USING CROPSYST SIMULATION MODEL TO PREDICT WHEAT CROP GROWTH UNDER DIFFERENT WATER AND NITROGEN REGIMES IN A MEDDLE EGYPT TYPE OF ENVIRONMENT (GIZA REGION)

Journal

[2]Namait Allah Y. Osman, [1]M. K. Sadik, [1]A. M. A. ABD El-Haleem, H. M. Eid and [1]H. M. Salem

J. Biol. Chem. Environ. Sci., 2009, Vol. 4(1): 41-61 www.acepsag.org

[1]Soil Science Department; Faculty of Agriculture, Moshtohor, Benha University
[2]Water Requirements Research Department; Soil, Water and Environment Research Institute, ARC

ABSTRACT

The 'CropSyst' (Cropping Systems Simulation) Model is a multi-year, multi-crop, daily time step crop growth simulation model, linked to a weather generator ClimGin v 4 ***(Stockle, 1996)*** was evaluated for its ability to simulate growth, biomass and grain yield, water and nitrogen use of crop production of wheat cultivar (Giza 168) grown in Giza region. Field experiment was conducted involving three water regimes (irrigating at 1.25, 1.00 and 0.75 evaporation pan coefficient EPC and three nitrogen levels (144, 180 and 216 kg N/ha) in Meddle Egypt environment (Giza region). Data collected from two distinct growing seasons (2004/2005, 2005/2006) were used in Calibration/ Validation model. Then, the model was used to predict the aboveground biomass, grain yield and ET crop. Results reveal that the CropSyst model was able to track the aboveground biomass, grain yield, ET crop and N uptake progress throughout the season when compared with observed data from the filed experiments. Statistical analysis showed a high correlation between simulated versus observed data with values of correlation coefficient (R^2) between 0.93 and 0.99. Running simulation showed that increasing soil water increased simulated aboveground biomes, grain yield and ET crop while N uptake was not effected by increasing soil water. Yields were positively affected by increased N-level and maximum simulated values were obtained at 216 kg N/ha but the ET crop increase was

limited. In general, the CropSyst model was useful to use particularly in the long term cropping system and climate change strategy. However future research should be done to evaluate the model for a wider use and different conditions and regions.

INTRODUCTION

In Egypt, water is a scarce natural resource for crop production. The agricultural sector uses about 83% of the total water resources (Abu Zeid, 1999). With increasing population, serious water shortages well occur and slow down further agricultural development. The great challenge for the coming decades will therefore be the task of increasing food production with less water especially in areas located in arid and semi-arid regions (FAO, 2002). Wheat is the most important winter cereal crop in Egypt used as a major food crop. The area devoted for wheat production is about 1.05 million hectares giving an average yield of 6.11 metric ton/ha (Awad et al., 2000). However, the local production does not meet the consumption. Therefore, increasing wheat production is very important; this is done by increasing newly reclaimed area and increasing yield per unit area which can be accomplished via improved agronomic practices including the use of high- yielding cultivars and efficient irrigation management as well as fertilization.

The importance of N for wheat in arid regions has increased the use of N fertilizers, particularly in the past two decades causing increased production of the wheat grains (Pala et al. 1992).

The impact on productivity of water application and N fertilization can not be analyzed independently of weather, soil characteristics, field hydrology, crop characteristics and rotation, among other factors. To develop best management practices (BMPs), Pala et al. (1996) stated that it is necessary to integrate these factors into a comprehensive cropping systems approach. A successful method of determining BMPs would provide valuable information to meet the growing demand for agricultural products and in the same time minimizing the environmental impact of agricultural activities and this can hardly be obtained by simple reliance on conventional field experimentation.

Computer simulation models, which are able to capture the long-term effects of weather fluctuations and the effects of various soil properties and management practices on the soil water balance, nutrient dynamics, and crop growth could contribute to further our understanding of cropping systems performance under different water and N regimes. Such models should improve the efficacy of decision making for fertilizer and water management. The model 'CropSyst Version 1' introduced by Stockle et al (1994) and developed by Stockle and Nelson (2001) 'CropSyst Version 3 ' is a management-oriented cropping systems model able to simulate a range of weather/management scenarios using few experiments as a base. The field experiments are required for model calibration and validation, which are the necessary steps before application of the model can be developed for a given region.

