Simulation of Soybean Growth under Sowing Date Management by CROPGRO Model

1Farzad Paknejad, 2Pouria Farahani Pad, 1Mohammad Nabi Ilkaee and 3Faezeh Fazeli
1Department of Agronomy and Agriculture Research Center, Karaj Branch, Islamic Azad University, Karaj, Iran
2Young Researcher Club Roudehen Branch, Islamic Azad University, Roudehen, Iran
3Department of Environment, Faculty of Civil Engineering, Shahid Rajaee Teacher Training University, Tehran, Iran

Abstract: Problem statement: Always because of weather change, determine of optimum sowing date in each zone is difficult. Dynamic models can help us for solving this problem. In order to evaluation of soybean simulation by using of CROPGRO-Soybean model at four sowing date in field research of Azad university of Karaj branch a field experiment conducted in form of split plot in based on randomize complete block design with four replication in 2009s. Approach: At this experiment simulation of some traits such Leaf Area Index (LAI), Leaf Dry Weight (LDW), Stem Dry Weight (SDW) and Biomass (B) evaluated for cv. Williams using of CROPGRO-Soybean. According to results, model was successful in the traits simulation, because of high Wilmot coefficient produced (0.6), 20 days after planting to the end of the growth duration. Results: Model explained well stem dry weight, as correlation coefficient in each sowing date was significant (p<0.01). Simulation precision for biomass was suitable, as coefficient differentiation was significant (p<0.01) for first to fourth sowing date (S1-S4) 0.889, 0.986, 0.909 and 0.796, respectively. These statistic parameters designated high ability of model for simulation of some traits measured in soybean for four sowing date management. Conclusion: We can use by model for sowing date management of soybean in Karaj climate condition, of course after repetitions of experiment and doing of model calibration. We proposed that soil and weather data measured in each place of experience and also plant morphology parameter measured precisely because this help to us for obtaining of objects.

Key words: CROPGRO-Soybean, simulation, LAI, leaf, stem and total dry weight, soybean, sowing date

INTRODUCTION

Obtaining of suitable model dynamic for planning sowing date management under each climate condition is important why that in basis it we can predict of many traits such biomass, grain yield, harvest index in different sowing date managements. Also using suitable model we can in basis sensitivity analysis obtained the most important factors affect on growth and development (Nasiri mahalati, 1999). Using crop model for agronomy management on physiological traits in crops caused that we reached to object, earlier (Boote et al., 2001). In analysis and resolution of growth indexes, were affected different factors such as sowing date and environmental condition. Sowing date by ways of changes of days length, photosynthesis rate and respiration affected on growth properties and dry matter production. Determining of suitable planting time cause to early, fast, uniformity and full germination, that this factor redound to soil cover faster, more sun radiation interception and light penetration reduction into canopy and increased crop competition capability opposite weeds (Latifi et al. 2004). According to (Hundale and Kaur, 1997) reports, using CERES- Wheat model for predicting grain yield in Panjab climate condition, also in irrigation management (Lobell and Ortiz-Manasterio, 2006) was successfully. Also (Landau et al., 1998) after simulation of wheat growth using CERES- Wheat pay to model test and validation it’s.

With attention to access identified and management methods of limited growth indexes factor, need to achievement of permanent and expensive
involves significant growth and reproductive processes, and with the use of computer software, such as CROPGRO-Soybean, the model can predict yield and other important traits. This model can be used to evaluate the effectiveness of different combinations of agricultural practices and environmental conditions. For instance, in the study covered by this article, the model was applied to Soybean cv. Williams, with the aim of evaluating the model's ability to predict yield and other important traits under different planting dates and other conditions. The results showed that the model performed well in predicting yield and other important traits, with the highest simulated yield occurring under the best growth conditions. Overall, the study demonstrated the potential of the CROPGRO-Soybean model in improving crop production management and predicting yield under different conditions.
RESULTS

LAI simulation: According to Table 1, Wilmot coefficient (Wilmot, 1982) for LAI in cv. Williams in all of sowing dates obtained more than 0.60, this was proof why model power was suitable for trait simulation. The highest and lowest of model precise rate equal to 0.93 and 0.754 for sowing dates of third and first, respectively (Fig 1). The result showed that variation coefficient R^2 0.675-0.936 obtaining of linear regression analysis in functions simulated among predicted for LAI, showing that model described well trait variation process (Table 1).

Table 1: Comparison of simulated and measured rates of LAI (line 1:1)

| D      | R^2 | Y = X   | Sowing date |
|--------|-----|---------|-------------|
| 0.754  | 0.675** | Y = 0.603X | First       |
| 0.889  | 0.936** | Y = 0.683X | Second      |
| 0.93   | 0.704** | Y = 1.074X | Third       |
| 0.889  | 0.534*  | Y = 1.159X | Fourth      |

Ns*, ** No significant, significant at level % 0.05 and 0.01, respectively

Table 2: Comparison of simulated and measured rates of leaf dry weight (line 1:1)

| D      | R^2 | Y = X   | Sowing date |
|--------|-----|---------|-------------|
| 0.608  | 0.356 ns  | Y = 1.322X | First       |
| 0.679  | 0.716** | Y = 1.960X | Second      |
| 0.65   | 0.934** | Y = 2.786X | Third       |
| 0.666  | 0.978** | Y = 2.742X | Fourth      |

