# Evaluation of BRASSICA Model for simulating the performance of Rapeseed- Mustard under *tarai* conditions of Uttarakhand

Dr H. S. Kushwaha, Ms Shweta Singh & Dr H. K. Rai

**G. B. Pant Univ. of Agri. & Tech., Pantnagar - 263145, Uttarakhand**


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**CCS HAU, Hisar**

# INTRODUCTION

Oilseed crops with an annual production 10 million tones of seed contribute significantly towards the agricultural economy of the country. The diverse agro-ecological conditions in the country are favourable for growing a variety of oilseed crops. The annual oilseeds include several edible oilseed, viz. groundnut, raper-seed-mustard, soybean, sunflower, safflower, sesame and niger and two no-edible sources, viz. castor and linseed. India ranks first in the world in the production of castor, safflower, sesame and niger, second on groundnut and rapeseed-mustard. Rapeseed and mustard crop are grown in a variety of agro climatic conditions. The production of rapeseed and mustard in India is around 6.38 million tones with an average productivity of 10.12 q per ha. Sowing dates of the crop is a foremost non-monetary critical input of production greatly affects the productivity of oilseed crops. Under delayed sowing, the seed yield is reduced on account of its depressing effect on the span of flowering and seed formation. The weather conditions play an important role on these crops specially the effects of vernalization, photoperiods and sowing dates on growth, development and yield of these crops. Being important oil seed crops of India it become essential to identify a model incorporation all possible soil, crop and weather factors for predicting the yield of oilseed in advance. Keeping this in mind an attempt has been made to apply the BRASSICA model developed by Rao (1992) for simulating the effect of date of sowing on Brassica campestris cv. PT-303 and Brassica juncia cv. Varuna on growth, development, yield and yield attributes.

# Materials & Methods

Field experiment was conducted in a sandy loam soil classified as mollisols (Deshpande *et. al.,* 1971) during rabi season of 2000-01 with Brassica campestris cv. PT-303 and Brassica juncia cv. Varuna sown of four dates viz.

1. 8$^{th}$ September ($D_1$),
2. 18$^{th}$ September ($D_2$)
3. 28$^{th}$ September ($D_3$)
4. 9$^{th}$ October ($D_4$)

at Crop Research Centre of the G. B. Pant University of Agriculture and Technology, Pantnagar (29$^{o}$ N latitude, 79$^{o}$ 30' E longitude, and at an altitude of 243.84 m) in the *tarai* belt of Uttarakhand. All standard package of practices were followed for raising the crops.

## Particles size distribution of Field experiment soil

| Horizon | Depth (cm) | Particles size distribution of < 2 mm fractions | | |
|---|---|---|---|---|
| | | Sand (%) | Silt (%) | Clay (%) |
| Ap | 0-20 | 53.2 | 35.5 | 11.2 |
| A-1 | 20-38 | 53.6 | 34.2 | 12.2 |
| B-1 | 38-48 | 60.9 | 27.6 | 11.5 |
| B-2 | 48-74 | 69.5 | 21.6 | 8.7 |
| B-31 | 74-104 | 73.2 | 17.3 | 9.6 |
| B-32 | 107-129 | 73.6 | 17.3 | 9.2 |

# Single value physical constants of the soil

| Soil depth (cm) | Bulk density ($Mgm^{-3}$) | Soil moisture content (%) at | |
|---|---|---|---|
| | | 0.033 MPa | 1.5 MPa |
| 0-20 | 1.58 | 20.3 | 5.2 |
| 20-38 | 1.54 | 19.1 | 5.3 |
| 38-48 | 1.52 | 16.4 | 4.9 |
| 48-74 | 1.54 | 12.6 | 4.2 |
| 74-104 | 1.49 | 10.5 | 4.6 |
| 107-129 | 1.50 | 11.0 | 4.2 |

# Chemical properties of soil

| Horizon | Depth (cm) | Organic Matter (%) | PH (1:2) | $CaCO_3$ equiv. (%) | CEC (cmol $p^+$ $kg^{-1}$) |
|---|---|---|---|---|---|
| Ap | 0-20 | 1.9 | 6.4 | 0.0 | 9.8 |
| A-1 | 20-38 | 1.1 | 6.1 | 0.0 | 8.6 |
| B-1 | 38-48 | 0.9 | 6.2 | 0.0 | 8.6 |
| B-2 | 48-74 | 0.6 | 6.2 | 0.0 | 6.2 |
| B-31 | 74-104 | 0.5 | 6.2 | 0.0 | 5.8 |
| B-32 | 107-129 | 0.4 | 6.4 | 0.0 | 6.6 |