In anticipation of future applications of the CropSyst model in the region, the objective of this study was to evaluate its ability to simulate growth, yield, water and nitrogen use of a wheat cultivar grown under different water and N regimes in Middle Egypt at the Giza Research Station of Agriculture Research Center of Egypt.

MATERIALS AND METHODS

The field experiments

The field data used for model calibration/ validation were obtained from two field experiments carried out at Giza Agricultural Research Station, Egypt, during 2004/2005 and 2005/2006 growing season under Giza region condition in Middle Egypt. The experiment was laid out in a split - plots design with three replicates. The plot area was 20.0 m^2 (4 x 5 m). The main plots were assigned to irrigation pan coefficient treatments and the sub-plots were assigned to nitrogen levels. Sowing dates were 8th and 1st December for the first and second seasons, respectively. Plants were harvested on 6th and 2nd of May for the two respective seasons. The preceding crop was sunflower in the two seasons. Irrigation was practiced according to the accumulative values of the daily evaporation records from class A pan establish in Giza Agro- cilametological Station for the different irrigation treatments. Application of irrigation regime treatments started from the third irrigation and corresponded to Evaporation Pan Coefficient (EPC). Treatments were as follows: (I_1) 1.25 EPC; (I_2) 1.00 EPC and (I_3) 0.75 EPC. Water consumptive use (CU) was determined via soil samples from the sub plots just before each irrigation and 48 hrs later as well as at harvest. Sampling depths were 15-cm successive layers down 60-cm depth of the soil profile.

The CU was calculated according to Israelsen and Hansen (1962) as follows:

$$\mathbf{CU = D \times Bd \times Q_2 - Q_1 / 100}$$

Where:

CU = actual evapotranspiration (in mm).
D = effective root depth (in mm).
Bd = bulk density of soil in (g/cm^3).
Q_2 = soil moisture percentage two days after irrigation (w/w).
Q_1 = soil moisture percentage before next irrigation (w/w).

The fertilizer nitrogen treatments were as follows: (N_1) 144 kg/ha; (N_2) 180 kg and (N_3) 216 kg N/ha in the forms of ammonium nitrate (33.5%N). Application was done in two equal splits; the first was applied before the life irrigation (El- Mohayah irrigation) and the second one after 21 days from the first one. All other practices were applied as adopted in the area. At harvest, the plants of each entire sub-plot were harvested in order to determine straw and grain yield. The number of spikes / m^2 was measured by counting all spikes per square meter selected in random from each sub-plot Ten spikes were randomly taken, from each sub-plot, and the weight of grains / spike and the 1000-grain weight was recorded, then all plots were harvested and yields were measured.

Weather data from a Agro- metological Station located at the Giza (Lat 30:03, Long: 31,13 and sea level 19.5 m) 50 m from the experimental site were recorded .Therefore, the weather data represent the field conditions reasonably well. Precipitation, maximum and minimum temperatures, sunshine and solar radiation were measured on a daily basis in each growing season for the model and then summarized as monthly weather data in Table1. Irrigation interval days are presented in Table 2

Table (1): Some meteorological data at Giza Agric. Res. Station, 2004/2005 and 2005/2006 seasons

Season	2004/2005					2005/2006				
Month	T max	T min	RF	SS	SR	T max	T min	RF	SS	SR
Dec	20.8	8.4	6.0	7.0	268	23.2	10.1	1.0	7.0	268
Jan	20.3	6.9	2.0	7.0	280	20.4	8.0	1.9	7.0	280
Feb	22.8	8.8	6.0	7.9	353	22.8	10.0	6.0	7.9	353
Mar	23.5	10.7	4.0	8.6	441	24.6	10.5	6.6	8.6	441
Apr	28.0	13.8	8.0	9.6	519	28.7	16.0	2.0	9.6	519
May	31.9	16.7	0.0	10.8	585	32.7	19.6	0.0	10.8	585
Mean	24.6	10.9	4.3	8.5	408	25.4	12.4	2.9	8.5	408

T max and T min = maximum and minimum temperatures, °C ; RF = rain fall, mm ; SS = actual sun shine, hr ; SR = solar radiation, cal/cm^2/day .

Table (2): Date of different irrigation for some wheat cultivars grown in Giza region in 2004/2005 and 2005/2006 seasons.

