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# Validation studies of DSSAT-3.5 for pearl millet in summer season in the Pune region of Maharashtra state

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## ABSTRACT

A field experiment was conducted during summer season of 2001 to identify optimum meteorological week (mw) for sowing of pearl millet. The treatments tried were five dates of sowing. The experiment was laid out in randomised block design with four replications. The results revealed that the yield of pearl millet was significantly the highest in sowing done in 6mw and decreased as sowing was delayed thereafter in 7, 8 and 9mw. Sowing date ($S_2$-6mw) was also significantly superior over rest of the treatments in respect to growth and yield attributing characters. The model also satisfactorily predicted the phenology. The percent error (PE) between predicted and observed grain yield was 4% indicate that the predictions matched well with observed data. The over prediction of LAI however, led to increase in the prediction of stover and biomass components.

*Key Words:* DSSAT-3.5 Validation, Summer pearl millet.

Pearl millet is the fourth most important cereal and staple food grain crop of India next to rice, wheat and sorghum. It is grown mostly in arid and semiarid tropics of India. It is an indispensable component of dry land farming system owing to its drought resistant capacity (Bidinger *et al.*, 1982). In India during 1999-2000 the area under pearl millet was 97.12 lakh hectares with annual production of 76.89 lakh tones and mean productivity of 792 kg $ha^{-1}$.

Crop favours warm climate (Sable, 1988) and temperature is an important meteorological variable that affects its growth and development (Lond *et al.*, 1988). Its linear response pattern enables accumulation of the dry matter faster, under high day or night temperature regimes (Thornley *et al.*, 1990). Thus the possibilities of growing the crop in summer season are tested with a view to increase its production and productivity. With this background in view, the present experiment was planned in the summer season of year 2001.

The CERES (Crop Environment REsources Synthesis) Pearl millet model is one of the dynamic crop growth model developed under DSSAT3.5 (Decision Support System for Agro-Technology Transfer) by IBSNAT. This model has been used to simulate the growth and productivity of pearl millet crop sown on different dates in the present study.

## MATERIALS AND METHODS

The experiment was conducted at College of Agriculture, Pune during the summer season of 2001 in a randomized block design with five treatments and four replications. The treatments under study were sowing in different meteorological weeks viz. $S_1$ (5mw), $S_2$ (6mw), $S_3$ (7mw), $S_4$ (8mw) and $S_5$ (9mw). The gross plot size was 4.5 x 3.6 m. and net plot size was 3.6 x 2.7 m. The seed was sown at row spacing of 45 x 15 cm. The soil of the experimental field was vertisol (medium black) clayey in texture. The recommended dose of fertilizer (60 kg N + 30 kg P + 30 kg $K_2O$ $ha^{-1}$) and all the recommended agronomic practices were adapted during the experimental period. The various phenological characters viz. no of days required for panicle initiation, anthesis and physiological maturity were recorded. Seed yield, fodder yield and biomass, were recorded at the time of harvest. To provide sufficient soil moisture during crop growth, irrigation's were applied as per the requirement of the crop.

## RESULTS AND DISCUSSION

The predicted and observed no of days for panicle initiation(PI), anthesis, physiological maturity, grain yield fodder yield and biomass are presented in Table 1. Phenology as well as yield contributing characters differed significantly due to different sowing treatments from the initial stage of the crop up to the harvest.

The rate of growth during panicle initiation stage is controlled by photoperiod. The model considers the optimum photoperiod ($P_2O$) and the photoperiod sensitivity of the crop variety ($P_2R$) for estimating the rate of development of the crop (Rood and Major, 1980; Kinry *et al* 1983; Carberry and Campbell, 1985). The mean no. of predicted and observed days required for PI was 20 and 19 respectively. The average difference between predicted and observed days of PI was 0.4 only with standard deviation of 0.5. However the days required for anthesis depends upon the number of days taken for panicle emergence. The mean value of the predicted days for anthesis is 48 as against observed days of 50. The mean difference between predicted and observed days of anthesis was -2.4 day only while, the standard deviation was 1.1 day. The mean predicted days for physiological maturity was 78 against observed days of 78; thus prediction was matching well with the observed values. The mean difference between predicted and observed number of days for physiological maturity was - 0.2 with standard deviation of ± 2.77. Since all the growth stages were predicted by the model with percent error less than 10%, it can be concluded that phenology was predicted reasonably well by the model.

The mean predicted and observed LAI was 5.48 and 3.08 respectively. The mean difference between predicted and observed LAI was 2.39 while the standard deviation was ±0.66. The mean predicted and observed grain yield was 3134 kg $ha^{-1}$ and 3043 kg $ha^{-1}$ respectively, with a mean difference of 90.8 kg $ha^{-1}$. The mean difference between predicted and observed

