Prediction of summer groundnut yield and yield attributing charactersusing CROPGRO-Peanut model

Abstract

Field experiments were carried out at College farm, B. A. College of Agriculture, Anand Agricultural University, Anand.The DSSAT v 4.6 CROPGRO-Peanut model was used to predict the phenology of groundnut crop under combinations of three sowing dates and four groundnut cultivars. The model was calibrated with a 2015 dataset of growth and phenological parameters for estimating the genetic coefficients of all four cultivar and was validated with a 2016 dataset of the same parameters. Simulations of yield and yield attributing charactersusing the calibrated model were found to be quite accurate. The model was able to reasonably simulate thepod yield, kernel yield and haulm yieldwith per cent error (± 10.06) between observed and simulated value for all cultivars under different sowing dates and high correlation coefficent (r> 0.96) but in case of harvest index model simulated with high per cent error (20.20%)and lowcorrelation coefficent (r> 0.23).

Key words:calibration, validation, groundnut, yield

Introduction

Crop growth simulation models are useful tools for considering the complex interactions between a range of factors that affect crop performance, including weather, soil properties and management. Crop modeling began with the computer age and the first models attempted to simulate individual processes within a plant such as light interception in crop canopies (Loomis and Williams, 1963). Subsequently different models were developed to simulate plant growth and development for many different crops. Individual crop models have been combined into comprehensive programs allowing modeling of various crops in rotation. Crop simulation modeling can be utilized for many purposes *viz.* as an aids in interpreting experimental results, as an agronomic research tool and as an agronomic grower tools (Whisler*et al.*, 1986).The CROPGRO-Peanut is a process-oriented model that is part of the Decision Support System for Agrotechnology Transfer (DSSAT). Before a crop model can provide accurate and reliable results, a researcher must first ensure that the model has been calibrated and that it will accurately simulate what it was designed to predict. Also, the model must be validated to the conditions for which the researcher wants to simulate.(Boote*et al.*, 1996) defined model calibration as adjusting the model parameters or relationships to make the model work for a site.Validation means simply comparison between output from the model with observed (measurement) data. An accuracy of model can be derived through some measured of the average (mean) difference between the observed and modeled values for those variables. The objective of the present study was to prediction of groundnut yield and yield attributing characters of groundnutcultivars grown under different environment.

Material and methods

The field experiment on groundnut was carried duringthe summer season of 2015 and 2016 at Agronomy Farm, B.A. College of Agriculture, Anand Agricultural University,Anand (Latitude of $22^0$35'N and longitude of 72^0 55'E andat an elevation of 45.1m above mean sea level). Theexperimental site located near to the agrometeorologicalobservatory and falls in the middle Gujarat Agro-ClimaticZone-III.The experiment was laid out in split plot designwith four replications and the details of treatments are asfollow. The four varieties of groundnut *viz.*,GG-2, GG-20,GJG-31 and TG-26 were sown on three different dates *viz.*,D_1early date (31^{th} January),D_2normal date (15^{th} February)and D_3late date (2^{nd}March).All therecommended package practices for spring seasonwere followed and care was taken against bioticstresses. The data on plant growth and development, soilcharacteristics, weather and crop management for 2015were used for calibration of the CROPGRO-peanut model asrequired for determining the genetic coefficients of GG-2,GG-20, GJG-26 and TG-26 cultivars using GLUE program.The calibrated genetic coefficients of groundnut cultivars(Table 1) were validated with data set of 2016.

Results and discussion

Pod yield (kg ha^{-1})

The observed and simulated value of pod yield underdifferent dates of sowing and cultivars of groundnut are presented in (Table- 2). The results revealed that the observed value of pod yieldunder differentdates of sowing were 1811 to 2123 kg ha^{-1} while the simulated valuewas1641 to 2348kg ha^{-1} withdeviation ranging between -9.4 to 12.1 percent. The lowest deviation was observed in third dates of sowing i.e02ndMarch. In case of different cultivars closesimulation is obtained i.e the observed pod yieldwas1772 to 2110kg ha^{-1} while modelsimulated 1853 to 2285kg ha^{-1}with deviation ranging between 2.8 to 6.4 per cent. The average error ascomputed by r, MAE, MBE, RMSE and PE were 0.85, 19.38, 19.38, 171.74 and 8.75 respectively indicating a fairly good simulation. Similar result reported by Pandey *et al.* (2001) by CROPGRO model for *kharif* groundnut.

Kernel yield (kg ha^{-1})

The observed and simulated kernel yield (kg ha^{-1})under different dates of sowing and cultivars are shown in (Table-2). It is found that the model simulated value to kernel yield was 1350 to 1580 (kg ha^{-1})were very close to the observed value 1234 to 1439 kg ha^{-1}under different dates of sowing. Among the cultivars close simulation is obtained i.e. the observed kernel yield were range between 1232 to 1455 (kg ha^{-1}) while model simulated 1396 to 1556 (kg ha^{-1})with deviation ranging between 7.0 to 13.3 per cent. The average error as computed by r, MAE, MBE, RMSE and PE were 0.96, 10.26, 10.26, 99.33 and 6.77 respectively.