Season	Irrigation regime	Evapor. (mm)	First Irri	Secod Irri	Third Irri	Fourth Irri	Fifth Irri	Sixth Irri	Seventh Irri
	1.25	82.5	8/12	4/1	3/2	19/2	14/3	29/3	12/4
2004/2005	1.00	110.0	8/12	4/1	9/2	1/3	23/3	12/4	
	0.75	137.5	8/12	4/1	14/2	6/3	6/4		
	1.25	82.5	1/12	28/12	27/1	16/2	7/3	23/3	6/4
2005/2006	1.00	110.0	1/12	28/12	3/2	26/2	23/3	11/4	
	0.75	137.5	1/12	28/12	9/2	20/3	15/4		

The 'CropSyst' model simulation input:

The 'CropSyst' is considered a user-friendly, conceptually simple but sound multi-year multi-crop daily time step simulation model. It was developed by the Biological Systems Engineering Department, Washington State University (Stockle and Nelson 2001) to serve as an analytical tool to study the effect of cropping system management on productivity and the environment. The model simulates the soil water budget, soil-plant nitrogen budget, crop canopy and root growth, dry matter production, grain yield, residue production and growing season length.

Simulation Models parameter requirements

Simulation files contain information allowing the user to build simulation conditions from a database of existing location, soil, crop, and management files. Simulation files also contain information regarding the period of simulation and initial values for variables, which require initialization.

1- Climatic Data

Location file includes latitude, longitude and sea levels, storms evapotranspiration, wind for the study site. Weather database file includes daily maximum and minimum temperatures, precipitation in real daily weather database format 'DAT 'or the Universal Environmental Data UED files generated byClimGen can be used directly by CropSyst for climate change scenarios.

2- Soils Data

The Giza soil is a montmorillonitic, thermic, deep (Abdel - Wahed 1983). Soil properties are shown in Table 3 and Table 4.

Table (3): Soil moisture constants (% by weight) and bulk density (g/cm^3) of soil site of Giza Agricultural Research Station.

Depth, cm	Field capaciy	Wilting point	Available water	Bulk density
00-15	41.9	18.6	23.24	1.15
15-30	33.7	17.5	16.18	1.20
30-45	28.4	16.9	11.46	1.22
45-60	28.1	16.5	11.51	1.28

Table (4): Some physical and chemical properties of the soil at Giza.

Particle-size distribution	
Soil fraction	Content %
Coarse sand	2.91
Fine sand	13.40
Silt	30.51
Clay	53.18
Textural class	Clay
Soil chemical analyses	Content
Organic matter	1.80%
Available N (KCl-extract)	40. 0 mg kg-1
Available P (Na - bicarbonate extract)	19.0 mg kg-1
Available K (NH4 - a acetate extract)	304 mg kg-1
pH (1:2.5, soil: water suspension)	7.4

3- Crop Variables:

Daily crop growth, expressed of biomass increase per unit area, is calculated on the basis of the minimum of four limiting factors; light, temperature, water and nitrogen. Details on the technical aspects and use of the CropSyst model are reported elsewhere (Stockle and Nelson 2001).

4 Management Variables:

Management variable include: cultivar selection (Giza168), crop rotation (including fallow years), irrigation, nitrogen fertilization, tillage operations and residue management as follows:

1. Planting and harvesting date
2. Maximum leaf area index at the flowering period.
3. Grain and biomes yield/ ha.
4. Water management: date, amount and irrigation system.
5. Fertilizer nitrogen management: date, amount, forms and method of application.
6. Pre-planting practices (type, date, and times of application).
7. Previous crop residue: quantity and depth.

5- Crop model calibration/ validation:

Calibration of the model was done using data of field experiment established as described above by modifying the model data with data collected from 9 out of 18 combinations of the two growing seasons, 3 water treatments, and 3 nitrogen treatments. Then, the model was validated by comparing observed experimental field results for a normal treatment (irrigation at 1.00 EPC with 180 kg N/ha) with simulated values obtained form the same treatment inputs including the fluctuation of growing season length, aboveground biomass, grain yield, cumulative evapotranspiration (ET) in both growing seasons. The crop and other input parameters calibrated are marked in Table 5.

RESULTS AND DISCUSSION

Filed experimental results

A seasonal summary of data collected during the two years of the experiment, on which the model was validated, is shown in Table 6. In general, total aboveground biomass and grain yields were increased with increasing amount of water applied and as responses to N fertilization. There was also a positive response due to N- fertilization levels for all water regimes in the two growing seasons. Water use (ET crop) ranged between 273 and 450 mm for 2004/2005 season and from 300 to 468 mm for 2005/2006 season. Obviously, water use increased with increasing amount of water applied according to EPC.

