شبكة المعلومات الجامعية

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شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

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Cairo University

Institute of African Research and Studies

Department of Natural Resources

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EVALUATION OF CROP WATER USE EFFICIENCY FOR SOME VARIETIES OF SUDANESE AND EGYPTIAN COWPEA AND ITS RELATION TO PRODUCTIVITY

Thesis

Submitted in Partial Fulfillment of the Requirements for The Doctor Of Philosophy Degree in African Studies of Natural Resources (Soil Resources)

By

EVON KAMEL RIZK HABIB

B.Sc. Agric. Sci., Zagazig University (1984),

Diploma in African Studies, Natural Resources (1995),

M.Sc. in African Studies, Natural Resources (1999),

Institute of African Research and Studies

Cairo University

Under the Supervision of

Prof. Dr. ADEL S. EL-HASSANIN

Prof. of Soil Science, and Vice-Dean of Institute of African Research and Studies, Cairo University

Prof. Dr. MOSTAFA H. EL-DOSOUKY

Prof. and Head of Water Requirements and Meteorology Unit, Desert Research Center,Cairo, Egypt

Prof. Dr. FAWZIA I. MOURSY

Prof. of Meteorology, and Head of Natural Resources Department, Institute of African Research and Studies,Cairo University

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APPROVAL SHEET

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EVON KAMEL RIZK HABIB

B.Sc. Agric. Sci., Zagazig University (1984),
Diploma in African Studies, Natural Resources (1995),
M.Sc. in African Studies, Natural Resources (1999),
Institute of African Research and Studies
Cairo University

This thesis for Ph.D. degree has been

Approved by:

Prof. Dr. SAAD EL-DEMERDASHE .....

Prof. of Soils and Chairman of Water Resources and Desert Soils Division, Desert Research Center.

Prof. Dr. MOHAMED ESSAM SHAWKY.....

Prof. of Soils Physics, Soil Department, Faculty of Agriculture, Cairo University .

Prof. Dr. ADEL SAAD EL-HASSANIN.....

Prof. of Soil Science, and Vice-Dean of Institute of African Research and Studies, Cairo University.

Prof. Dr. MOSTAFA HASSAN EL- DOSOUKY.....

Prof. of Soils and Head of Water Requirements and Meteorology Unit, Desert Research Center.

Date of examination: / / 2002.

Title: **"Evaluation of crop water use efficiency for some varieties of Sudanese and Egyptian cowpea and its relation to productivity"**

The current work was carried out in the Agricultural Experimental Station of the Desert Research Center at Maryut, Alexandria Governorate, Egypt, during two seasons 2000 and 2001.

The study intends to evaluate the influence of soil moisture deficit, irrigation water amounts and plant density population and their interaction on growth characters, yield and yield components, actual evapotranspiration, water use efficiency, water economy, crop coefficient, stress coefficient and irrigation efficiency of Sudanese and Egyptian cowpea grown under calcareous soil conditions.

Experimental treatments:

The treatments include: Three soil moisture deficit from available soil water: (D1 = 30 % & D2 = 50 % and D3 = 70 %), three quantities of irrigation water calculated by using: (Q1, Priestley & Taylor model, Q2, Penman – Monteith equation and Q3, Radiation method) and three plant density population treatments: (PD1 = 100 % (low), PD2 = 110 % (medium) and PD3 = 120 % (high).

Four replicates.

The obtained results can be summarized as follows :

A) Effect of soil moisture deficit:

1- Highly significant effect and significant differences are found in number of pods per plant, number of seeds per pod, seeds weight per pod, seeds weight per plant, 1000-seed weight, plant moisture content %, straw yield, seed yield, total fresh yield and total dry yield, and significant differences on all growth characters, yield and yield components, water use efficiency and water economy of Sudanese and Egyptian cowpea during the two seasons, the common magnitude is in the order: $D_2 > D_1 > D_3$.

2- Highly significant effect and significant differences are observed in actual evapotranspiration (ETa), crop coefficient (Kc), stress coefficient (Ks) and irrigation efficiency (Ea) of Sudanese and Egyptian cowpea during the two seasons. In brief, (ETa), (Kc), (Ks) and (Ea) decreased with increasing soil moisture deficit, the common magnitude is in the order: $D_1 > D_2 > D_3$. of Sudanese and Egyptian cowpea during the two seasons.

