Effect of Date of Sowing on Development of Root Rot Complex Disease in Groundnut (*Arachis hypogaea* L.)

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**Abstract**

The objective of research was to evaluate the effect of different sowing dates on the development of root rot complex disease on the two cultivars of groundnut namely SG-99 and M-522. Effect of sowing date on the disease development was studied at three locations with seven sowing dates and three replications. The crop was sown at 15th March, 30th March, 15th April, 30th April, 15th May, 30th May and 15th July. The highest number of yield contributing characters and pod yield was recorded in early sown crop (15th and 30th March sown crop) because of less disease development. Due to unfavourable weather for disease development, early sown crop escaped from disease attack. Among the total seven sowing dates, 15th March was most suitable for SG-99 and 30th March for M-522. The early sowing of virginia type groundnut (M-522) was more sensitive to the temperature compared to spanish type (SG-99). Low temperature during germination adversely effected the germination of virginia type groundnut variety (M-522).

**Keywords**

Sowing dates, Groundnut, Virginia type, Spanish type, Root rot complex, Yield contributing characters

**Introduction**

Groundnut is one of the most important oilseed crops that occupy an area of 25.44 million hectares with production of 45.22 million tons in the world (Anonymous 2014). In India, groundnut is major oilseed crop with area of 4.7 million hectares with a total production of 7.4 million tons having productivity of 1552 kg/ha (Anonymous 2015). Growth and yield of a crop depend on a number of factors. However, biotic stresses play the most important role. Among the biotic stresses, role of diseases, insect and nematodes is important. The oilseed crops, particularly groundnut are very sensitive to
seed and soil borne diseases caused by different plant pathogenic fungi like *Aspergillus niger*, *A. flavus*, *Macrophomina phaseolina*, *Rhizoctonia solani* and *Sclerotium rolfsii* (Parvathi *et al.*, 1985). These pathogens attack the crop alone or in combination and produces symptoms in complex form with collar rot, dry root rot and stem rot symptoms. This root rot complex pose a major threat causing considerable damage to crop during any stage of its growth. Date of sowing of crop also have remarkable effect on root rot complex disease development in groundnut. Various scientists conducted field trials to study the effect of date of sowing on disease development and pod yield. In Egypt, May 1st is the best sowing date and disease was 44.6% as compared to other dates (Atta-Alla *et al.*, 2004). Late sowing of both semi spreading and bunch type varieties in month of June had resulted in declined in yield and less growth as compared to timely sowing in the month of May (Sardana *et al.*, 2008). Similarly, five sowing dates at Pune were studied and results revealed that the sowing groundnut on 6th July significantly influenced various growth contributing characters and pod yield which was found significantly superior over all the sowing date treatments (Kanade *et al.*, 2015). The present study was planned with objective to compare the effect of seven sowing times on disease development and pod yield of two groundnut cultivars grown under irrigated conditions in Punjab state.

**Materials and Methods**

The experiment on date of sowing was conducted during 2017 at three locations- 1) Oilseed research farm at Punjab Agricultural University, Ludhiana 2) Krishi Vigyan Kendra, Kheri, Sangrur 3) Punjab Agricultural University Regional Research Station, Ballowal Saunkhri. Two cultivars, SG-99 and M-522 were sown following the recommended cultivation practices like seed rate, spacing, irrigation and fertilizer application etc. mentioned in package of practices for cultivation of *kharif* crops in Punjab. Experiment on effect of date of sowing was sown in plots of 3 X 5 m² size. Total seven sowing dates15th March, 30th March, 15th April, 30th April, 15th May, 30th May and 15th July were taken. Observations on germination and mortality of plants due to root rot complex were recorded at weekly interval for two months. The percent disease incidence was calculated on the basis of mortality of plants. Observations on number of gynophores, pod yield and plant biomass were also recorded. The soil of the experimental field had adequate fertility and was suitable for a growth of the groundnut crop in Randomized Block Design (RBD). The groundnut crop was harvested when the colour of inner side of shell turned grayish. The maturity of pods was ensured by uprooting the border plants. The tabulated data were statistically processed by the standard method of analysis of variance for the Randomized Block Design and test of significance as given by Panse and Sukhatme (1985). The data were statistically analyzed as per randomized block design using computer programme SAS software.

