa tuai jagung manis atau kekacang. Kandungan N, P dan K komponen-komponen pokok bagi tiap-tiap tanaman juga tidak terjejas. Keputusan ini menunjukkan bahawa bekalan unsur-unsur tersebut adalah tidak terhad.

Nilai Nisbah Persamaan Tanah (LER) dan nilai Nisbah Persamaan Kawasan Masa (ATER) sistem-sistem penanaman berselang tanpa rumpai menunjukkan bahawa ketiga-tiga kekacang yang digunakan adalah serasi dengan jagung manis dan juga menunjukkan penggunaan tanah yang cekap. Sebaliknya, nilai-nilai LER dan ATER dari sistem-sistem penanaman berselang berumpai menunjukkan kekacang-kekacang ini tidak sesuai ditanam bersama jagung manis dan juga menunjukkan ketidakcekapan penggunaan tanah dalam sistem-sistem berkenaan. Nilai LER (1.32) dan nilai ATER (1.45) yang paling tinggi diperolehi dari sistem tanpa rumpai jagung manis + kacang

'cowpea' dan nilai LER (0.87) dan nilai ATER (0.89) yang paling rendah diperolehi dari sistem berumpai jagung manis + kacang tanah.

Berasaskan kepada hasil, nilai LER dan nilai ATER kajian ini, nyatalah kacang 'cowpea' yang paling sesuai untuk ditanam sebagai tanaman selang antara baris jagung manis.

CHAPTER I

INTRODUCTION

Crop production systems, collectively termed as multiple cropping, are common agricultural practices of small farmers in the tropical and subtropical regions of the world. By planting more crops yearly in the same field, they are able to increase productivity per unit area of land. Intercropping, defined broadly as growing of two or more crops simultaneously on the same field , is among the most common of these systems (Andrews and Kassam, 1976). It has received notable attention by reseachers as well as farmers (Papendick et al., 1976).

Much research has been directed towards studying intercropping as a management system (IRRI, 1974; Papendick et al., 1976). Intercropping of annuals with other annuals is the most common form of intercropping and prominent among these is the cereal + legume combinations. The advantages of these intercrop combinations are well-documented (IRRI, 1973; Beets, 1982) but how these can further improve the small farmers' livelihood is still far from the ultimate goal of researchers.

In addition to the obvious potential yield advantage, the cereal-legume combinations justify yield stability, efficient

resource utilisation including labour, cheaper weed management, improved diet and reduction of market risks for the farmers (Beets, 1982).

Conceptually, in order to fully exploit the benefits of intercropping, it must be recognised that competition between the associated crops must be minimised and compatibility between crops be maximised. In cereal-legume intercroppings, competition and compatibility between crops are to a certain degree understood, but these investigations were obtained in optimal well-managed weed control situations. Studies under low level weed-management situations were limited.

Maize, mungbean and groundnuts are among the most commonly planted intercrops in South East Asia (Syarifuddin *et al.*, 1973) and are important cash crops in Malaysia (Wong *et al.*, 1979).

Maize is the second most important cereal after rice (*Oryza sativa* L.) and is grown mostly for fresh corn and also for dry grain. Early maturing varieties, such as the Thai Super Sweet, are better than the late maturing ones because they make the best use of the moisture season (Ratan, 1974; Beets, 1982; Lee *et al.*, 1983). Maize is often used as base crop in most cropping systems.

Mungbean is an important leguminous cash crop in Malaysia. It is an important protein supplement as cakes and boiled beans (Abu

Kassim et al., 1977). Mungbean cannot be grown during the height of the rainy season since the crop is susceptible to water-logging and cannot be harvested in wet weather. However, yields can be reduced by moisture stress. Mungbean is commonly grown by tropical farmers as intercrop in cereals.

Cowpea is a versatile crop which can be grown for dry peas, vegetable or fodder. It can tolerate both heavy rains and drought but give higher yields when grown under relatively high level of light intensity. The crop is commonly planted by tropical farmers in intercropping systems with the belief that it can smother weeds (Akobundu, 1979; Beets, 1982). Cowpea, however, is less common in Malaysia and the intention to include it in this study was to try to exploit its potential as a useful component crop for intercropping under local conditions.

Groundnut grown in Malaysia is mainly consumed as dried beans. Early maturing varieties generally give lower yields than late maturing varieties. However, the former fit better in a cropping system because they can be harvested at almost the same time with the other crops in the system. Groundnut tolerates heavy rains at the beginning of the planting season but excessive rain after pod formation induces diseases and physiological problems. The crop tolerates some shading and is therefore often used in mixed croppings (IRRI, 1973).

