UNIVERSITI PUTRA MALAYSIA

EFFECT OF AVAILABLE SOIL MOISTURE ON THE GROWTH AND YIELD OF GROUDNUT (ARACHIS HYPOGAEA L.)

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EFFECT OF AVAILABLE SOIL MOISTURE ON THE GROWTH AND YIELD OF GROUNDNUT (*Arachis hypogaea* L.)

By

MD. ABDUR RAHMAN SARKAR

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in the Faculty of Agriculture, University of Agriculture Malaysia

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DEDICATION

Dedicated to the memory

of my departed father

ACKNOWLEDGEMENTS

The author expresses his deep sense of gratitude and indebtedness to his supervisors Dr. Lim Eng Siong and Dr. Mok Chak Kim for their painstaking and scholastic guidance, advice, and constant encouragement during the entire period of this study and for their invaluable constructive criticisms during the preparation of the thesis.

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An abstract of the thesis presented to the Senate of Universiti Pertanian Malaysia in partial fulfilment of the requirements for the Degree of Doctor of Philosophy.

EFFECT OF AVAILABLE SOIL MOISTURE ON THE GROWTH AND YIELD OF GROUNDNUT (Arachis hypogaea L.)

By

Md. Abdur Rahman Sarkar

Chief Supervisor : Associate Professor Dr. Lim Eng Siong

Supervisor : Associate Professor Dr. Mok Chak Kim

Faculty : Agriculture

Experiments were carried out under glasshouse conditions with a locally grown Spanish type groundnut variety V 13 to determine the effect of available soil moisture on the growth and yield.

The vegetative growth was found to be depressed by the prolonged deficit of available soil moisture at early flowering. The pod yield was found to be reduced by moisture deficits of both short and prolonged duration occurring at early flowering and pegging stages in comparison to podding stage. However, the reduction in pod yield was more severe due to the prolonged deficit of available soil moisture at early flowering. Twenty percent available soil moisture reduced pod yield more severely during the prolonged druation treatment.

The vegetative growth (particularly in terms of dry matter) was adversely affected when irrigation was scheduled at or below 70 percent available soil moisture. As a consequence of the adverse effect of low levels of available soil moisture on the vegetative growth, the pod and seed yields were also adversely reduced.

The flowering and podding were found to be more sensitive to low levels of available soil moisture in respect of yield.

With a view to maximizing yield, the groundnut crop should preferably be irrigated to maintain the level of available soil moisture at field capacity especially during the stage of flowering and podding.

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi sebahagian dari syarat-syarat untuk memperolehi Ijazah Doktor Falsafah.

KESAN KELEMBAPAN TANAH YANG SEDIA ADA KE ATAS TUMBESARAN DAN PENGHASILAN KACANG TANAH (Arachis hypogaea L.)

Oleh

Md. Abdur Rahman Sarkar

Ketua Penyelia : Profesor Madya Dr. Lim Eng Siong

Penyelia : Profesor Madya Dr. Mok Chak Kim

Fakulti : Pertanian

Eksperimen telah dijalankan di bawah keadaan rumahkaca ke atas satu varieti kacang tanah Spanish tempatan, varieti V 13, untuk menentukan kesan kelembapan tanah yang sedia ada terhadap tumbesaran dan penghasilannya.

Tumbesaran tampang pada peringkat pembungaan awal telah didapati dirosotkan oleh kekurangan kelembapan tanah yang sedia ada yang berpanjangan. Hasil lenggai juga didapati telah dikurangkan oleh kekurangan kelembapan yang berlaku pada tempoh jangka pendek dan panjang pada peringkat pembungaan awal dan penuggatan berbanding dengan peringkat pelenggaian. Walau

bagaimanapun, pengurangan hasil lenggai berlaku dengan lebih teruk akibat daripada kekurangan air tanah yang sedia ada yang berpanjangan pada peringkat pembungaan awal. Kelembapan tanah yang sedia ada pada paras 20 peratus sangat menjejaskan hasil lenggai.

Tumbesaran tampang (Khasnya dari segi bahan kering) telah terjejas apabila bekalan air diadakan pada paras kelembapan tanah yang sedia ada pada atau di bawah 70 peratus. Kesan buruk ke atas tumbesaran tampang yang disebabkan oleh kelembapan tanah yang rendah ialah hasil lenggai dan biji benih menjadi kurang dengan teruk.

Dari segi penghasilan, peringkat pembungaan dan pelenggaian telah didapati lebih sensitif kepada paras rendah kelembapan tanah yang sedia ada.

Untuk mendapatkan hasil yang maksimum, tanaman kacang tanah perlu diberikan bekalan air supaya paras kelembapan tanah yang sedia ada dikekalkan pada had basah (field capacity),istimewa sekali pada masa peringkat pembungaan dan pelenggaian.

