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Investigation of SSM-Wheat Model to Forecast of Growth and Yield of Wheat in Response to Fertilizer Nitrogen in order to Decrease Pollution Environmental and Diseases

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ABSTRACT

Objective: Environmental and economic challenges resulting from the application of nitrogen fertilizers have increased Concerns about its productivity in the agricultural systems. Thus an experiment in order to investigate ability SSM-Wheat for simulation growth and yield of wheat (cultivar N-87-20) in response to fertilizer nitrogen in the direction decrease Pollution environmental and diseases were conducted. **Methods:** Simulation be done for 20 years' time period from 1996 to 2016 with using daily weather data (minimum and maximum temperature, rainfall and radiation), experiment data and information of field soil. In order to test of model results be used from assessment indicators coefficient of determination (R), coefficient of variation (CV), root mean square error (RMSE). **Results:** On the basis of evaluation of results, model could grain yield, biological yield, leaf area index in pollination stage and harvest index forecasted well, as root mean square error (RMSE) between measured data and simulated data mentioned traits were 958.82, 2305.62, 1.12, 6.58 respectively. Observed and simulated data day to and day to physiological maturity were very similar too, and difference between observed and simulated data of phonological stages no significant was and RMSE day to pollination and day to physiological maturity were 3.72 and 4.89 respectively. SSM-Wheat model in elevation of mentioned traits for wheat cultivar N-87-20 was prospered well and acceptable. So SSM-Wheat model can be used in the direction recovery nitrogen nutrition management of plants, Nitrogen nutrition with the aim access to maximum yield and decrease consumption of luxury nitrogen fertilizer in wheat in order to reduce pollution of environmental and disease.

Introduction

Environmental and economic challenges resulting from the application of nitrogen fertilizers have increased Concerns about its productivity in the agricultural systems. Nitrogen fertilizer in thirty year recent has been an important role in increase of grain yield and one of the most important costs of production in wheat be counted (Mc Donald, 2002; Black & Dyson, 2008). According to reports Heffer (2008) from 98 million ton consumption nitrogen in world 40 percent is used in cereals. It is anticipated, in case of continue linear and being to increase consumption nitrogen fertilizer in Iran, consumption of nitrogen fertilizers for production cereals will reach to two million ton in the year 1400(Zarefyzabadi et al, 2006). The consumption of irregular fertilizers will have consequences environmental and be caused increasing of digestive diseases, as an example cancer of the stomach. Nitrogen fertilizers are one of the most important water polluters' factors (via leaching nitrate) and air (via nitrate oxides)

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(Paz et al, 1999). Set the amount consumption of fertilizers to agree with need plant for access to maximum of yield is an essential purpose. In the last few years, many models in order to estimate the amount of consumption fertilizer in future be demonstrated in order to prevent from luxury consumption fertilizers, for example SUNDIAL (Gibbon et al, 2005), CERES-Wheat (Zeinali, 2009), CERES-N (Zubillaga et al, 2007), Cropsyst (Soltani, 2013 and Stockle et al, 2003), RZWQM (Fang et al, 2013). According vent from luxury conesumption fertilizers for example: SUNDIAL (Gibon et al, 2005), CERES-Wheat to results be obtained from some of the models, the amount of consumption fertilizers in Iran to the years 1395 and 1400 will increased to 4.6 and 5 million ton respectively. The performance of field researches need to spending time and cost, while the computer simulation model can with performance simulation of large experiments, saving in time and cost is caused (Pannkuk et al, 1998). Of course cropping simulation models never cannot became replacing field experiments, but the best case that is witch be used as supplement experiments. In this case will can slightly need to field experiment be decreased and effectual results these experiments be increased (Soltani, 2008). Alizadeh and Soltani (2016) with using from SSM-Wheat model, Simulation of soil nitrogen balance in wheat (*Triticumaestivum*L.) production in Gorgan, Iran examined and results was acceptable, also Torabi et al (2013) assessment of nitrogen fertilizing of wheat farms in Gorgan region, Iran evaluated with using from model and results was acceptable. Therefore this research in direction Investigation of SSM-Wheat model to forecast of growth and yield of wheat in response to fertilizer nitrogen in order to decrease pollution environmental and diseases was conducted.

