

Prediction of summer groundnut yield and yield attributing characters using CROPGRO-Peanut model

Comment [AS1]: Improve the Title

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 characters using the calibrated model were found to be quite accurate. The model was able to reasonably simulate the pod yield, kernel yield and haulm yield with per cent error (± 10.06) between observed and simulated value for all cultivars under different sowing dates and high correlation coefficient ($r > 0.96$) but in case of harvest index model simulated with high per cent error (20.20%) and low correlation coefficient ($r > 0.23$).

Key words: calibration, validation, groundnut, yield

Comment [AS2]: Please improve the abstract. Rearrange the sentences. First introduction on crop relating to yield simulation model

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 aid 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 measure of the average (mean) difference between the observed and modeled values for those variables. The objective of the present study was to predict groundnut yield and yield attributing characters of groundnut cultivars grown under different environment.

Comment [AS3]: Elaborate on CROPGRO MODEL

Material and methods

The field experiment on groundnut was carried during the summer season of 2015 and 2016 at Agronomy Farm, B.A. College of Agriculture, Anand Agricultural University, Anand (Latitude of 22°35'N and longitude of 72°55'E and at an elevation of 45.1m above mean sea level). The experimental site located near to the agro-meteorological observatory and falls in the middle Gujarat Agro-Climatic Zone-III. The experiment was laid out in split plot design with four replications and the details of treatments are as follow. The four varieties of groundnut viz., GG-2, GG-20, GJG-31 and TG-26 were sown on three different dates viz., D₁ early date (31st January), D₂ normal date (15th February) and D₃ late date (2nd March). All the recommended package practices for spring season were followed and care was taken against biotic stresses. The data on plant growth and development, soil characteristics, weather and crop management for 2015 were

used for calibration of the CROPGRO-peanut model as required 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.

Comment [AS4]: Please give a detailed elaboration of CROPGRO

Results and discussion

Pod yield (kg ha^{-1})

The observed and simulated value of pod yield under different dates of sowing and cultivars of groundnut are presented in (Table- 2). The results revealed that the observed value of pod yield under different dates of sowing were 1811 to 2123 kg ha^{-1} while the simulated value was 1641 to 2348 kg ha^{-1} with deviation ranging between -9.4 to 12.1 percent. The lowest deviation was observed in third dates of sowing i.e. 02nd March. In case of different cultivars close simulation is obtained i.e. the observed pod yield was 1772 to 2110 kg ha^{-1} while model simulated 1853 to 2285 kg ha^{-1} with deviation ranging between 2.8 to 6.4 per cent. The average error as computed 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 *khari* groundnut.

Comment [AS5]: Depict in italics

Comment [AS6]: Depict in italics

Comment [AS7]: Please explain on how these parameters correlated with the values yield and yield attributing characters.

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 yield were 4684 to 5263 (kg ha⁻¹) with deviation ranging between -10.5 to -15.6 per cent. Among the cultivars observed value of haulm yield were 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 has overestimated haulm yield under 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 under different dates of sowing and cultivars of groundnut are presented in (Table-2). The results revealed that the observed value harvest index under different dates of sowing were 28.0 to 28.7 per cent while the simulated value was 34.0 to 38.8 percent with deviation ranging between 21.5 to 35.5 per cent. In case of different cultivars observed value to harvest index were 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 to overestimate the harvest index under most of the treatments except. The statistical test criteria computed by r, MAE, MBE, RMSE and PE were 0.23, 0.63, 0.63, 5.72 and 20.20 respectively.

Comment [AS8]: Please elaborate its application of the values with yields

Comment [AS9]: Please discuss on the abbreviations of parameters

Conclusions

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

References

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Comment [AS10]: Please add references if possible

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
FI-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)

Comment [AS11]: Please elaborate the parameters or about the parameters.

Comment [AS12]:

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 (%)
D₁(31stJanuary)	1953	2184	12.1	1325	1444	9.0	4978	4221	-15.2	28.3	34.4	22.1
D₂(15th February)	2123	2348	10.7	1439	1580	10.0	5263	4711	-10.5	28.7	38.8	35.5
D₃ (02nd March)	1811	1641	-9.4	1234	1350	9.6	4684	3959	-15.6	28.0	34.0	21.5
V₁ (GG 2)	2021	2084	2.8	1346	1475	9.4	5323	4706	-11.7	27.5	34.0	23.7
V₂ (GG 20)	2110	2208	4.4	1455	1556	7.0	5423	4644	-14.4	28.1	36.7	30.6
V₃ (GJG 31)	1945	2285	6.4	1297	1404	8.5	4576	3969	-13.4	29.7	35.0	17.6
V₄ (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		

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