CHAPTER I

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) which belongs to the family Papilionaceae in the Order Leguminosae, is regarded as one of the leading crops in the world for the production of oil and plant protein. It is extensively cultivated in the tropical and sub-tropical countries for direct use as food, for the oil, and for the protein rich meal produced after oil extraction.

Erratic rainfall, in the tropical and sub-tropical countries is one of the important causes responsible for the low yield in groundnut as it is usually grown there as a rainfed crop. The crop generally requires an evenly distributed rainfall of at least 550 mm (Sellschop, 1966) during the growing season when grown as a rainfed crop. Soil moisture deficits frequently occur under rainfed condition when anticipated rain does not occur in time or when rainfall is scanty. Under such conditions, the crop has to depend upon the stored soil moisture which is soon depleted through evapotranspiration. Consequently the growth and yield of the crop is severely depressed. Prolonged and severe moisture deficits can result in complete crop failure unless the soil moisture is replenished in time. Natural rainfall supplemented with irrigation can ensure favourable soil moisture regimes

conducive to optimum yield. However, irrigation is costly and the quantity of water is usually limited. Therefore, judicious use of irrigation is desirable.

Plants are not equally sensitive to soil moisture deficits at different stages of growth in terms of growth and yield reduction. Rather, there are some specific stages of growth during which soil moisture deficits are more proned to reduce the growth and yield. Scanty rainfall during the moisture sensitive growth stages, can result in severe yield reduction unless depleted available soil moisture is replenished with supplemental irrigation. The irrigation cost may be minimized by supplying adequate water at the moisture-sensitive stage and less water at other stages of growth.

The determination of the level of available soil moisture upto which irrigation can be delayed, is an important cost reducing aspect in groundnut irrigation. The interval between irrigations should be as large as possible without appreciable reduction in crop yield. This will also ensure the application of the right amount of water. Over-irrigation, which is costly and detrimental to the crop, can thus be avoided.

Groundnut is one of the promising short-term cash crops in Malaysia included in the crop diversification programme. It is generally grown here as a rainfed crop. It is, therefore, probable that the groundnut yield can be reduced in times of

inadequate rainfall. There is limited and sporadic information on the growth and yield of groundnut in relation to soil moisture deficits under local condition. Research work in this field thus warrants due attention.

The present study was, therefore, carried out with the following objectives :

1. To determine the growth and yield response of groundnut at different growth stages to short and prolonged duration at various levels of available soil moisture.

2. To determine the optimum level of available soil moisture for the growth and production of groundnut, and to determine the moisture sensitive growth stage.

CHAPTER II

REVIEW OF LITERATURE

This review of literature covers the development of plant water deficit and its effects on physiological processes as well as on the growth, development and yield of crop plants in general and groundnut in particular.

Development of Plant Water Deficit

Plant water deficits generally occur when water loss through transpiration is more than water absorption. According to Kramer (1963), water deficits in plants can be caused either by excessive loss of water or by inadequate absorption, or by a combination of the two. The water potential in a non-transpiring plant approaches the water potential in the soil, but with the commencement of transpiration, a gradient in water potential develops from the soil, to and through the plant; thus water moves from the soil, through the plant, and out to the atmosphere (Fischer and Hagan, 1965). Temporary midday deficits occur in rapidly transpiring plants because the resistance to water movement through roots causes absorption to lag behind transpiration even in moist soil. Longer-term and more severe water deficits develop when decreas

cause decreased absorption of water. Thus, daily cycles in water stress are controlled chiefly by transpiration, but long term, severe water deficits develop chiefly because of decreasing availability of soil water (Kramer, 1969). The decreasing availability of soil water causes an increase in the water potential gradient between the soil and the root. As a result, a greater soil–root water potential difference is required to move water from soil to roots to replace the loss by transpiration. At this stage the rate of water movement from the soil to the roots is so slow that recovery from wilting is not possible and permanent wilting occurs.

Water Stress and the Physiological Processes in Plants

Water stress affects physiological processes such as protoplasmic dehydration, photosynthesis, respiration, transpiration and translocation of photosynthates.

Protoplasmic Dehydration

The dehydration of the protoplasm has profound effect on the various physiological processes in plant life. According to Stocker (1960), the dehydration of the protoplasm occurs in two stages - the reaction phase, when plants are first subjected to water stress and the restitution and hardening phase, which occurs if water stress lasts for several days. The reaction phase is characterized by a decrease in viscosity of the protoplasm, increased permeability to water, urea and glycerine, increased proteolysis, and increased respiration. In the restitution phase,