Haulm yield (kg ha^{-1})

The observed and simulated haulm yield (kg ha^{-1})under different dates of sowing and cultivars are presented in (Table-2). It is found that the model simulated haulm yield under different dates of sowing were ranging between 3959 to 4711(kg ha^{-1})the observed haulm yieldwere 4684 to 5263 (kg ha^{-1}) with deviation ranging between -10.5 to -15.6 per cent. Among the cultivars observed value of haulm yieldwere 4576 to 5423 (kg ha^{-1}), while model simulated 3868 to 4706 (kg ha^{-1})with deviation ranging between -11.7 to -15.6 per cent. The model hasoverestimated haulm yieldunder most of the treatments except. The average error as computed by r, MAE, MBE, RMSE and PE were 0.96, 57.50, -57.50, 500.84 and 10.06 respectively.

Harvest index

The comparison between observed and simulated value of harvest index underdifferent dates of sowing and cultivars of groundnut are presented in (Table-2). The results revealed that the observed value harvest indexunder differentdates of sowing were 28.0 to 28.7 per cent while the simulated value was34.0 to 38.8 percent with deviation ranging between 21.5 to 35.5 per cent. In case of different cultivarsobserved value to harvest indexwere 27.5 to 29.7 % while model simulated 34.0 to 37.3 %with deviation ranging between 17.6 to 33.7 per cent. The model was found tooverestimate the harvest indexunder most of the treatments except. The statistical test criteria computed by r, MAE, MBE, RMSEand PE were 0.23,0.63, 0.63, 5.72 and 20.20 respectively.

Conclusions

Overall results shows that the calibrated CROPGRO- Peanut model performance was somewhere underestimated or overestimated but found within quite acceptable limitsfor simulation of yield and yield attributing characters (*viz.*, pod yiled, kernel yield and haulm yield) with error percent less than 10.06. but for model performance for prediction of harvest index was not good witherror percent more than 20.0. Hence, thismodel can be used for simulating the pod yield, kernel yield and haulm yield of groundnutcultivars.

References

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Table 1: Genetic coefficients for cultivars GG 2, GG 20, GJG 31 and TG 26

Parameter	GG-2	GG-20	GJG-31	TG-26
CSDL	11.84	11.84	11.84	11.84
PPSEN	0.00	0.00	0.00	0.00
EM-FL	19.5	19.5	18.5	18.5
FL-SH	11.0	10.0	8.0	11.0
Fl-SD	20.0	19.0	18.0	18.0
SD-PM	40.00	39.00	35.00	36.00
FL-LF	89.00	87.00	80.00	80.00
LFMAX	1.50	1.50	1.48	1.40
SLAVR	270	260	240	240
SIZLF	16.0	16.0	16.0	16.0
XFRT	0.84	0.84	0.84	0.80
WTPSD	0.155	0.200	0.200	0.200
SFDUR	24.0	22.0	24.0	22.0
SDPDV	1.46	1.65	1.46	1.55
PODUR	3.0	4.0	4.0	4.0
THRSH	76.0	74.0	74.0	80.0
SDPRO	.270	.270	.270	.270
SDLIP	.510	.510	.510	.510

(Mote, *etal*.2018)

Table 2: Test criteria in evaluation of model with respect to yield and yield components

Treatment	Pod yield (kg ha^{-1})			Kernel yield (kg ha^{-1})			Haulm yield (kg ha^{-1})			Harvest index		
	Obs.	**Sim.**	**D (%)**	**Obs.**	**Sim.**	**D (%)**	**Obs.**	**Sim.**	**Er. (%)**	**Obs.**	**Sim.**	**D (%)**
D_1(31stJanuary)	1953	2184	12.1	1325	1444	9.0	4978	4221	-15.2	28.3	34.4	22.1
D_2(15th February)	2123	2348	10.7	1439	1580	10.0	5263	4711	-10.5	28.7	38.8	35.5
D_3 (02nd March)	1811	1641	-9.4	1234	1350	9.6	4684	3959	-15.6	28.0	34.0	21.5
V_1 (GG 2)	2021	2084	2.8	1346	1475	9.4	5323	4706	-11.7	27.5	34.0	23.7
V_2 (GG 20)	2110	2208	4.4	1455	1556	7.0	5423	4644	-14.4	28.1	36.7	30.6
V_3 (GJG 31)	1945	2285	6.4	1297	1404	8.5	4576	3969	-13.4	29.7	35.0	17.6
V_4 (TG 26)	1772	1853	4.2	1232	1396	13.3	4577	3868	-15.6	28.0	37.3	33.7
r	0.85			0.96			0.96			0.23		
MAE	19.38			10.26			57.50			0.63		
MBE	19.38			10.26			-57.50			0.63		
RMSE	171.74			99.33			500.84			5.72		
PE	8.75			6.77			10.06			20.20		