# BRASSICA-Model : Brief Description

**The model was developed by Rao (1992) was used for simulating the growth, development, yield and yield attributes of rapeseed (Brassica *Campestris L*.) cv PT-303 and mustard (*Brassica juncia* L.) cv Varuna. This model takes into account several physiological processes associated with the growth and development of brassica species. Computationally, the model has four following components –**

1. Calculation of radiation parameters and temperatures on hourly basis from the daily values of bright sunshine hours, maximum & minimum temperatures during the crop season.
2. Determines phenological stages of the crop based on the temperature variations.
3. Computes net canopy photosynthesis after providing respiratory losses and assimilate distribution among different plant organs depending on the phenological stages of the crop.
4. Computes growth of various plant organs, senescence of leaves and mobilization of nitrogen from different plant parts for the development of pod and seeds.

# Results & Discussion

## Leaf Area Index (LAI)

Data on observed and simulated values of LAI in respect to *brassica campestris* cv. PT-303 and *brassica juncea* cv. Varuna showed that there were more than 50 per cent variation (51.45 to 53.90 per cent) among different sowing dates between observed and simulated values of leaf area index (LAI) in PT-303. However, these variations were less (9.1 to 29.4 per cent) in Varuna indicating that model underestimated LAI in PT-303 compared to Varuna.

**Comparison of observed values of LAI in rapeseed (Brassica campestris L.) cv. PT-303 and mustard (Brassica juncea L.) cv. Varuna sown on four dates during Rabi season of 2000-01 with the simulated values using Brassica model.**

| Sl. No. | Date of Sowing | 8.9.2000 | | | 18.9.2000 | | | 28.9.2000 | | | 9.10.2000 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OB. | SM | % V | OB. | SM | % V | OB. | SM | % V | OB. | SM | % V |
| | | Leaf area index (LAI) | | | | | | | | | | | |
| 1. | PT-303 | 2.30 | 1.06 | **53.9** | 2.86 | 1.16 | **59.4** | 3.00 | 1.40 | **53.3** | 2.82 | 1.37 | **51.45** |
| 2. | Varuna | 3.37 | 3.68 | **9.1** | 3.90 | 3.46 | **11.2** | 5.09 | 3.97 | **22.0** | 4.35 | 5.63 | **29.40** |

OB = Observed values SM = Simulated values
% V = Percent variations

## Days taken to Physiological maturity

In PT-303 the per cent variation between observed & simulated number of days taken to physiological maturity in I$^{st}$ date of sowing (8$^{th}$ Sept.) was 15.5 and this variation increased with delay in sowing dates upto 9$^{th}$ October (37.7 per cent). However, in Varuna these variations were low ranging from 3.3 in 8$^{th}$ Sept. sowing date to 15.0 in 9$^{th}$ October sowing crop. It indicated that model simulated days taken to physiological maturity well in Varuna compared with PT-303.

**Comparison of observed values of days taken to physiological maturity in rapeseed (Brassica campestris L.) cv. PT-303 and mustard (Brassica juncea L.) cv. Varuna sown on four dates during Rabi season of 2000-01 with the simulated values using Brassica model.**

| Sl. No. | Date of Sowing | 8.9.2000 | | | 18.9.2000 | | | 28.9.2000 | | | 9.10.2000 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OB. | SM | % V | OB. | SM | % V | OB. | SM | % V | OB. | SM | % V |
| | | Days to Physiological maturity | | | | | | | | | | | |
| 1. | PT-303 | 90 | 104 | **15.5** | 87 | 113 | **29.4** | 89 | 119 | **33.7** | 90 | 124 | **37.7** |
| 2. | Varuna | 121 | 117 | **3.3** | 118 | 124 | **5.0** | 117 | 132 | **12.8** | 113 | 130 | **15.0** |

OB = Observed values SM = Simulated values
% V = Percent variations

# Yield Attributes

The observed and simulated yield attribute parameters included number of seeds per siliquae, number of seeds per $m^2$, weight per seed (g) & siliquae number per $m^2$. The results are presented in Table.

# Seed Yield and Stover yield

The simulated seed yield and stover yields (kg $ha^{-1}$) were compared with the observed values. The results are presented in Table.