Materials and Methods

Model Description

SSM-Wheat model, (Soltani and Sinclair, 2012) is a simple model for wheat that with help its can analyzed production and genetically and environmental and monumental of restrictions in produce wheat. This model for wheat with applying a simple principle ability utilization and extension has for others plant seeded. The model parameters in experiment separately be determined and be evaluated (Table 1) and be used for agronomy experiment in year 2014-15. Experimental treatments included there net nitrogen fertilizer rates of (0 , 75 and 150 kg. ha^{-1}) begin split that in stage before of planting, tillering and stem elongation.

Table 1: Some of plant estimated parameters of SSM-Wheat model in cultivar N-87-20.

Parameter	Wheat (Cultivar N-87-20)
Coefficient of transpiration (Pascal)	5.8
Coefficient of	0.65
Leaf specific area	0.021
Slope potential of harvest index (gr.gr^{-1}.d^{-1})	0.014
Days from sowing to emergency	6
Days from emergency to first-tiller	8.5
Days from first-tiller to first- node stem	9.8
Days from first- node stem to booting	5.2
Days from booting to ear emergency	3.3
Days from ear emergency to	6.1

Field Conditions

This experiment was conducted at the research farm of Gorgan, Iran(latitude 54° 14 N´ longitude 38° 05´E) 174 m above sea level) in 2014-15. The climate of research area is characterized by mean annual precipitation of 536 mm, mean annual temperature of 15.8 c°. The soil was loamy- clay. Soil test results are shown in table 2.

Table 2: Physical and chemical characteristics of the experimental soil in the first and second years.

		Available K (ppm)		Available P(ppm)		Ammonium nitrogen(ppm)		Nitrate nitrogen		Total nitrogen (%)	
Soil depth	Soil texture	Second year	First year	Second year	First year	Second year	First year	Second year	First year	Second year	First year
0-30	Loamy-Clay	200	240	2.46	3.55	5.01	4.62	8.64	8.32	0.18	0.18
30-60	Loamy-Clay	140	180	1.60	1.72	3.90	4.31	4.52	5.90	0.18	0.18

Experiment plan and agronomic operation

Experiment plan based on randomized complete block with four replication was conducted and sown by hand on December (18th) 2014 with a density of 300 seeds per m^2. Each plot had 10 rows of 6 m length, spaced 50 cm apart. The distance between seed within rows was 15 cm. All plots were irrigated at two stages of stem elongation and flowering weeds, diseases were controlled by poison. During plan t growth and development as required. On the basis of soil test 150 $kg.ha^{-1}$ triple super phosphates and 100 $kg.ha^{-1}$ potassium sulfate was used. At the flowering stage 20 plants were randomly harvested from the central rows of each plot to determine wheat leaf area using a leaf area meter device .At physiological maturity stage 20 plants were randomly harvested and biological yield and grain yield per unit area was recorded. Excel software was used to draw the figures

Weather and soil information

On the basis of reach area, daily weather data long-term including (maximum and minimum temperature, rainfall and radiation) were received from general office of weather Golestan province, Iran (reach area). In order to distinct soil properties of research area including soil texture and soil chemical characteristics was drilled a profile to depth 90 cm and was separated to 4 layer and was measured soil characteristic each layer (Table 3). In order to evaluate results of model be used from assessment indicators coefficient of determination (R), coefficient of variation (CV), root mean square error (RMSE).

Table 3: Characteristics of research field soil each layer.

OC (%)	EC (meds. Cm^{-2})	pH	Moisture in field capacity	Apparent specific weight of soil	Sand (%)	Silt (%)	Clay (%)	Layer depth (cm)
1.2	595	7.9	0.31	1.265	36	36	28	15
1.96	595	7.9	0.35	1.265	41.9	31.41	28.16	15
0.92	612	7.93	0.32	1.247	39.35	38.29	28.2	30
0.78	685	8	0.34	1.263	41.67	41.65	32.15	30

Results and discussion

Phonological stages

The results of evaluation models showed that coefficient of determination (R) between and simulated data of day to anthesis and day to physiological maturity were 0.98 and 0.96 respectively, the amount of root mean square error (RMSE) between and simulated data of day to pollination and day to physiological maturity were respectively. Also coefficient of variation (CV) between and simulated data of day to anthesis and day to physiological maturity were 3.5 and 3.8 respectively (Figure 1& 2). Therefore on the basis of results, SSM-Wheat model in forecast phonological stages of wheat in response to nitrogen fertilizer was successful; so that trend witch simulated data follow in response to nitrogen fertilizer is similar to observed data excessively. Basically period of growth and phonological stages can affect yield by consumption more sources or via decrease environmental stress and decrease phonological period in plant. Therefore in conditions is deficit intense nitrogen fertilizer may nitrogen effect development phonological in plants (Hay and Walker, 1989).

