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EXTENDED ABSTRACT

Investigation the Effect of Nitrogen Fertilizer on Maize Yield Parameters (*single cross hybrid 704)* for AquaCrop Model

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Introduction

Water and nitrogen are two main factors of plant production. Water scarcity is one of the most important challenges in the production of agricultural products in arid and semi-arid regions, as in most parts of Iran. A great deal of research has been done on the interaction between water and nitrogen and has shown that irrigation and nitrogen treatments interact with the yield. So far, various models have been developed to simulate plant performance in response to different levels of water and nitrogen. The FAO organization has provided the AquaCrop model. This model simulates yield performance in response to water consumption. The effect of nitrogen deficiency on yield in the latest versions of the AquaCrop model (versions 4 and 5) is carried out using semi-quantitative method. In this method, nitrogen deficiency is assumed to be based on four parameters: 1- Normalized water productivity (WP*), 2- maximum canopy cover (CCx), 3- The Canopy growth coefficient (CGC) and 4- Canopy decline coefficient (CDC). The hypothesis of this research is that there is a relationship between the four above parameters and nitrogen fertilizer for corn, and from them, we can determine the values of four parameters for each fertilizer level and use them in the AquaCrop model. Therefore, the first goal of this study was to determine the equations between nitrogen fertilizer and the four above parameters. The second goal of this study was to evaluate the accuracy of the AquaCrop model for simulating the response of corn to nitrogen fertilizer using parameters derived from the equations defined in the first part.

Materials and Methods

This research was carried out in the research farm of Aburaihan campus, University of Tehran, on a single Cross 704 crop cultivar for two consecutive years of 2015 and 2016. Nitrogen required by using urea fertilizer (containing 46% nitrogen) as a completely randomized design with three replications in seven treatments including: no fertilizer, 50, 100, 150, 200, 250 and 300 kg ha^{-1} (in this research respectively, treatments were designated as N0 to N6 symbols). Fertilization operations were carried out with three replications at 22, 52 and 65 days after planting in 2015, 28, 40 and 66 days after planting in 2016. The time of harvesting in the first year was 119 days after planting date (September 27, 2015) and in the second year 115 days after planting day (September 5, 2016). The plant samples were taken from the experimental plots to measure the dry matter (biomass) during the growing season. The number of sampling in the first and second years of cultivation (2015 and 2016) was six and seven times, respectively. Data for year 2015 and 2016 were used for calibration and validation, consequently. The relationship between fertilizer and the four parameters of WP *, CGC, CCx and CDC were determined using

data from year 94. Then, using these relationships, four of the above parameters were determined for fertilizer treatments of 2015 and verified and compared with actual values. In the end, the AquaCrop model was implemented using 2015-year data and the estimated parameters for each fertilizer application, and the estimated biomass results of the model were compared with the actual biomass values. The measured values of the biomass in different treatments were considered as actual values and simulated values of the model as estimated values.

Results and Discussion

Normalized water productivity followed to fertilizer use from a second order equation with a high determination coefficient (0.98). This coefficient of determination indicates that the second-order equation simulates about 98% of the normalized water productivity changes associated with nitrogen fertilizer use. The maximum value of the normalized water productivity parameter of corn was 34.2 gr m^{-2} with 222 kg ha^{-1} fertilizer application. This value was about 0.5 gr m^{-2} greater than the recommended value from the appendix of the AquaCrop Model Guide (33.7 gr m^{-2}) (Raes et al., 2009). The correlation of the WP^*, CDC, CCx and DGC with regard to fertilizer (N) were as follows:

$$WP^* = -0.0003 \times N^2 + 0.1332 \times N + 19.371 \quad (1)$$

$$CCx = -0.0002 \times N^2 + 0.1157 \times N + 75.641 \quad (2)$$

$$CGC = -6 \times 10^{-5} \times N^2 + 0.0311 \times N + 11.95 \quad (3)$$

$$CDC = -10^{-5} \times N^2 + 0.009 \times N + 9.25 \quad (4)$$

Conclusion

The results showed that N fertilizer in the form of a second-order function affects the parameters WP *, CCx, CGC and CDC. The equations based on this study have an accurate coefficient for estimating the above parameters on the amount of nitrogen fertilizer consumed. These equations were used to estimate the aforementioned parameters for data validation. Estimated parameters of the equations based on imported AquaCrop model and biomass were simulated for different values of fertilizer. Comparison of the results showed that there is acceptable accuracy between the measured and simulated biomass values. Therefore, four equations based on this study can be used to estimate the amount of nitrogen fertilizer on the parameters of corn crop growth for the study area and the results of estimating these parameters in the AquaCrop model for yield simulation.