B) Effect of irrigation water amounts :

1- Highly significant effect, significant differences and a significant increase are found in all growth characters, yield and yield components, water use efficiency, water economy, crop coefficient, stress coefficient and irrigation efficiency of Sudanese and Egyptian cowpea by decreasing the amounts of irrigation water applied. The magnitude is in the order: Q1 > Q2 > Q3 during the two seasons.

2- Highly significant effect and significant differences are remarkable in actual evapotranspiration of Sudanese and Egyptian cowpea during the two seasons, but non significant differences between Q1 and Q2. However, a significant increase by increasing the amounts of irrigation water applied. In brief, the common magnitude is in the order: Q3 > Q1 > Q2.

C) Effect of plant densities:

1. Highly significant effect, significant differences and highly significant increase are apparent in all growth characters, yield and yield components, water use efficiency and water economy of Sudanese and Egyptian cowpea during the two seasons. The magnitude is in the order: $PD_1 > PD_2 > PD_3$.
2. A significant increases by decreasing plant densities were obtained for number of pods per plant, number of seeds per pod, seeds weight per pod, seeds weight per plant, 1000-seed weight and seed yield, the magnitude is in the order: $PD_1 > PD_2 > PD_3$ for the two seasons of Sudanese cowpea. Moreover, a significant increases by increasing plant densities were obtained for straw yield, total fresh yield and total dry yield, the magnitude is in the order: $PD_3 > PD_2 > PD_1$ for the two seasons of Sudanese cowpea. On the other hand, for total dry yield, the magnitude is in the order: $PD_2 > PD_1 > PD_3$ for the two seasons of Egyptian cowpea.
3. Highly significant effect and significant differences are found in actual evapotranspiration, crop coefficient, stress coefficient and irrigation efficiency of Sudanese and Egyptian cowpea in the two seasons and increased with increasing plants density, the magnitude is in the order: $PD_3 > PD_2 > PD_1$.

Cairo University
Institute of African Research and Studies
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Title : "Evaluation of crop water use efficiency for some varieties of Sudanese and Egyptian cowpea and its relation to productivity"

Name : Evon Kamel Rizk Habib.

Degree : Ph.D. in African Studies of Natural Resources.

Supervisors :

(1) Prof. Dr. Adel S. El-Hassanin,

(2) Prof. Dr. Fawzia I. Moursy,

(3) Prof. Dr. Mostafa H. El-Dosouky.

ABSTRACT

Key words : Irrigation water amounts, soil moisture deficit, plant density population, actual evapotranspiration, water use efficiency, water economy, crop coefficient, stress coefficient, irrigation efficiency, Sudanese and Egyptian cowpea, growth parameters, yield and yield components.

The current work was carried out during two seasons 2000 and 2001 in the Agricultural Experimental Station of the Desert Research Center at Maryut, Alexandria Governorate, Egypt.

The study intends to evaluate the influence of soil moisture deficit, irrigation water amounts and plant density population and their interaction on growth characters, yield and yield components, actual evapotranspiration, water use efficiency, water economy, crop coefficient, stress coefficient and irrigation efficiency of Sudanese and Egyptian cowpea grown under calcareous soil conditions.

Experimental treatments:

The treatments include: Three soil moisture deficits from available soil water: (D1 = 30 % & D2 = 50 % and D3 = 70 %), three quantities of irrigation water calculated by using: (Q1, Priestley & Taylor model, Q2, Penman – Monteith equation and Q3, Radiation method) and three plant density population treatments: (PD1 = 100 % (low), PD2 = 110 % (medium) and PD3 = 120 % (high). Four replicates.

The obtained results can be summarized as follows :

A) Effect of soil moisture deficit:

1- Highly significant effect and significant differences are found in number of pods per plant, number of seeds per pod, seeds weight per pod, seeds weight per plant, 1000-seed weight, plant moisture content %, straw yield, seed yield, total fresh yield and total dry yield, and significant differences on all growth characters, yield and yield components, water use efficiency and water economy of Sudanese and Egyptian cowpea during the two seasons, the common magnitude is in the order: $D_2 > D_1 > D_3$.

