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Simulating the effect of climate change on the growth and performance of rapeseed (*Brassica napus* L.) using the DSSAT model in Alborz province

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Abstract

With the increasing demand for renewable energy and vegetable oils, rapeseed production has become popular in recent years. Modeling the growth and performance of rapeseed is a useful method for predicting the response of rapeseed to different environments. In this study, the CSM-CROPGRO-Canola model was investigated in DSSAT v4.7 software to simulate the growth and yield of two spring canola varieties (Delgan and Hayola 420) in the Karaj region. This model was investigated using plant data and soil properties collected from field experiments under planting date and nitrogen fertilizer treatments during two growing seasons (2016-2018). The validation results of the phenological stages (start of flowering, the start of germination, the start of seed formation and physiological ripening) showed that for the Delgan variety, the root mean square error (RMSE) values were less than 4 days and for Hayola variety less than 5 days, which shows the excellent ability of the model. It has been in the simulation of developmental stages. Also, the model was able to simulate the total dry matter on different planting dates and different levels of nitrogen fertilizer. The validation results of rape seed yield also showed that the value of RMSE was 395 and 265 kg/hectare, d 0.97 and R2 0.89 and 0.91 respectively for Delgan and Hayola cultivars were 420, which confirms the high accuracy of the model and proper calibration. it is In general, the CSM-CROPGRO-Canola model predicted well the responses of grain yield to management and environmental conditions and was used to evaluate the effects of climate change. Four general circulation models (GFDL-CM4, IPSL-CM6A-LR, MIROC6 and NorESM2-LM) under the influence of two SSP scenarios (ssp245 and ssp585) were used for weather forecasting. Daily climate data including the amount of radiation, daily precipitation, the maximum and minimum temperature for the base year (1985-2014) as well as three future climate periods (2020-2046, 2047-2073 and 2074-2100) were obtained in two scenarios of these four CMIP6 climate models became. In the base period (1988-2014), the average minimum and maximum daily temperatures were 7.2 and 20.2 degrees Celsius, respectively, and the average annual precipitation in this area was 292 mm. In all models and scenarios, the increasing trend of minimum and maximum temperature is predicted. The highest daily minimum temperature (13.9 degrees Celsius) is predicted in the future period of the IPSL-CM6A-LR model ssp585 scenario, and the highest daily maximum temperature (27.3 degrees Celsius) is predicted in the future period of the GFDL-CM4 model ssp585 scenario. In general, in the output of all models, the minimum and maximum temperature have increased until the year 2100, and this increase is greater in the ssp585 scenario than in the ssp245 scenario. The results of investigating the effect of climate change on rapeseed developmental stages showed that with climate change in all models and scenarios, the length of the vegetative period decreases and the length of the reproductive period increases. In the ssp585 scenario, a greater decrease in the length of the growing season is expected than in the ssp245 scenario. Also, in the distant future, the length of the growing season will decrease more than in the near future due to a greater increase in temperature. The greatest increase in the reproductive period of cultivars (up to 18 days for the Delgan variety and up to 20 days for the Hayola420 variety) is predicted in the ssp585 scenario in the distant future (2074-2100). But in the ssp245 scenario, the increase in the length of the reproductive period was predicted to be much less even in the far future period. The simulation results of the CROPGRO-Canola model with the future climate data produced by four climate models under two scenarios in the three future time periods showed that the yield potential of the studied cultivars varied in different years and was observed up to eight tons per hectare. The potential yields of Delgan and Hayola 420 cultivars in the base period were simulated as 7089 and 5423 kg/ha, respectively. The average seed yield of rapeseed cultivars will decrease in future periods until 2100 in all models and scenarios. The decrease in seed yield of canola cultivars in the future was evident in the ssp585 scenario, which was predicted up to 67% for the Delgan cultivar and up to 73% for the Hyola420 cultivar. In the far future ssp245 scenario, the lowest rate of yield reduction of rapeseed cultivars (19 and 28% reduction respectively for Delgan and Hayola 420 cultivars) in the NorESM2-LM model and the highest yield reduction rate (44 and 56% reduction respectively for Delgan and Hayola 420 cultivars) It was observed in the MIROC6 model.

Keywords: Climate change, Genetic coefficients, Rapeseed, Crop growth models