Table (6): water consumptive use (mm), grain and biological yield (kg /ha) of wheat cultivar Giza168 as affected by irrigation regime and fertilizer N level at Giza region in 2004 /2005 and 2005/2006 seasons as collected from experimental data.

Season	2004/2005				2005/2006			
	N- levels (kg/ ha							
Irrigation	144	180	216	Mean	144	180	216	Mean
-------------------Water Consumptive Use (mm)----------------								
1.25 EPC	354	382	450	395	366	421	468	418
1.00 EPC	311	350	401	354	321	385	439	382
0.75 EPC	273	305	325	301	300	304	329	311
Mean	313	346	392	350	329	370	412	370
---------- ---Grain Yield kg/ha-----------------								
1.25 EPC	6163	7080	7315	6852	6814	7598	7666	7358
1.00 EPC	5424	6564	6936	6307	6470	7675	7786	7310
0.75 EPC	5136	5664	5832	5544	5244	5916	6199	5786
Mean	5575	6437	6694	6235	6175	7063	7217	6818
--------------------- biological yield kg/ha---------------------------								
1.25 EPC	13634	15360	16510	15168	15168	17069	17549	16238
1.00 EPC	12559	13440	14479	13493	14904	14928	16586	15737
0.75 EPC	10378	11160	12785	11465	11314	12000	13464	12259
Mean	12190	13320	14591	13375	13369	14666	15866	14319

Also, N application increased the average water use by 20.15 % for both seasons. Growing season duration value patterns of both seasons were also having a similar pattern. Growing season duration values were 149 and 153 day for season 1 and 2, respectively. Throughout the experiment, all other yield components increased due to increased N fertilization and also increased with increasing Evaporation Pan Coefficient (EPC).

The model performance

Crop model Calibration:

Calibration of crop input parameters allowed the CropSyst model to perform satisfactorily in mimicking the changes throughout the growing season. Also aboveground biomass, grain yield, ET, and N uptake at harvest for all treatment combinations were simulated reasonably well.

Crop Validation:

Data selected for validation were collected from field at Giza region to represent the major conditions e.g. Et crop, growing season duration, final grain yield and biomess for the two growing seasons. Crop model was validated comparing the observed experimental field results for normal treatment (irrigation at 1.00 EPC with 180 kg N/ha) with simulated values obtained form the same treatment input in both growing seasons (table 7)

Validation results indicate that the observed and the simulated values are comparable for the wheat cultivatar of the experiment. Change percentage ranged from 0.94 to 1.05 % while values of correlation coefficient (R^2) ranged between 0.93 and 0.99 for the tested variables, and the most similar ones were growing season duration, grain yield values and Et crop while biological yield values were rather different. On other hand the selected cultivar (Giza168) was superior in matching with the model. This trend was true in both growing seasons. Crop phonology was predicted closely to the observed values for anthesis, grain filling and physiological maturity for the 2004/2005 and 2005/2006 seasons (data not shown). Simulated maturity date was one week later than observed in 2005/2006 season. In general, validation results were acceptable for the purpose of the study, which indicates that the CropSyst model is valid for predicting wheat crop production and water requirement under middle Egypt (Giza) environmental condition.

Table (7): Correlation coefficient (R^2), relating observed data to predicted (simulated) data and the change rate % (predicted/ observed) regarding various parameters for wheat crop during 2004/2005 and 2005/2006 seasons

Season	2004/2005				2005/2006			
Variable	R^2	Predi ted	Observed	Change rate	R^2	Predicted	Observed	Change rate
Actual Evapot. mm/season	0.99	341	354	0.96	0.94	357	381	0.94
Grain Yield kg /ha	0.99	6489	6564	0.99	0.93	7463	7675	0.97
Biomass Yield kg /ha	0.93	13227	13440	0.98	0.94	15465	14928	1.04
Crop Season Duration in day	0.99	148	149	0.99	0.99	161	153	1.05

Crop simulated results

Simulated aboveground biomass, grain yield, cumulative ET crop and growing season duration at harvest are presented in table 7. The simulated treatment followed closely the 1:1 line when plotted against the experimental data (Figures 1a-b, 2a-b 3a-b and 4a-b). The statistical analysis confirmed that the CropSyst model predicted the tested variable reasonably well.