**Comparison of observed values of LAI & days taken to physiological maturity in rapeseed (Brassica campestris L.) cv. PT-303 and mustard (Brassica juncea L.) cv. Varuna sown on four dates during Rabi season of 2000-01 with the simulated values using Brassica model.**

| Sl. No. | Date of Sowing | 8.9.2000 | | | 18.9.2000 | | | 28.9.2000 | | | 9.10.2000 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OB. | SM | % V | OB. | SM | % V | OB. | SM | % V | OB. | SM | % V |
| | | Leaf area index (LAI) | | | | | | | | | | | |
| 1. | PT-303 | 2.30 | 1.06 | 53.9 | 2.86 | 1.16 | 59.4 | 3.00 | 1.40 | 53.3 | 2.82 | 1.37 | 51.45 |
| 2. | Varuna | 3.37 | 3.68 | 9.1 | 3.90 | 3.46 | 11.2 | 5.09 | 3.97 | 22.0 | 4.35 | 5.63 | 29.40 |
| | | Days to Physiological maturity | | | | | | | | | | | |
| 1. | PT-303 | 90 | 104 | 15.5 | 87 | 113 | 29.4 | 89 | 119 | 33.7 | 90 | 124 | 37.7 |
| 2. | Varuna | 121 | 117 | 3.3 | 118 | 124 | 5.0 | 117 | 132 | 12.8 | 113 | 130 | 15.0 |

OB = Observed values SM = Simulated values
% V = Percent variations

# Yield Attributes

1. Variations between observed and simulated values of number of seeds per siliquae were 22.31, 16.1, 35.6 and 29.3 per cent in 8, 18 and 28 September and 9 October sown PT-303 cultivar. However, the respective variations in Varuna cultivar were 7.6, 11.7, 19.9 and 19.3 per cent sown on above respective dates. This showed that seeds per siliquae, were underestimated in both cultivars irrespective of sowing dates.

2. Variations in prediction of number of seeds per $m^2$ of the cultivars. In PT-303 the per cent variations in first sowing date were 64.4 and the variation further increased in third date sown crop. Highest aviations of 80 per cent in seed number were found in 9 October sown PT-303. In varuna the per cent variations were 46.2, 20.1, 2.3 and 8.4 per cent, sown on above respective dates. This shows that sliquae number per $m^{-2}$ in PT-303 were underestimated by model and overestimated in Varuna.

# Comparison of observed values of yield and yield attributes of rapeseed (*Brassica campestris* L.) cv. PT-303 and mustard (*Brassica juncea* L.) cv. Varuna sown on four dates during Rabi season of 2000-01 with the simulated values using Brassica model.

| SN | Date of Sowing | 8.9.2000 | | | 18.9.2000 | | |
|---|---|---|---|---|---|---|---|
| | | OB | SM | % V | OB | SM | % V |
| | | **PT-303** | | | | | |
| 1. | Seeds per pod | 11.16 | 8.67 | 22.3 | 9.66 | 8.10 | 16.1 |
| 2. | Number of seeds per $m^2$ | 33619.5 | 11963.0 | 64.4 | 44877.0 | 12783.0 | 71.5 |
| 3. | Weight per seed (g) | 0.00398 | 0.01151 | 189.1 | 0.00485 | 0.01703 | 251.1 |
| 4. | Pod number per $m^2$ | 3012.5 | 1380.0 | 54.1 | 4645.7 | 1577.0 | 66.0 |
| 5. | Seed yield (kg/ha) | 857.50 | 1377.0 | 60.5 | 1085.4 | 2176.0 | 100.4 |
| 6. | Stover yield (kg/ha) | 2266.66 | 1813.0 | 23.3 | 3658.3 | 1788.0 | 51.1 |
| | | **Varuna** | | | | | |
| 1. | Seeds per pod | 11.83 | 10.92 | 7.6 | 12.50 | 11.07 | 11.7 |
| 2. | Number of seeds per $m^2$ | 45740.0 | 66915.0 | 46.2 | 77031.2 | 92583.0 | 20.1 |
| 3. | Weight per seed (g) | 0.00389 | 0.00257 | 33.9 | 0.00421 | 0.00300 | 28.7 |
| 4. | Pod number per $m^2$ | 3866.5 | 6128.0 | 58.4 | 6162.5 | 8391.0 | 36.1 |
| 5. | Seed yield (kg/ha) | 891.16 | 7117.0 | 92.6 | 1235.41 | 2773.0 | 124.4 |
| 6. | Stover yield (kg/ha) | 5472.9 | 6296.0 | 15.0 | 56229.0 | 6960.0 | 23.7 |

Continue from Previous Table….