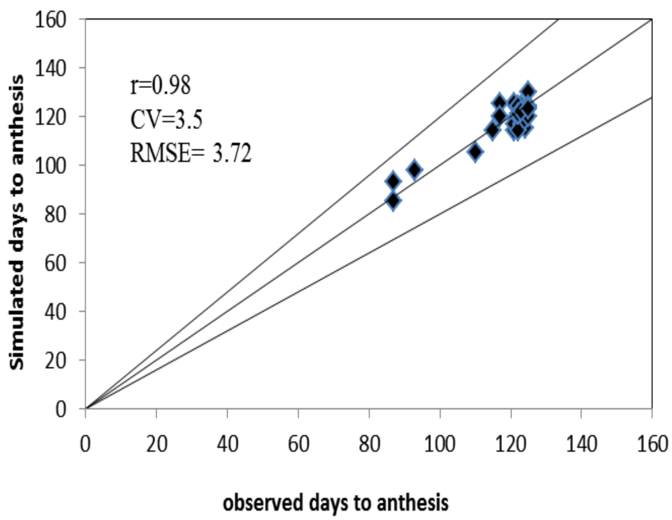

Fig. 1: Simulated versus observed days to anthesis. The 20% ranges of discrepancy between simulated and observed are indicated by dashed lines. Solid line is 1:1 line.

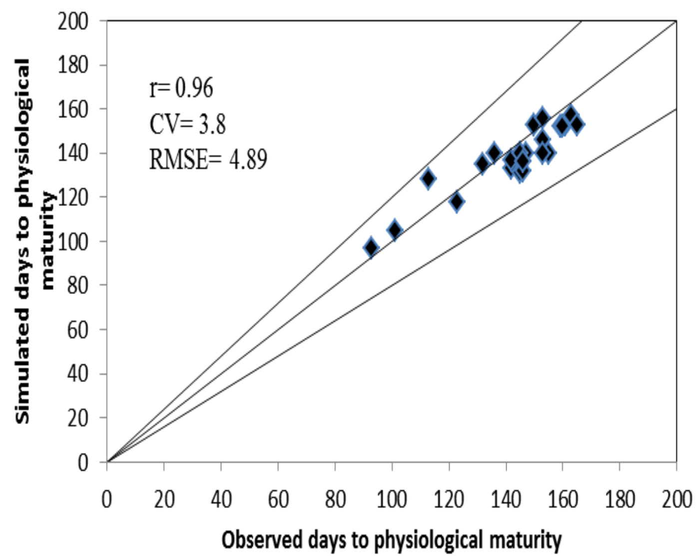

Fig. 2: Simulated versus observed days to physiological maturity. The 20% ranges of discrepancy between simulated and measured are indicated by dashed lines. Solid line is 1:1 line.

Biological yield

Biological yield in cereals actually with increasing application nitrogen fertilizer until to reach to maximum of yield, that after will fixed or will stopped, inclination has to increase linear (Hay and walker, 1989; Zia et al. 2003). Model could biological yield forecasted well, as R, CV and RMSE between observed and simulated data were 0.74, 18.93 and 2305.62respectively (Figure 3). Khaleleaghdam et al (2015) reported that SSM-Wheat anticipation of grain yield and biological yield evaluated well.