The statistical analysis results as recorded in table 8 indicate that ETc was predicted very closely to the actual ET values with correlation coefficient (R^2) values of 0.99 and 0.94 while root mean error square RMES were 1.68 and 4.73 for both seasons, respectively (Figures 3:a,b). On the other hand ET values varied due to Evaporation Pan Coefficient. The ET values increased as EPC values increased but ET crop value showed diminutive effect due to N levels. This my be due to the model's phonology response to N uptake by plant and possible variations with low level of nitrogen.

Regarding grain yield, the same trend was true in both growing seasons with R^2 values being 0.99, 0.93 and RMES were 0.082 and 0.254(Figures 1:a, 2:a). Simulated grain yield recorded high response to EPC and N application levels with most positive response to irrigation at 1.25 EPC and 216 kg N/ha N_3. Maximum grain yield was obtained by I_1 x N_3 and I_2 xN_3 in the first and second seasons, respectively.

Aboveground biomes prediction values followed closely the 1:1 line when plotted against the observed data and R^2 values of 0.0.93 and 0.94 for season 1 and 2, respectively while root mean error square RMES were 0.444 and 0.664 for the same respective seasons (Figures 1:b, 2:b). Regarding irrigation treatment, predicted aboveground biomes values increased positively with increases reached to 24 and 31 % with

I_1 1.25 EPC compared to I_3 0.75 EPC for season 1 and 2, respectively. The same trend was found with respect to N-levels. There was an increase of 9.71 % due to N3 over N1 in season 1 and 10.39 % in season 2. Crop phonology was predicted closely to the observed values for anthesis, grain filling and physiological maturity for 2004/2005 and 2005/2006 seasons (Figures 4:a,b).

The statistical analysis indicate that growing season duration was predicted very closely to the actual values with R^2 value of 0.99 and RMES values of 1.32 and 1.26 for season 1 and 2, respectively. Simulated maturity date was one week later than observed in 2005/2006 season. However, although over estimation occurred in the upper end of the N uptake range, predicted values of response to N level were increased with increased N application levels. N use efficiency as pointed in table 9, showed very high response to the model with value between 0.98 and 1.00. All other simulated details are recorded in tables 8 and 9 as a sample of daily output files.

Table 8. Statistical summary comparing simulated vs. observed data.

Variable	Data from	Sim. mean	Obs. mean	R^2	Slope	Const	RMES	d c %
Grain Yield kg /ha	Fig. 1a	6166	6235	0.99	1.06	324.3	0.082	0.99
Biomass Yield kg /ha	Fig. 1b	12775	13367	0.93	1.18	168.9	0.444	0.96
Actual Evapotranspi. mm/season	Fig. 3a	339*	350*	0.99	2.15	379.6	1.68	0.97
Crop Season Length .day	Fig. 4a	148	149	0.99	0.983	4.141	1.26	0.99
Grain Yield kg /ha	Fig. 2a	6751	6819	0.93	0.985	165.5	0.254	0.99
Biomass Yield kg /ha	Fig. 2b	14548	14776	0.94	0.873	2074	0.666	0.98
Actual Evapotranspi. mm/season	Fig. 3b	355*	370*	0.94	0.360	221.8	4.73	0.96
Crop Season Length .day	Fig. 4b	161	153	0.99	0.932	1.523	1.32	1.05

(*) ET values are in mm.

Table (9): Summary simulated values at harvest for wheat cultivatar Giza 168 as effected by water and nitrogen regime during 2004/2005 and 2005/2006 seasons.