**Results and Discussion**

The data on effect of sowing dates on the percent germination, per cent disease incidence, pod yield and yield contributing traits were collected from all the locations and pooled.

**Germination percentage**

As far germination is concerned, both variety and location behaved differently. The results presented in Table 1 were obtained from the trials conducted at all three locations and data is also pooled. The pooled data (Table 1) revealed that the maximum germination
percentage was observed in the 30\textsuperscript{th} May sown crop in both varieties (88.24\% in SG-99 and 86.23 \% in M-522). On the other hand, minimum germination was observed in 15\textsuperscript{th} March sown crop in both cultivars (73.83\% in SG-99 and 50.54\% in M-522). The present results concluded that the germination percentage for both the varieties was increased with subsequent sowing dates starting from 15\textsuperscript{th} March upto 30\textsuperscript{th} May and again decreased in 15\textsuperscript{th} June sown crop. Between varieties, the germination of SG-99 was better than M-522 in all sowing dates. The low germination in 15\textsuperscript{th} March sown crop in both varieties especially in M-522 was due to the low temperature which was around 16-17 °C. It had been revealed that early sowing of Virginia type groundnut (M-522) was more sensitive to the temperature whereas spanish type (SG-99) was less sensitive to the temperature. Hence, we can conclude that the sowing of M-522 should not be done under low temperature conditions particularly less than 20°C otherwise seed requirement need to be recalculated.

While the SG-99 could be sown early as it gave good germination even under low temperature conditions. The results are in line with findings of Salmasi \textit{et al.}, (2006) in dil who reported maximum germination was observed in the seeds of 3 April (92.0\%) sowing date. Likewise, Sharma \textit{et al.}, (2013) reported the maximum germination (92.30\%) in seeds obtained from early sowing dates. They also reported that the germination of SG-99 was significantly higher than M-522 in all sowing dates.

\textbf{Disease Incidence}

As far disease incidence is concerned, the per cent disease incidence was recorded from three locations and in two varieties and then whole data was pooled. The pooled data (Table 1) showed that the minimum disease incidence of 7.61 per cent and 9.78 per cent for varieties SG-99 and M-522 respectively was recorded in spring crop sown during 15\textsuperscript{th} March.

There was a non-significant difference in disease incidence in both varieties for 15\textsuperscript{th} March and 30\textsuperscript{th} March sown crop. However, the maximum disease incidence of 33.54 per cent (SG-99) and 35.17 per cent (M-522) was observed in the 15\textsuperscript{th} June sown crop. Results showed that early sowing of groundnut escaped the disease attack and there was progressive increase in the disease incidence with delay in date of sowing. There was increase in disease incidence (Figure 1) with subsequent sowing dates starting from 15\textsuperscript{th} March upto 15\textsuperscript{th} June.

The both varieties also showed significant difference of disease incidence between them. The Spanish type variety (SG-99) showed more tolerance to the root rot complex disease than virginia type (M-522) over all the locations and in all the sowing dates. Both varieties showed same behaviour for disease score as 15\textsuperscript{th} and 30\textsuperscript{th} March sown crop showed escape from disease while 15\textsuperscript{th} June sown crop showed maximum disease incidence (Plate 1) because the agrometerological conditions were congenial for disease development.