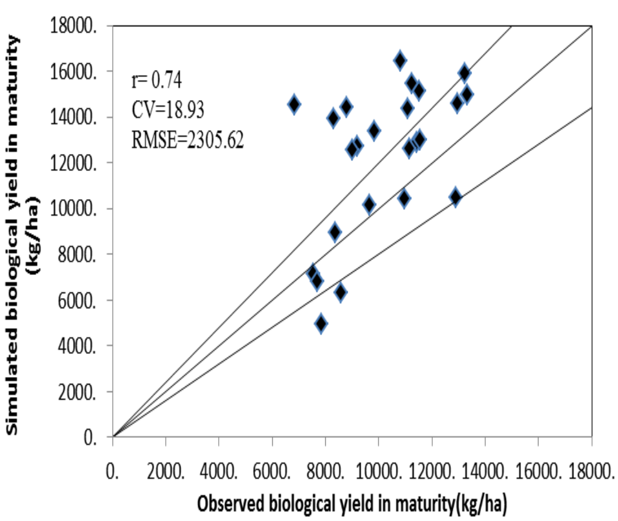

Fig. 3: Simulated versus observed biological yield. The 20% ranges of discrepancy between simulated and observed are indicated by dashed lines. Solid line is 1:1 line.

Leaf area index

One of the effective factors on the expansion of leaf area plant in the amount of access to nitrogen and deficit nitrogen limited expansion of leaf area, therefore expansion of leaf area be considered as an important factor in determining need plant (Soltani and Sinclair, 2012). Although accuracy model in forecast leaf area index in pollination stage in comparison with others traits was less, but was acceptable, as R, CV and RMSE between observed and simulated data were 0.37, 26.25 and 1.12 respectively (Figure 4). Plurality effective factors on leaf area index and impossibility to quantitative one by one, simulation carful leaf area index has made difficult (Banayanaval, 1999).

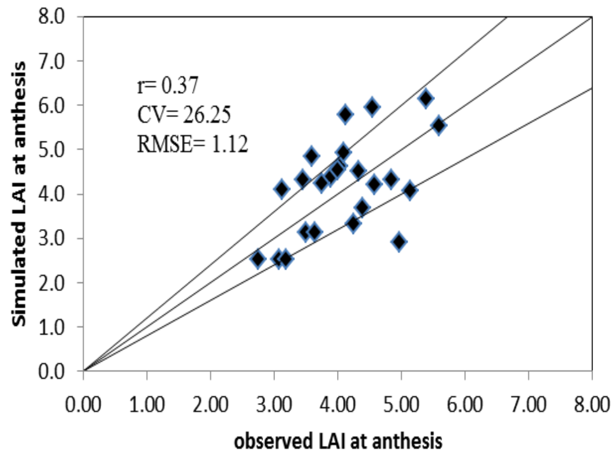

Fig.4: Simulated versus observed LAI at . The 20% ranges of discrepancy between simulated and measured are indicated by dashed lines. Solid line is 1:1 line.

Grain yield

Limitation nutrition elements especially nitrogen is the most important factors limited of yield in wheat (Davis et al, 2002). Need wheat to nitrogen is more in comparison with others elements. Results evaluation of model showed that R, CV and RMSE between measured and simulated data of grain yield were 0.62, 22.48 and 958.82 (Figure 5).

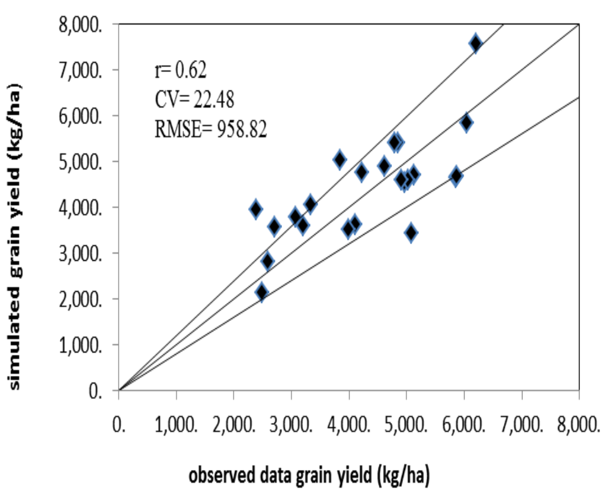

Fig. 5. Simulated versus observed grain yield. The 20% ranges of discrepancy between simulated and measured are indicated by dashed lines. Solid line is 1:1 line.

Conclusion

SSM-Wheat model in elevation of mentioned traits for wheat cultivar N-87-20 was prospered well and acceptable. On the other hand, field experiments are costly and time consuming, model can causes save in time and cost, so SSM-Wheat model can be used in the direction recovery nitrogen nutrition management of plants, Nitrogen nutrition with the aim access to maximum yield and decrease consumption of luxury nitrogen fertilizer in wheat in order to reduce pollution environmental and disease.

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