Ns*, ** No significant, significant at level % 0.05 and 0.01, respectively

Table 3: Comparison of simulated and measured rates of stem dry weight (line 1:1)

| D      | R^2 | Y = X   | Sowing date |
|--------|-----|---------|-------------|
| 0.868  | 0.628** | Y = 0.937X | First       |
| 0.934  | 0.906** | Y = 1.285X | Second      |
| 0.797  | 0.929** | Y = 1.920X | Third       |
| 0.762  | 0.853** | Y = 10976X | Fourth      |

Ns*, ** No significant, significant at level % 0.05 and 0.01, respectively

Table 4: Comparison of simulated and measured rates of biomass (line 1:1)

| D      | R^2 | Y = X   | Sowing date |
|--------|-----|---------|-------------|
| 0.947  | 0.889** | Y = 0.804X | First       |
| 0.985  | 0.986** | Y = 1.156X | Second      |
| 0.899  | 0.909** | Y = 1.479X | Third       |
| 0.876  | 0.796** | Y = 1.428X | Fourth      |

Ns*, ** No significant, significant at level % 0.05 and 0.01, respectively

Fig. 1: Simulated (line) and measured (square) rates of LAI under four sowing date
Fig. 2: Simulated (line) and measured (square) rates of leaf dry weight under four sowing date

Fig. 3: Simulated (line) and measured (square) rates of stem dry weight under four sowing date
**Leaf weight simulation:** $R^2$ coefficient obtained of line (1:1) for leaf dry weight in different sowing dates showing that model simulation has been suitable ability (Table 2). Variation dimension of $R^2$ coefficient between 0.356-0.978, showed that model in some treatments was not acted well and in some of treatments acted excellent (Table 2). Variation dimension of $d$ coefficient was between 0.608-0.679, showed that model could be predicted acceptably variation trait under four sowing date. According to Fig. 2, model predicted approximately suitable variation process of leaf dry weight in all of treatments, but at two sampling stages 80 and 90 days after planting, simulated rates was so much less than measured data.

**Stem dry weight simulation:** According to results of regression curve (line 1:1) for stem dry weight in all of sowing date, model had been suitable description for this trait (Table 3). Variation dimension rate $R^2$ for all of treatments was differed 0.628-0.929 and correlation coefficient in all of treatments at levels $p<0.01$ was significant (Ehdaee, 2002). Variation process simulated and measured rates for stem dry weight in all of sowing dates by model had been $d$ coefficient 0.762-0.934 showing that model predicted well variation process of this trait (Fig. 3).

**Biomass simulation:** $R^2$ coefficient in line (1:1) between measured and simulated biomass near to 1 and showing that model had successful for predicting of biomass in different sowing date (Table 4). Variation dimension of $R^2$ varied 0.796-0.986, this result show that model could be predicted suitably biomass in four sowing date (Table 1). According to Fig. 4 biomass process for simulated and measured data in all of the sowing date, show that variation dimension of $d$ coefficient had been 0.876-0.985, as model simulated well biomass in different sowing dates (Fig. 2). Model predicted biomass in third and fourth sowing date lower than measured field data (Fig. 4).

**DISCUSSION**

According to Fig. 1 at first sowing date because of colder weather, with decreasing respiration, LAI improvement was more than other sowing dates and model predicted well this occurrence. Reduction of model precision in first sowing date, probably to reason...
of unsuitable plant standing under field condition, therefore for obtaining of better results we must be applied all of the management details. Model CROPGRO-Soybean in study of LAI predicting was used continually. By using of this model (Shrikant and Jones, 2002) presented acceptable predicting for LAI in Soybean under different climate condition. Existing of weeds in each of growth stage and unsuitable separation of plant constitutive details such leaf, stem and pod affected on measured error increasing (Soltani et al., 2005). In many studies about simulation of the leaf dry weight, further account to more error in comparison to biomass and for determine of gap yield, biomass production in canopy is more important than leaf weigh (Bhatia et al., 2008).

Reduction of model predicting precise in sowing date third and fourth, probably because account to unsuitable weather and go away from growth potential caused reduction of predicting precise (Hundale and Kaur, 1997). Reason of lower estimation biomass in third and fourth sowing dates, probably became because of emergence unsuitable condition in basis of account to warm weather and creation of uniformity in plant standing (Mahallati, 2000). Suitable predicting of Soybean biomass in different sowing date showed that this traits in this model could be predicted well dry matter production in basis of uptake of sun radiation by plants green cover, maximum and minimum temperature, in potential growth condition. According to Harnos (2006), CROPGRO-Soybean model could be predicted well biomass in 9 different zones, variation dimension of R² obtained to 0.98-0.95.

**CONCLUSION**

Results of evaluation of CROPGRO-Soybean in this study showed that, generally model in different sowing date management simulated total biomass better than grain yield, stem and leaf dry matter. Model in simulation of total dry matter in four sowing date acted well. If this process continued in several years in same zone, we can used model after calibration its due to grain yield, stem and leaf dry matter for research objects and management programming, specially about determination of optimum sowing date.

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