These results justify the findings of Helal \textit{et al.}, (1994) and Atta-Alla \textit{et al.}, (2004) in Egypt who reported least percentage of pre- and post- emergence damping-off and pod rots in early sown groundnut crop compared to all other dates of sowing. Likewise, Craufurd \textit{et al.}, (2006) found that infection of \textit{Aspergillus} was ranged from 19-81 per cent and increased with late sowing of groundnut. The results also corroborate the findings of Kumar M and Kudada (2018) who reported that the early sowing in French beans decreases the \textit{Rhizoctonia} root rot disease incidence.
**Table 1** Effect of date of sowing on germination and root rot complex incidence in groundnut

| Date of Sowing | Variety | Germination Percentage | Disease Incidence (%) |
|---------------|---------|------------------------|-----------------------|
|               |         | Ludhiana | Ballowal | Saunkhri | Kheri | Pooled | Ludhiana | Ballowal | Saunkhri | Kheri | Pooled |
| 15-March      | SG-99   | 75.83 (60.53) | 74.20 (59.45) | 71.46 (57.69) | 73.83 (59.21) | 7.45 (15.83) | 8.11 (16.54) | 7.28 (15.65) | 7.61 (16.01) |
|               | M-522   | 48.81 (44.30) | 45.33 (42.30) | 57.50 (49.29) | 50.54 (45.29) | 8.92 (17.37) | 10.78 (19.16) | 9.64 (18.08) | 9.78 (18.22) |
|               |         | 82.50 (64.24) | 81.96 (64.84) | 75.10 (60.04) | 80.85 (64.02) | 8.34 (16.78) | 9.23 (17.68) | 8.54 (16.98) | 8.70 (18.15) |
| 30-March      | SG-99   | 74.13 (59.40) | 74.53 (59.67) | 72.70 (58.07) | 78.24 (62.17) | 8.46 (17.91) | 10.78 (19.16) | 9.64 (18.08) | 10.40 (18.81) |
|               | M-522   | 80.63 (63.86) | 81.50 (64.50) | 77.83 (61.89) | 80.83 (64.01) | 8.54 (16.98) | 9.78 (18.22) | 9.78 (18.22) | 10.40 (18.81) |
| 15-April      | SG-99   | 82.50 (64.84) | 86.30 (68.25) | 78.35 (62.25) | 84.66 (66.91) | 15.28 (23.00) | 16.93 (24.29) | 15.87 (23.46) | 16.03 (23.59) |
|               | M-522   | 80.63 (63.86) | 81.50 (64.50) | 77.83 (61.89) | 80.83 (64.01) | 8.54 (16.98) | 9.78 (18.22) | 9.78 (18.22) | 10.40 (18.81) |
| 30-April      | SG-99   | 87.00 (68.84) | 86.30 (68.25) | 78.35 (62.25) | 84.66 (66.91) | 17.11 (24.43) | 19.30 (26.05) | 17.94 (25.05) | 18.12 (25.18) |
|               | M-522   | 85.43 (67.53) | 83.33 (65.88) | 82.26 (65.06) | 82.97 (65.61) | 26.54 (31.00) | 27.94 (32.46) | 27.45 (31.58) | 27.21 (31.43) |
| 15-May        | SG-99   | 89.33 (70.91) | 88.20 (69.88) | 82.53 (65.27) | 79.91 (63.34) | 26.54 (31.00) | 27.94 (32.46) | 27.45 (31.58) | 27.21 (31.43) |
|               | M-522   | 87.20 (69.01) | 87.00 (68.84) | 82.03 (64.89) | 81.23 (64.01) | 26.23 (30.79) | 28.17 (32.04) | 26.65 (31.07) | 27.02 (31.30) |
| 30-May        | SG-99   | 90.50 (72.02) | 90.33 (71.85) | 84.90 (67.11) | 88.24 (69.92) | 27.23 (31.44) | 28.82 (32.46) | 27.45 (31.58) | 27.83 (31.83) |
|               | M-522   | 88.63 (70.27) | 87.16 (68.97) | 80.53 (63.79) | 86.23 (68.19) | 29.87 (33.11) | 32.15 (34.53) | 30.25 (33.35) | 30.76 (33.67) |
| 15-June       | SG-99   | 87.33 (69.12) | 83.33 (65.88) | 82.26 (65.06) | 82.97 (65.61) | 32.45 (34.71) | 34.94 (36.22) | 33.24 (35.19) | 33.54 (35.38) |
|               | M-522   | 85.43 (67.53) | 83.83 (66.26) | 79.30 (62.91) | 82.32 (65.11) | 34.15 (35.74) | 36.31 (37.04) | 35.04 (36.28) | 35.17 (36.36) |
| CD at 5 % (Variety) | - | 1.43 | 3.09 | 2.75 | 1.41 | 0.59 | 0.54 | 0.62 | 0.33 |
| CD at 5 % (Date)     | - | 2.68 | 5.78 | 5.15 | 2.64 | 1.11 | 1.01 | 1.15 | 0.61 |
| CD at 5 % (Location)  | - | - | - | - | - | - | - | - | - |
| CD at 5 % (Variety×Date) | - | 3.78 | 8.18 | 7.28 | 3.74 | 1.57 | 1.43 | 1.63 | 0.86 |
| CD at 5 % (Location×Date) | - | - | - | - | - | 4.58 | - | - | - |
| CD at 5 % (Location×Variety) | - | - | - | - | - | 2.45 | - | - | - |
| CD at 5 % (Location×Variety×Date) | - | - | - | - | - | 0.99 | - | - | - |
| CV at 5%         | - | 2.74 | 6.00 | 5.76 | 5.00 | 3.56 | 3.08 | 3.63 | 3.43 |