2- Highly significant effect and significant differences are observed in actual evapotranspiration (ETa), crop coefficient (Kc), stress coefficient (Ks) and irrigation efficiency (Ea) of Sudanese and Egyptian cowpea during the two seasons. In brief, (ETa), (Kc), (Ks) and (Ea) decreased with increasing soil moisture deficit, the common magnitude is in the order: $D_1 > D_2 > D_3$. of Sudanese and Egyptian cowpea during the two seasons.

B) Effect of irrigation water amounts :

1- Highly significant effect, significant differences and a significant increase are found in all growth characters, yield and yield components, water use efficiency, water economy, crop

coefficient, stress coefficient and irrigation efficiency of Sudanese and Egyptian cowpea by decreasing the amounts of irrigation water applied. The magnitude is in the order: Q1 > Q2 > Q3 during the two seasons.

2- Highly significant effect and significant differences are remarkable in actual evapotranspiration of Sudanese and Egyptian cowpea during the two seasons, but non significant differences between Q1 and Q2. However, a significant increase is associated with increasing the amounts of irrigation water applied. In brief, the common magnitude is in the order: Q3 > Q1 > Q2.

C) Effect of plant densities:

1. Highly significant effect, significant differences and highly significant increase are apparent in all growth characters, yield and yield components, water use efficiency and water economy of Sudanese and Egyptian cowpea during the two seasons. The magnitude is in the order: $PD_1 > PD_2 > PD_3$.
2. A significant increases for number of pods per plant, number of seeds per pod, seeds weight per pod, seeds weight per plant, 1000-seed weight and seed yield were obtained by decreasing plant densities, the magnitude is in the order: $PD_1 > PD_2 > PD_3$ for the two seasons of Sudanese cowpea. Moreover, a significant increases by increasing plant densities were obtained for straw yield, total fresh yield and total dry yield, the magnitude is in the order: $PD_3 > PD_2 > PD_1$ for the two seasons of Sudanese cowpea. On the other hand, for total dry yield, the magnitude is in the order: $PD_2 > PD_1 > PD_3$ for the two seasons of Egyptian cowpea.
3. Highly significant effect and significant differences are found in actual evapotranspiration, crop coefficient, stress coefficient and irrigation efficiency of Sudanese and Egyptian cowpea in the two seasons and increased with increasing plants density, the magnitude is in the order: $PD_3 > PD_2 > PD_1$.

D) Conclusions and Recommendations :

From the previous findings, one can conclude that:

1. Irrigation at medium soil moisture deficit (D_2=50%) from available soil water and use (Priestly & Taylor model, Q1) or (Penman-Monteith equation, Q2) to calculate irrigation water amounts with addition of 60 % over (20 % leaching requirements and 40 % irrigation system efficiency losses) with rate low plant densities (PD_1=100%), to obtain the highest water use efficiency, of Sudanese and Egyptian cowpea at the same conditions should be carefully evaluated in the studied area.
2. The economical level of irrigation water depends on the unit price of both irrigation water and produced yield. To obtain the highest yield together with irrigation water saving and highest irrigation efficiency, it is advised to apply 592.08 mm. (2486.76 m^3/fed.) for Sudanese cowpea and 487.68 mm (2048.28 m^3/fed) for Egyptian cowpea at sites similar to that of the experiment.
3. It is clear that using the combination of the traditional quantities of irrigation water calculated from (Priestley & Taylor model, Q1) with low plant densities (PD_1=100%) under medium soil moisture deficit (D_2=50%) gave the best values of Investment Ratio (IR) either with Sudanese cowpea or Egyptian cowpea in Maryut area and also at sites similar to that of the experiment.
4. The new in this study is to combine economical and stress approaches of irrigation water and management through calculation of the investment ratio (IR), stress coefficient (Ks), irrigation efficiency (Ea) and irrigation scheduling of Sudanese and Egyptian cowpea crops under different managements.

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