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***Short Communication***

# Influence of soil temperature, moisture and planting depth on black scurf development in potato (*Solanum tuberosum* L.)

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Potato (*Solanum tuberosum* L.) popularly known as 'king of vegetables' has emerged as fourth most important food crop in India after rice, wheat and maize. Black scurf disease caused by *Rhizoctonia solani* (Kuhn.) is a major problem all over the world. This pathogen is widespread, ecologically diverse and soil-borne in nature. Black scurf disease of potato has been reported to cause marketable yield losses up to 30-50% (Kumar *et al.,* 2017). The disease development is further influenced by different climatic conditions. The soil micro-climate has a great influence on disease severity as soil temperature and moisture are the primary determinants of growth of soil-borne pathogens (Hwang *et al.,* 2000). Excessive soil moisture may affect potato tubers which lead to swollen lenticels and increased susceptibility to tuber-borne infections (Adams and Stevenson, 1990). The incidence of the disease is significantly influenced by depth of planting as with change in depth of planting disease development increases (Clarke and Martin 1935). Shallow planting at 5.0 cm soil-depth recorded lower extent of necrotic stems and disease intensity in comparison with the highest value when infected seed tubers were planted at 20 cm soil-depth (Singh *et al.,* 2005). The disease management with chemicals is economically not viable and unsafe for the environment. Therefore, the need of the hour is to find suitable management strategy that will lead to decrease in inoculum level in the soil. In line with this, cultural methods can prove to be promising one in minimizing the inoculum level in soil and the tubers. Keeping in view, the present investigation was undertaken to find out influence of soil temperature, moisture and planting depth under field conditions on development of black scurf disease in potato.

**Table 1:** Rating scale (0-4 scale) adopted for the measurement of the disease index (severity)

| Disease rating scale | Description |
|---|---|
| 0 | Healthy |
| 1 | Up to 25% tuber area scurfed |
| 2 | 26-50% tuber area scurfed |
| 3 | 51-75% tuber area scurfed |
| 4 | >75% tuber area scurfed |

The present investigation was carried out in the Research farm of Vegetable Science, CCS Haryana Agricultural University, Hisar during *rabi* seasons, 2015-16 and 2016-17. Hisar is situated at latitude of 29°10'N, longitude 75°46'E and altitude 215.2 m above mean sea level and falls in semi-tropical region of Western zone of India. The infected potato tubers of cultivar 'Kufri Bahar' were planted during first fortnight of November, 2015 and 2016 under field conditions (plot size: 3.0 x 2.0 m; spacing: 60 x 45 cm) using RBD with three replications at different depth of planting (soil depth: 15, 20 and 25 cm). Observations of soil temperature and moisture were recorded at weekly interval after 45 days of planting till harvesting by using soil thermometer and gravimetric method, respectively. The disease incidence and disease severity index were recorded after harvesting of the potato tubers. The regression equation analysis was carried out by using OPSTAT statistical software (Sheoran, 2006).

The percent disease incidence (PDI) was calculated by using the formula proposed by Ahmad *et al*. (1995) as described below:

$$\text{PDI (\%)} = \frac{\text{No. of tubers infected}}{\text{Total number of tubers observed}} \times 100$$

**Table 2:** Mean soil temperature, soil moisture and disease status at different depths of planting

| Year | Soil depth* (cm) | Soil temp. (°C) | | Soil moisture (%) | Disease incidence (%) | Disease severity (%) |
|---|---|---|---|---|---|---|
| | | Morning | Evening | | | |
| 2015-16 | 15 | 14.7 | 17.3 | 16.4 | 43.0 | 20.0 |
| | 20 | 15.4 | 16.4 | 17.4 | 51.6 | 25.0 |
| | 25 | 16.6 | 14.9 | 17.7 | 58.3 | 26.7 |
| 2016-17 | 15 | 14.6 | 17.5 | 17.2 | 46.7 | 22.5 |
| | 20 | 15.4 | 16.6 | 18.2 | 54.3 | 24.2 |
| | 25 | 16.6 | 15.0 | 18.3 | 60.0 | 28.3 |

*All values represent means of three replications

**Table 3:** Correlation coefficient between soil and disease incidence (pooled)

| S. No. | Parameter | Correlation coefficient* |
|---|---|---|
| 1 | Morning soil temperature (°C) | 0.947* |
| 2 | Evening soil temperature (°C) | -0.921* |
| 3 | Soil moisture (%) | 0.881* |

*Significant at p= 0.01 level of significance

Disease severity index (DSI) was calculated according to the formula adopted by Kumar and Raj (2016) (Table 1).

$$\text{DSI (\%)} = \frac{\text{Sum of all numerical rating}}{\text{Total number of tubers observed} \times \text{Max. grade}} \times 100$$

The results on the effect of various depths of planting (15, 20 and 25 cm) of potato seed-tubers on the development of black scurf in potato (Table 2) revealed that with increase in depth of planting, the per cent disease incidence and severity increased during both the years. Maximum per cent disease incidence (58.3 and 60.0%) and severity (26.7 and 28.3%) were observed when infected tubers were sown at 25 cm soil-depth, while a minimum per cent disease incidence (43 and 46.7%) and severity (20 and 22.5%) was observed when infected tubers were planted at soil-depth of 15 cm in the respective years.

The correlation coefficient of per cent disease incidence (PDI) with soil temperature and soil moisture (Table 3) revealed that PDI was significantly and positively correlated with morning soil temperature (0.947*) and soil moisture (r=0.881*) and negatively correlated with evening soil temperature(r= -0.921**). The results revealed that as the depth of planting increases morning soil temperature morning ($ST_{morn}$) is also more but evening soil temperature ($ST_{even}$) is less.

Multiple regression equations between soil temperature and soil moisture at different depths of planting and black scurf development of potato are presented in Table 4. It is revealed that evening soil temperature ($ST_{even}$) and soil moisture (SM) were found the contributing factors for the incidence of the disease as well as disease severity. These factors $ST_{even,}$ and SM collectively contributed 99 per cent in disease incidence.

With the increase in depth of planting, per cent disease incidence and severity increased during both the years. The present results were also in conformity with the findings of Singh *et al.* (2005) who reported that black scurf incidence was significantly influenced at different depths of planting. The findings of Singh (1998) indicated a linear and negative response of black scurf development with soil temperature. Similar findings was also reported by Kumar and Gupta (2016) who showed that the correlation coefficient of *Bemisia tabaci* population (vector of potato apical leaf curl virus disease) were significantly and positively correlated with the different weather variables.

From the present investigation, it could be concluded that at the shallow depth of planting, disease incidence and severity of black scurf of potato was minimum as compared to deep planting of tubers. Black scurf incidence and severity

**Table 4:** Multiple regression equations between disease and soil parameters (pooled)

| Dependant variable (Y) | Regression equation ( $Y=a+bx_1$) | $R^2$* | F |
|---|---|---|---|
| Disease incidence | $Y= 32.481 - 3.688\ ST_{even} + 4.552\ SM$ | 0.99 | 806.6 |
| Disease severity | $Y= 20.166 - 1.696\ ST_{even} + 1.817\ SM$ | 0.93 | 20.4 |

*Significant at p= 0.01 level of significance, $ST_{morn}$ – Soil temp. morning, $ST_{even}$ – Soil temp. evening, SM– Soil moisture

showed a negative correlation with evening soil temperature($ST_{even}$) whereas, a positive correlation with morning soil temperature and soil moisture.

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