Treatment	Emergence	Harvest	Yield	Above ground biomass	Soil water drainage	ET act.	Total nitrogen uptake	Total nitrogen applied	Nitrogen use efficiency	Nitrogen leached	
	Day	**Day**	**Kg/ha**	**Kg/ha**	**Mm**	**Mm**	**Kg N/ha**	**Kg /ha**	**%**	**KgN/ha**	**Description**
1.25 *144	353	148	6160	13446	0	358.5	166	167	0.99	0	Wheat (winter
1.25*180	353	148	6959	14613	0	363.1	201.6	203	0.99	0	Wheat (winter)
1.25*216	353	148	7227	14998	0	360.6	237.3	239	0.99	0	Wheat (winter)
1.00*144	353	148	5547	12227	0	340.3	166.3	167	1.00	0	Wheat (winter)
1.00*180	353	148	6489	13227	0	340.5	203.4	203	1.00	0	Wheat (winter)
1.00*216	353	148	6721	13530	0	338.7	237.7	239	0.99	0	Wheat (winter)
0.75*144	353	148	5109	10379	0	317.1	165	167	0.99	0	Wheat (winter
0.75*180	353	148	5579	11152	0	317.2	201.1	203	0.99	0	Wheat (winter)
0.75*216	353	148	5701	11402	0	317.2	236.5	239	0.99	0	Wheat (winter)
1.25 *144	348	162	6386	15399	0	383	166.4	167	1.00	0	Wheat (winter
1.25*180	348	162	7302	17009	0	370.3	200.9	203	0.99	0	Wheat (winter)
1.25*216	348	162	7829	17846	0	369	237.2	239	0.99	0	Wheat (winter)
1.00*144	348	162	6678	14342	0	356.8	165.8	167	0.99	0	Wheat (winter)
1.00*180	348	162	7463	15465	0	357	201.5	203	0.99	0	Wheat (winter)
1.00*216	348	162	7867	16003	0	355	235.2	239	0.98	0	Wheat (winter
0.75*144	348	162	5472	11268	0	334.6	166.4	167	1.00	0	Wheat (winter)
0.75*180	348	161	5807	11684	0	334.8	199.9	203	0.98	0	Wheat (winter
0.75*216	348	161	5959	11919	0	334.8	235.8	239	0.99	0	Wheat (winter)

Table (10) biological and grain yield, cumulative ET and growing season length values at harvest in related to observed data for wheat cultivatar Giza 168 as effected by water and nitrogen regime during two growing seasons.

Treatment	Grain Yield Kg/ha		Biological yield Kg/ha		ET act. mm		Grain Yield Kg/ha		Biological yield Kg/ha		ET act. mm	
	Sim	Ob	Sim	Ob	Sim	Ob	Sim	Ob	Sim	Ob	Sim	Ob
1.25 *144	6160	6163	13446	13634	358.5	395	6386	6814	15399	15168	383	418
1.25*180	6959	7080	14613	15360	363.1	395	7302	7598	17009	17069	370	418
1.25*216	7227	7315	14998	16510	360.6	395	7829	7666	17846	17549	369	418
1.00*144	5547	5424	12227	12559	340.3	354	6678	6470	14342	14904	356.8	381
1.00*180	6489	6564	13227	13440	340.5	354	7463	7675	15465	14928	357	381
1.00*216	6721	6936	13530	14479	338.7	354	7867	7786	16003	16586	355	381
0.75*144	5109	5136	10379	10378	317.1	301	5472	5244	11268	11314	334.6	311
0.75*180	5579	5664	11152	11160	317.2	301	5807	5916	11684	12000	334.8	311
0.75*216	5701	5832	11402	12785	317.2	301	5959	6199	11919	13464	334.8	311
Over all means	**6166**	**6235**	**12775**	**13367**	**339**	**350**	**6751**	**6819**	**14548**	**14776**	**355**	**370**

CONCLUSIONS

These results for site and years need to be extrapolated in time (long-term responses) and to other regions in order to be more useful. The study suggests that the use of crop modeling, after proper calibration and validation may be a feasible approach for such future extrapolations as climate change and other crop prediction studies, especially with linking the model with the weather generator ClimGin v 4 and GSP techniques. It may be recommended that more research is necessary to evaluate CropSyst in other regions.

REFERENCES

Abdel Wahed, A. 1983. Research report on soil survey. Soil Survey EMCIP Res. Extension Centers . Publication . No.62 Consortium for International Development. ARC, Cairo May 1983.

Abu-Zeid, M. 1999. Egypt’s Water Policy for the 21st Century, 7th Nile 2002 Conference, March 15-19, 1999, Cairo, Egypt.

Awad, H.A., H.E.Khalifa and M.H. El-khouli. 2000.Influence of nitrogen fertilizer levels and water deficit during some growth stages on wheat yield at the North Delta of Egypy. J. Agric. SciMansoura Univ.,25(7):4727-4735.

FAO. 2002. Deficit irrigation practices. FAO Water Reports No. 22, Rome, Italy.

Israelsen, O.W.and V.E.Hansen 1962. Irrigation principles and practices .3rd ed ., John Wiley and Sons Inc., New York ,USA .

James, L.G. 1988. Principles of farm irrigation system design. John Wiley and Sons, Inc., NY, USA.