Among the important aspects of intercropping are species compatibility and the weed management. These variables were chosen for the present study because of their economic and farm management reasons.

In view of the significance of intercropping and its role in the development of suitable farming systems for developing countries of the tropics, the present study was conducted with the following objectives:

(i) To evaluate the performance of sweet corn and three selected legumes in sweet corn + legume systems under weeded and nonweeded regimes.

(ii) To evaluate the compatibility of the legumes with corn in the sweet corn + legume systems.

(iii) To evaluate the influence of the legume species on the occurrences of weeds in the associated intercropping systems.

(iv) To determine the influence of intercropping on the assimilation of NPK by both crops and weeds.

CHAPTER II

LITERATURE REVIEW

Multiple Cropping in Tropical Agriculture

Multiple cropping is a widespread practice in the tropics, and the extent to which it is practised varies from region to region and country to country (Andrews and Kassam, 1976). Arnon (1972) reported that an estimated 98 percent of cowpeas in Africa is grown in association with other crops. In Taiwan, Korea, Japan and South East Asian countries, multiple cropping is widely adopted due to its simple and cheap strategy for absorbing the rapidly increasing farm labour and to provide adequate vegetative cover to reduce soil erosion in erosion-prone hilly lands (Siddoway and Barnett, 1976).

The tropics, with its high, unevenly distributed rainfall intensity and adequate level of solar energy, is characterised by a temperature regime that is favourable for crop production all year round (Harwood and Price, 1976). These prevailing conditions are the main prerequisites for intensive farming and on which the level of agricultural productivity is greatly dependent (Harwood and Price, 1976; Beets, 1982). Blencove (1970) suggested that multiple cropping is an excellent alternative to capital-

intensive industrilisation for increasing the income among the least privileged rural population in the developing countries.

However, compared to the temperate region, the average yield of a crop in the tropics is generally lower (Beets, 1977). This can be offset to a certain degree by multiple cropping, an ancient practice of growing more than one crop on the same piece of land during one calendar year (Beets, 1982). In essence, it represents a philosophy of maximum crop production by maximising use of available solar energy and other natural or improved resources (Gomez and Gomez, 1983). It is recognised that a well-planned multiple cropping system is one of the feasible ways of developing and raising agricultural production in the tropics (Sanchez, 1976; Zandstra et al., 1978).

With the rapid increase in population and the decreasing supply of new lands available for cultivation, multiple cropping can be an excellent strategy for intensifying land use where the succession of crops is very rapid and where the management of one crop can influence significantly the performance of the succeeding crops (Gomez and Gomez, 1983). The use of multiple cropping can successfully maintain soil fertility and suppress weed problems to a manageable level (Oelsligle et al., 1976; Ayeni et al., 1983).

The unique requirements as well as the urgent need for the rapid generation and dissemination of multiple cropping technology have received much attention (Beets, 1982; Ruthenberg, 1980). The technology stresses the following important characteristics (Gomez and Gomez, 1983):

(i) the component crops of a cropping pattern must be planned and implemented jointly as the management of one crop greatly affects the productivity of the others;

(ii) the management practice for a component crop is chosen not to maximise production of that particular crop but to maximise production of the whole system.

Multiple Cropping Systems

For the purpose of this review, the following terminology as defined by Beets (1982) and Gomez and Gomez (1983) has been adopted:

A crop production strategy refers to a subset of the farm production strategy that involves only crops as its component and is described by the spatial and temporal arrangements of crops to be raised in a parcel of land (cropping pattern). A crop

production strategy can be either monocropping or multiple-cropping.

Sequential cropping refers to the growing of two or more crops in sequence on the same field within a 12-month period, with the succeeding crop planted only after the preceding crop has been harvested, such that a farmer manages only one crop at any one time in the same field. Double and triple cropping are common forms of sequential cropping.

Relay cropping refers to the growing of two or more crops simultaneously in the same field such that one crop is planted after the other has flowered.

Intercropping is the growing of two or more crops simultaneously on the same field such that the period of overlap is long enough to include the vegetative stages of the crops. There are two types of intercropping techniques: mixed intercropping, an intercropping with no distinct row arrangements; and row intercropping, an intercropping where at least one crop is planted in rows. This review will mainly consider this form of multiple cropping where its importance and role in tropical agricultural systems will be emphasized.