Figures in parentheses are angular transformed values.
**Table 2** Effect of date of sowing on pod yield of groundnut

| Date of Sowing | Variety | Ludhiana | | | Ballowal Saunkhri | | | Kheri | | | Pooled | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fresh pod yield (kg/ha) | Dry pod yield (kg/ha) | | Fresh pod yield (kg/ha) | Dry pod yield (kg/ha) | | Fresh pod yield (kg/ha) | Dry pod yield (kg/ha) | | Fresh pod yield (kg/ha) | Dry pod yield (kg/ha) |
| 15-March | SG-99 | 8811 | 5400 | 8422 | 5211 | 7978 | 4889 | 8422 | 5211 | 8722 | 5489 |
| | M-522 | 7189 | 3733 | 7522 | 3900 | 6856 | 3578 | 7189 | 3867 | 6489 | 3567 |
| 30-March | SG-99 | 8567 | 5156 | 8933 | 5489 | 8633 | 5200 | 8422 | 5211 | 5489 | 3567 |
| | M-522 | 9633 | 4778 | 9078 | 4778 | 9333 | 4800 | 9356 | 4878 | 6489 | 3567 |
| 15-April | SG-99 | 7044 | 4422 | 6500 | 4000 | 6778 | 4000 | 6778 | 4067 | 6489 | 3567 |
| | M-522 | 6489 | 3456 | 6111 | 3144 | 6867 | 3633 | 6489 | 3567 | 6489 | 3567 |
| 30-April | SG-99 | 5322 | 3311 | 5489 | 3367 | 5656 | 3489 | 5489 | 3311 | 5489 | 3311 |
| | M-522 | 4822 | 2500 | 5078 | 2689 | 4944 | 2556 | 4944 | 2800 | 4944 | 2800 |
| 15-May | SG-99 | 4700 | 2889 | 4456 | 2744 | 4944 | 2556 | 4700 | 2811 | 4700 | 2811 |
| | M-522 | 4667 | 2433 | 4422 | 2311 | 4178 | 2267 | 4422 | 2344 | 4422 | 2344 |
| 30-May | SG-99 | 4022 | 2556 | 3778 | 2344 | 3433 | 2144 | 3744 | 2356 | 3744 | 2356 |
| | M-522 | 3844 | 2000 | 3267 | 1733 | 3556 | 1867 | 3556 | 1956 | 3556 | 1956 |
| 15-June | SG-99 | 2933 | 1867 | 3100 | 1922 | 2822 | 1744 | 2956 | 1778 | 2956 | 1778 |
| | M-522 | 2522 | 1322 | 2600 | 1511 | 2656 | 1389 | 2589 | 1467 | 2589 | 1467 |
| CD at 5 % (Variety) | - | 211 | 144 | 89 | 200 | 100 | 100 | 67 |
| CD at 5 % (Date) | - | 400 | 287 | 167 | 356 | 189 | 189 | 122 |
| CD at 5 % (Location) | - | - | - | - | - | - | - | 78 |
| CD at 5 % (Variety×Date) | - | 567 | 389 | 244 | 522 | 278 | 267 | 178 |
| CD at 5 % (Location×Date) | - | - | - | - | 333 | 222 |
| CD at 5 % (Location×Variety) | - | - | - | - | - | 178 | 122 |
| CD at 5 % (Location×Variety×Date) | - | - | - | - | 467 | 311 |
| CV at 5% | - | 5.91 | 4.13 | 4.43 | 4.92 | 5.12 | 5.05 | 5.98 |
Table 3 Effect of date of sowing on plant biomass of groundnut