**Table 1:** Predicted and observed phenology, yield and yield contributing characters of pearl millet

| Treat | Phenology | | | | | | | | | LAI | | | Grain yield (kg ha$^{-1}$) | | | Fodder yield (kg ha$^{-1}$) | | | Biomass (kg ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PI (days) | | | Anthesis (days) | | | Phy. maturity (days) | | | | | | | | | | | | | | |
| | P | O | D | P | O | D | P | O | D | P | O | D | P | O | D | P | O | D | P | O | D |
| $S_1$ | 20 | 21 | -1 | 50 | 52 | -2 | 83 | 80 | 3 | 5.37 | 3.1 | 2.27 | 3012 | 3086 | -74 | 7934 | 6928 | 1006 | 10946 | 10014 | 932 |
| $S_2$ | 21 | 20 | 1 | 50 | 51 | -1 | 82 | 80 | 2 | 5.21 | 3.32 | 1.89 | 3416 | 3300 | 116 | 8996 | 8037 | 959 | 12412 | 11323 | 1089 |
| $S_3$ | 20 | 19 | 1 | 48 | 50 | -2 | 78 | 78 | 0 | 6.15 | 3.19 | 2.66 | 3204 | 3175 | 39 | 9226 | 7960 | 1266 | 12439 | 10973 | 1466 |
| $S_4$ | 19 | 19 | 0 | 46 | 49 | -3 | 75 | 78 | -3 | 4.66 | 2.99 | 1.67 | 3033 | 2880 | 153 | 9475 | 7042 | 2433 | 12508 | 10029 | 2479 |
| $S_5$ | 19 | 18 | 1 | 44 | 48 | -4 | 73 | 76 | -3 | 4.11 | 2.10 | 2.2 | 2997 | 2777 | 220 | 9574 | 7204 | 2370 | 12571 | 9981 | 2590 |
| Mean | 19.8 | 19.4 | 0.4 | 47.6 | 50.0 | 2.4 | 78.2 | 0.2 | 5.48 | 78.4 | 3.08 | 2.39 | 3134 | 3043 | 90 | 9041 | 7432 | 1606 | 12175 | 10465 | 1710 |
| S.D ± | 0.8 | 0.9 | 0.5 | 2.6 | 1.5 | 1.1 | 4.3 | 1.6 | 2.7 | 0.6 | 0.2 | 0.6 | 180.1 | 213.6 | 112.9 | 658.4 | 525.1 | 735.2 | 690.9 | 638.0 | 777 |

P = Model prediction
O = Observed value
D = (P-O)

S. D. - Standard deviation
P. I. - Penicle initiatio
LAI - Leaf area index

**Table 2:** Summarized data set of observed and predicted phenology and growth parameters of pearl millet

| Variable | Units | N | Observed | Predicted | SD Obs. | SD Pred. | Deviation |
|---|---|---|---|---|---|---|---|
| PI | day | 5 | 19.4 | 19.8 | 0.9 | 0.84 | 0.70 |
| Anthesis | day | 5 | 50.0 | 47.6 | 1.6 | 2.61 | 0.50 |
| Phy. Mat. | day | 5 | 78.4 | 78.2 | 1.7 | 4.32 | 0.78 |
| LAI | - | 5 | 3.08 | 5.48 | 0.20 | 0.61 | -11.9 |
| Biomass | kg $ha^{-1}$ | 5 | 10465.2 | 12175 | 638.0 | 689.9 | -0.8 |
| Straw | kg $ha^{-1}$ | 5 | 7432 | 9041 | 525.1 | 658.4 | -2.1 |
| Yield | kg $ha^{-1}$ | 5 | 3043.6 | 3134.4 | 213.7 | 1801.1 | 0.8 |

fodder yield was 1606 kg $ha^{-1}$ with standard deviation of ± 735.16 kg $ha^{-1}$. The mean difference between predicted and observed biomass was 1710.2 kg $ha^{-1}$ with standard deviation of ± 777.69 kg $ha^{-1}$.

The model over predicted the biomass for all the five treatments. However, amongst the five sowings, observed and model predicted values were fairly matching for the first two sowings of 5 and 6 mw. Hence, it can be concluded that the model over predicted values of the growth parameters for the last two sowings of 8 and 9 mw with error ranging between 10 and 25%, probably influenced by the large errors in predictions of the maximum LAI by the model.

The summarized means of observed (O) and predicted (P) values of variables along with the standard deviation of observation and prediction and the degree of agreement are presented in Table 2. This describes the quality of simulation. Willmott (1982) pointed out that the Degree of Agreement (D) is an important parameter in crop modelling. It should be within 0 (zero) and 1. However, in this study values ranged within ±0.80 with exception for LAI. The large variability in LAI by the model needs correction.

## REFERENCES

Bidinger, F. R., Mahalakshmi ,V., Jalulkdar, B.S. and Alagirswami, G. 1982. Improvement of drought resistant in pearl millet. Inst. Rice Res. Los. Bonos Lagura, PP.357-375.

Lond, S. P. and Woodward, F. J. (eds.). 1988. Plants and temperatures Symposia of the Society for Experimental Biology, No. 42.

Carberry, P.S., and Campbell, L.C. 1985. The growth and temperature of pearl millet as affected by photoperiod. *Field Crop Res.*, 11 : 207-217.

Kinry, J.R., Ritchie, J.T., and Musser, R.L. 1983. Dynamic nature of the photoperiod response in Maize. *Agron. J.*, 75:700-703.

Rood, S.B., and Major, D.J. 1980 Responses of early corn inbreeds to photoperiod. *Crop. Sci.*, 20:679-682.

Singh, R.S., Joshi, N.L. and Singh, H.P. 1998. Pearl millet phenology and growth in relation to thermal time under arid environment. *J. Agron. Crop Sci.*, 180 (2): 83-91.

Thornely, J.H.M. and Johnson, I. R. 1990. Plant and crop modelling. Mathematical approach to plant and crop physiology model. In Belt wide cotton Production Research conference Proceedings. p. 724.

Varshneya, M.C., Naidu, T.R.V., Bote, N.L. and Dafare, G.S. 1996. Studies on Growth and Development of sorghum by CERES - Sorghum model. Proceedings of the International Agricultural Engineering Conference Pune, India, 9 to 12 December, 1996 pp : 1041-1049.

Willmott 1982. Validation of the model. Chapter No 8 in CERES - Wheat Book draft No.1, IBSNAT, Univ. of Hawai.