| SN | Date of Sowing | 28.9.2000 | | | 9.10.2000 | | |
|---|---|---|---|---|---|---|---|
| | | OB | SM | % V | OB | SM | % V |
| | | **PT-303** | | | | | |
| 1. | Seeds per pod | 12.50 | 8.05 | 35.6 | 11.50 | 8.13 | 29.3 |
| 2. | Number of seeds per $m^2$ | 77875.0 | 11948.0 | 84.6 | 4815.0 | 9437.0 | 80.4 |
| 3. | Weight per seed (g) | 0.00573 | 0.02138 | 273.2 | 0.0043 | 0.02706 | 529.3 |
| 4. | Pod number per $m^2$ | 5750.0 | 1485.0 | 74.1 | 4187.5 | 1161.0 | 72.2 |
| 5. | Seed yield (kg/ha) | 1547.9 | 2554.0 | 64.9 | 1191.6 | 2554.0 | 114.3 |
| 6. | Stover yield (kg/ha) | 5658.5 | 1771.0 | 68.7 | 4220.8 | 1230.0 | 701.85 |
| | | **Varuna** | | | | | |
| 1. | Seeds per pod | 13.83 | 11.07 | 19.9 | 14.0 | 11.29 | 19.3 |
| 2. | Number of seeds per $m^2$ | 86437.5 | 88454.0 | 2.3 | 92750.0 | 84883.0 | 8.4 |
| 3. | Weight per seed (g) | 0.00572 | 0.00363 | 36.5 | 0.00685 | 0.00433 | 36.7 |
| 4. | Pod number per $m^2$ | 6250.0 | 7991.0 | 27.8 | 6625.0 | 7520.0 | 13.5 |
| 5. | Seed yield (kg/ha) | 1376.66 | 3211.0 | 133.2 | 1487.5 | 3678.0 | 147.7 |
| 6. | Stover yield (kg/ha) | 6715.4 | 7431.0 | 10.6 | 7479.16 | 69.27 | 7.3 |

OB = Observed values SM = Simulated values
% V = Per cent variations

3. Variations in weight per seed (g) were very high (189.1 per cent) on 8th September sowing date which further increased 529.3 per cent with delay in sowing dates upto 9 October in PT-303. The respective variations in Varuna were less i.e. 33.9, 28.7, 36.5 and 36.7 per cent cultivar sown on 8,18,28 September and 9 October sowing dates showing that weight per seed (g) were overestimated in PT-303 compared to Varuna.

4. There were more than 50 per cent variations (54.1 to 74.1 per cent) among different dates of sowing between observed and simulated values of sliquae number per $m^2$ in PT-303. However, in Varuna in first sowing of date per cent variations was 13.5 per cent which decreased with delay in sowing dates upto 9 October. This shows that the simulated values of sliquae number per $m^2$ were underestimated in PT-303 and overestimated in Varuna.

# Seed yield & Stover yield

1. Seed yield variations between observed and simulated values were 60.5, 100.4, 64.9 and 114.3 per cent in 8, 18, 28 September and 9 October sown PT-303. However, in Varuna the respective variations were 92.6, 124.4, 133.2 and 147.7 per cent sown on these respective dates. It showed that seed yield of both the cultivars was overestimated by the model.

2. The variations between observed and simulated values Stover yield were 23.3, 51.1, 68.7 and 701.8 in PT-303 and 15.0, 23.7, 10.6 and 7.3 per cent in Varuna as sown on 8, 18, 28 September and 9 October, respective dates..It showed that stover yield in PT-303 was over estimated but differences were less in Varuna.

# Conclusion

1. There was more than 50 per cent variation (51.45 to 53.90 per cent) among different sowing dates between observed and simulated values of leaf area index (LAI) in PT-303 and these variations were less (9.1 to 29.4 per cent ) in Varuna indicating that model underestimated LAI in PT-303 compared to Varuna.

**2.** Number of seeds per pod and number of seeds per m2 were overestimated in PT-303 compared to Varuna

**3.** Seed yield of both the cultivars was over estimated by the model. However, Stover yield was under estimated in PT-303 and over estimated in Varuna cultivar.

**4.** Thse results further reveal that various crop variables and crop coefficients are needed to be changed in crop variable data file to suit the genotype for various agro-climatic zones in general and for *tarai* conditions as specific. After incorporating some of the possible modifications by carrying out more field experiments, the model can be utilized as a practical tool for forecasting the growth and yield components of rapeseed-mustard crops.

# Thank

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Jai kisan Jai Vigyan