| Date of Sowing | Variety | Ludhiana | Ballowal Saunkhri | Kheri | Pooled |
|---------------|---------|----------|-------------------|-------|--------|
|               |         | Fresh plant biomass (000'kg/ha) | Dry plant biomass (000'kg/ha) | Fresh plant biomass (000'kg/ha) | Dry plant biomass (000'kg/ha) | Fresh plant biomass (000'kg/ha) | Dry plant biomass (000'kg/ha) |
| 15-March      | SG-99   | 28.33    | 8.24              | 49.91 | 14.88  | 28.68    | 13.66    | 32.31    | 11.88 |
|               | M-522   | 28.89    | 8.28              | 54.09 | 15.46  | 25.46    | 10.33    | 32.81    | 11.36 |
| 30-March      | SG-99   | 28.89    | 12.48             | 38.63 | 11.09  | 31.59    | 12.97    | 33.03    | 12.18 |
|               | M-522   | 29.07    | 12.78             | 62.32 | 17.72  | 32.59    | 13.16    | 41.33    | 14.56 |
| 15-April      | SG-99   | 26.11    | 10.00             | 36.19 | 12.08  | 29.26    | 12.89    | 30.52    | 11.66 |
|               | M-522   | 26.18    | 10.37             | 48.09 | 14.23  | 28.14    | 12.41    | 34.14    | 12.33 |
| 30-April      | SG-99   | 22.67    | 8.89              | 29.57 | 9.71   | 31.86    | 13.42    | 28.03    | 10.68 |
|               | M-522   | 23.11    | 8.67              | 29.03 | 9.34   | 33.33    | 14.00    | 28.49    | 10.67 |
| 15-May        | SG-99   | 14.44    | 8.06              | 26.29 | 9.12   | 26.11    | 11.11    | 22.28    | 9.43  |
|               | M-522   | 18.89    | 7.96              | 31.39 | 10.54  | 31.86    | 13.58    | 27.38    | 10.69 |
| 30-May        | SG-99   | 4.56     | 3.59              | 24.56 | 78.11  | 30.14    | 14.59    | 19.76    | 8.67  |
|               | M-522   | 5.84     | 3.29              | 37.46 | 11.16  | 28.03    | 13.53    | 23.78    | 9.33  |
| 15-June       | SG-99   | 4.44     | 1.89              | 25.81 | 8.87   | 17.78    | 7.92     | 16.01    | 6.23  |
|               | M-522   | 6.40     | 3.24              | 30.96 | 9.58   | 16.11    | 7.33     | 17.82    | 6.91  |

CD at 5% (Variety) | - | 0.97 | 0.56 | 2.00 | 0.60 | 2.04 | 0.90 | 0.98 | 0.39 |
CD at 5% (Date)    | - | 1.8  | 1.04 | 3.74 | 1.12 | 3.82 | 1.69 | 1.82 | 0.73 |
CD at 5% (Location)| - | -    | -    | -    | -    | -    | -    | 1.19 | 0.48 |
CD at 5% (Variety×Date) | - | 2.56 | 1.47 | 5.29 | 1.59 | 5.41 | 2.38 | 2.58 | 1.04 |
CD at 5% (Location×Date) | - | -    | -    | -    | -    | -    | 3.16 | 1.28 |
CD at 5% (Location×Variety) | - | -    | -    | -    | -    | -    | -    | 1.69 | 0.68 |
CD at 5% (Location×Variety×Date) | - | -    | -    | -    | -    | -    | -    | 4.47 | 1.80 |
CV at 5%           | - | 8.32 | 10.62| 8.42 | 8.18 | 11.56| 11.61| 9.86 | 10.37 |