Pala, M. ,C. O. Stockle and H. C. Harris .1996. Simulation of durum wheat (triticum durum) growth under differential water and nitrogen regimes in a mediterranean type of environment using CropSyst. Agricultural Systems.

Pala, M., Matar, A., Mazid, A., and El Hajj, K. 1992. Wheat response to nitrogen and phosphorus fertilization under various environmental conditions of northern Syria. In: Fertilizer Use Efficiency under Rain-fed Agriculture in West Asia and North Africa (J. Ryan and A. Matar, eds.), Proceedings of the 4th Regional Workshop by ICARDA/UNDP, 5-10 May, 1991, Agadir, Morocco, pp. 92-105.

Stockle C.O. and R. Nelson .2001. Cropping System Simulation Model User’s Manual. Biological Systems Engineering Department, Washington State University, Pullman ,USA .

Stockle C.O., G.S .Campbell and R .Nelson .1997. ClimGen for Windows, a weather generator program. Biological Systems Engineering Dept., Washington State University, Pullman, WA.

Stockle, C. O., and Nelson, R., 1994. Cropping Systems Simulation Model Users' Manual. (Version 1.02.00), Biological Systems Engineering Dept., Washington State University, Pullman, USA .

Stockle, C. O., S. Martin and G. S. Campbell. 1994. CropSyst, a cropping systems model: water/nitrogen budgets and crop yield. Agricultural Systems 46:335-359.

أستخدام برنامج المحاكاة CropSyst للتنبؤ بمحصول القمح النامي تحت معاملات مختلفة من الري والتسميد تحت الظروف البيئية لمصر الوسطى (منطقة الجيزة)

نعمة الله يوسف عثمان [2]- محمد كمال صادق [1]-على محمد أحمد عبد الحليم [1]- حلمي محمد عيد [2]-هيثم محمد سالم [1]

[1] قسم علوم الأراضي– كلية الزراعة بمشتهر – جامعة بنها.

[2] قسم بحوث المقننات المائية و الري الحقلي – معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية.

أقيمت تجربة حقلية بمحطة البحوث الزراعية بالجيزة خلال موسمي 2005/2004 و 2006/2005 لاستخدام نتائجها في تقيم مقدرة برنامج المحاكاة CropSyst (نموذجَ محاكاة للنمو و المحصولِ متعدّدِ المحصولَ متعدّدَ السَنَواتَ،) على تَقليد و التنبؤ بالمحصول والاستهلاك المائي لمحصولِ القمح صنف (جيزة 168) النامي تحت الظروف البيئية لمنطقة مصر الوسطى(الجيزة) حيث تم جدولة ا لرى باستخدام **ثلاث** معاملات للبخر من الوعاء القياسي هي (**1.25 & 1.00 &0.75**) و أضافه **ثلاث** مستويات متزايدة من التسميد النيتروجيني هي (144 ؛ 180 و 216 كجم /هكتار) **.** بعد تعديل بيانات البرنامج بالبيانات الحقلية تم إجراء اختبار التأكد والصلاحية بمقارنة القيم الفعلية والمتنبأ بها و كما تم حساب مربع انحرافات الخطأ التجريبي ومعامل التوافق وقد اظهر البرنامج كفاءة عالية للتنبؤ عند مقارنة القيم . كما أن التحليل الإحصائي أظهر قيما عالية لمعامل الارتباط تراوحت بين 0.93 و 0.99 وقد أظهرت نتائج المحاكاة بعد تشغيل البرنامج أن زيادة مستوى الماء الميسر لامتصاص النبات في التربة أدى إلى زيادة محصول الحبوب -المحصول البيولوجي وكذا الاستهلاك المائي للنبات حيث سجل معامل بجر الوعاء 1.25 أعلى القيم. كما أظهرت النتائج أيضا ريادة في المحصول بزيادة مستويات النيتروجين المضاف حيث سجلت أعلى القيم مع 216 كجم ن/هكتار إلا إن الاستهلاك المائي زاد زيادة طفيفة فقط. وعلى ذلك يمكن التوصية باستخدام برنامج CropSyst في التنبؤ بالمحاصيل على نطاق أوسع وتحت ظروف مناخية مختلفة خاصة في مشاريع التنمية المستدامة و أيضا في الدراسات المستقبلية للتغير في المناخ وذلك باستخدام برامج التنبؤ بالمناخ **ClimGin v 4** التي يتضمنها البرنامج.