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Table 4: Effect of date of sowing on number of gynophores and pods per plant in groundnut

| Date of Sowing | Variety     | No. of gynophores/ plant | No. of pods/ plant |
|---------------|-------------|--------------------------|-------------------|
|               |             | Ludhiana | Ballowal | Saunkhri | Kheri | Pooled | Ludhiana | Ballowal | Saunkhri | Kheri | Pooled |
| 15-March      | SG-99       | 123.66   | 80.43    | 123.13   | 109.07 | 103.60 | 68.06    | 71.13    | 80.93    |
|               | M-522       | 137.06   | 79.13    | 167.33   | 127.84 | 83.46  | 81.26    | 100.20   | 88.30    |
| 30-March      | SG-99       | 149.30   | 63.03    | 124.26   | 112.19 | 68.33  | 66.60    | 72.73    | 69.22    |
|               | M-522       | 104.66   | 74.83    | 115.06   | 98.18  | 57.86  | 53.40    | 57.73    | 56.33    |
| 15-April      | SG-99       | 115.46   | 75.70    | 117.73   | 102.96 | 53.53  | 53.33    | 87.66    | 64.84    |
|               | M-522       | 105.73   | 54.43    | 112.60   | 90.92  | 44.13  | 54.53    | 55.73    | 55.62    |
| 30-April      | SG-99       | 104.86   | 54.56    | 96.46    | 85.29  | 59.80  | 58.46    | 48.13    | 55.46    |
|               | M-522       | 69.33    | 60.73    | 100.53   | 76.86  | 39.53  | 59.20    | 68.26    | 49.15    |
| 15-May        | SG-99       | 69.93    | 58.60    | 101.20   | 76.58  | 49.06  | 51.06    | 54.80    | 51.64    |
|               | M-522       | 63.26    | 63.33    | 93.00    | 73.19  | 39.86  | 39.66    | 51.33    | 45.10    |
| 30-May        | SG-99       | 51.46    | 55.53    | 81.26    | 62.75  | 33.33  | 37.73    | 50.73    | 45.93    |
|               | M-522       | 46.26    | 55.03    | 70.80    | 57.36  | 31.80  | 35.26    | 42.00    | 36.35    |
| 15-June       | SG-99       | 36.20    | 50.30    | 35.06    | 40.52  | 21.46  | 30.00    | 20.26    | 23.90    |
|               | M-522       | 37.93    | 51.93    | 36.06    | 41.97  | 26.00  | 33.53    | 32.60    | 30.71    |
| CD at 5 % (Variety) | -     | 5.68     | 2.48     | 6.95     | 3.01   | 3.71   | 4.11     | 5.69     | 2.56     |
| CD at 5 % (Date)    | -     | 10.62    | 4.65     | 13.01    | 5.63   | 6.94   | 7.69     | 10.63    | 4.80     |
| CD at 5 % (Location) | -    | -        | -        | -        | 3.68   | -      | -        | -        | 3.14     |
| CD at 5 % (Variety× Date) | -   | 15.03    | 6.57     | 18.41    | 7.96   | 9.81   | 10.88    | 15.08    | 6.79     |
| CD at 5 % (Location × Date) | -    | -        | -        | -        | 9.75   | -      | -        | -        | 8.31     |
| CD at 5 % (Location × Variety) | -  | -        | -        | -        | 5.21   | -      | -        | -        | 4.44     |
| CD at 5 % (Location × Variety × Date) | - | - | - | - | 13.79 | - | - | - | 11.75 |
| CV at 5%       | -          | 10.42    | 6.25     | 11.17    | 10.31  | 11.50  | 12.75    | 15.48    | 13.58    |
Table 5 Effect of date of sowing on number of ripened and immature pods per plant in groundnut

| Date of Sowing | Variety   | No. of ripened pods/ plant | No. of immature pods/ plant | Pooled |
|---------------|-----------|----------------------------|----------------------------|--------|
|               |           | Ludhiana      | Ballowal | Saunkhri | Kheri | Pooled | Ludhiana | Ballowal | Saunkhri | Kheri | Pooled |
| 15-March      | SG-99     | 42.20         | 43.60    | 34.33    | 40.04 | 24.06 | 23.46    | 21.80    | 23.11    |
|               | M-522     | 46.46         | 44.26    | 44.46    | 45.06 | 27.06 | 27.40    | 37.66    | 30.71    |
| 30-March      | SG-99     | 41.00         | 40.46    | 32.93    | 38.13 | 20.66 | 22.06    | 20.93    | 21.22    |
|               | M-522     | 33.40         | 31.40    | 25.80    | 30.20 | 24.20 | 24.20    | 18.90    | 22.44    |
| 15-April      | SG-99     | 35.40         | 28.80    | 49.73    | 37.93 | 21.20 | 19.99    | 14.40    | 19.22    |
|               | M-522     | 22.06         | 22.40    | 42.86    | 29.10 | 24.20 | 24.20    | 18.90    | 22.44    |
| 30-April      | SG-99     | 26.26         | 28.46    | 42.06    | 32.26 | 16.53 | 16.80    | 20.40    | 17.91    |
|               | M-522     | 19.86         | 24.60    | 32.00    | 25.48 | 29.20 | 10.80    | 14.60    | 18.20    |
| 15-May        | SG-99     | 29.73         | 34.20    | 28.33    | 30.76 | 11.26 | 11.46    | 11.33    | 13.11    |
|               | M-522     | 21.53         | 25.20    | 32.06    | 26.26 | 11.60 | 11.13    | 16.60    | 13.11    |
| 30-May        | SG-99     | 21.53         | 24.00    | 28.93    | 24.82 | 4.86  | 5.80     | 23.00    | 11.22    |
|               | M-522     | 19.66         | 22.66    | 27.00    | 23.10 | 7.80  | 5.46     | 10.33    | 7.86     |
| 15-June       | SG-99     | 17.66         | 21.20    | 18.13    | 19.06 | 4.66  | 5.40     | 4.40     | 4.82     |
|               | M-522     | 19.53         | 21.93    | 19.66    | 20.37 | 4.66  | 5.60     | 5.40     | 5.22     |
| CD at 5% (Variety) | -       | 2.51          | 2.35     | 2.42     | 1.36  | 1.05  | 1.20     | 1.49     | 0.71     |
| CD at 5% (Date)       | -       | 4.69          | 4.39     | 4.53     | 2.54  | 1.96  | 2.25     | 2.80     | 1.32     |
| CD at 5% (Location)    | -       | -             | -        | -        | 1.66  | -     | -        | -        | 0.86     |
| CD at 5% (Variety× Date) | -   | 6.63          | 6.21     | 6.41     | 3.59  | 2.77  | 3.18     | 2.40     | 1.87     |
| CD at 5% (Location × Date) | - | -             | -        | -        | 4.40  | -     | -        | -        | 2.29     |
| CD at 5% (Location × Variety) | - | -             | -        | -        | 2.35  | -     | -        | -        | 1.22     |
| CD at 5% (Location × Variety × Date) | - | -             | -        | -        | 6.22  | -     | -        | -        | 3.24     |
| CV at 5%       | -       | 13.85         | 12.54    | 11.45    | 12.55 | 11.10 | 12.63    | 13.92    | 12.75    |
Fig. 1 Percent disease incidence of groundnut varieties SG-99 and M-522 on different dates of sowing.

Fig. 2 Dry pod yield of groundnut varieties SG-99 and M-522 during different dates of sowing.
**Fig. 3** Yield contributing parameters of variety SG-99 sown during different dates of sowing

**Fig. 4** Yield contributing parameters of variety M-522 sown during different dates of sowing
Plate 1: Effect of date of sowing on crop stand due to disease in (a) 30 March sowing date and (b) 15 June sowing date.
Dry pod yield

Pod yield of groundnut crop sown at different dates were recorded. The pooled data (Table 2) revealed that the highest pod yield for both varieties was recorded in 30 March sown crop (5489 kg/ha in SG-99 and 4878 kg/ha in M-522) and the lowest pod yield was recorded in crop sown during 15 June (1778 kg/ha in SG-99 and 1467 kg/ha in M-522). The pod yield was decreased (Figure 2) with subsequent dates starting from 15 March to 15 June due to increase in the disease incidence during the same period. Both the varieties showed significant difference among them for pod yield. The highest pod yield was recorded in variety SG-99 and the other variety M-522 gave lower yield in all dates of sowing all over the locations. The maximum yield was recorded on the 30th March sown crop but in the prevailing scenario of Punjab and fitting the crop in Potato-Rice system it is desirable to sow the crop early (15-March) because it vacate the field for sowing of next crop (Rice) with very nominal decrease in the yield of SG-99 variety. However, the maximum pod yield was recorded in 30th March sown crop but sowing of this crop delays the sowing of the preceding crop (Rice). So, if we go for sowing a crop during 15th March, there was a nominal decrease in the yield from 15th March sown crop but it fits best in the cropping system.

For virginia type groundnut (M-522) the desirable date of sowing is 30th March and after that there is a decrease in yield potential. Hence, we concluded that early sowing in both varieties escaped the disease attack and give maximum yield potential. These results were in accordance with earlier findings of Abd El-Halem et al., (1986), Reddy and Reddy (2000), Sukbok et al., (2002) and Sardana et al., (2008). Similarly, Canavar and Kaynak (2008) in Turkey, reported that pod yield of peanut was affected by sowing time, with early sowing resulting in high yield.

Dry plant biomass

The pooled data (Table 3) showed that the maximum dry plant biomass production was recorded in 15 March sowing date for SG-99 (11.88 thousand kg/ha) and 30 March sowing date for M-522 (14.56 thousand kg/ha). On the other hand, the minimum dry plant biomass production was observed in 15th June sown crop (6.23 thousand kg/ha for SG-99 and 6.91 thousand kg/ha for M-522). The plant biomass production was recorded to decrease from 15th March to 15th June sown crop in both the varieties. These results corroborate the earlier findings of Ali et al., (1994) and Bala et al., (2011).

Yield contributing parameters

The data on four yield contributing parameters namely number of gynophores/plant, number of pods/plant, ripened pods/plant and immature pods/plant were also recorded (Figure 3 and 4). The pooled data (Table 4 and 5) showed that the maximum number of gynophores/plant in variety SG-99 was observed during 15th March (109.07) and 30th March (112.19) sown crop with non-significant difference between them, however in variety M-522 it is observed only in 15th March (127.84) sown crop. On the other side, the minimum number of gynophores was recorded in 15th June sown crop in both the varieties. Our results are in line with those reported by Park et al., (1986) and Reddy and Reddy (2000).

The total number of pods/plant, number of ripened pods/plant and number of immature pods/plant was higher in 15th March sown crop in both of the test varieties and number decreased with subsequent delay in dates of sowing. Similar results have been reported by Abd El-Halem et al., (1986), Park et al., (1986), Reddy and Reddy (2000), Canavar and Kaynak (2008) and Kanade et al., (2015) in
groundnut, they concluded that number of pods per plant was higher for early and middle planting dates than late planting dates.

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How to cite this article:
Amritpal Singh Sekhon, P.S. Sandhu, Pankaj Sharma, K.K. Sharma and Rakesh Belludi. 2019. Effect of Date of Sowing on Development of Root Rot Complex Disease in Groundnut (Arachis hypogaea L.). Int.J.Curr.Microbiol.App.Sci. 8(11): 1192-1205. doi: https://doi.org/10.20546/ijcmas.2019.811.140