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# Study on the vesicular-arbuscular mycorrhiza of three cultivars of potato (*Solanum tuberosum* L.)

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**Summary** The establishment and development of vesicular-arbuscular mycorrhizal (VAM) fungi were studied in three cultivars of potato, which differed in susceptibility to 'Late blight', in a field experiment on a lateritic sandy-loam during two growing seasons (1980 and 1981). The cultivars 'SSC 1174' (highly resistant) and 'Kufri Jyoti' (resistant) showed an earlier establishment and more rapid development of VAM fungi than 'up-to-date' (highly susceptible). The first mycorrhizal infection in both 'SSC 1174' and 'Kufri Jyoti' was observed after 12 days in 1980 and 8 days in 1981, whereas, in 'up-to-date' it was observed after 19 and 12 days respectively. The mycorrhizal infection increased with the age of the plants in all the three cultivars.

## Introduction

The importance of vesicular-arbuscular (VA) mycorrhizal fungi in agricultural crops has been widely recognized. The beneficial effect was attributed to increased phosphorus uptake by the endophyte[3, 5, 8, 11, 12, 14]. Black and Tinker[1] have reported a suppressed VA mycorrhizal infection in potato by phosphate fertilization. Despite this study, nothing is known about the development of VA mycorrhizal fungi with respect to the age of host plant in potato.

The present study was undertaken to evaluate systematically the mycorrhizal status of three different cultivars of potato during two growing seasons. Potato was selected for its importance as the staple food of the people of this region.

## Materials and methods

### *Sampling site*

A site in the University Campus, which is located at 25°34′ N latitude and 91°56′ E longitude and at an altitude of 1540 m was selected for the study. The soil of the sampling site was of sandy-loam lateritic nature with the following properties pH 5.85, organic matter 3.62%, total nitrogen 0.30%, available phosphorus 3.06 ppm and exchangeable potassium 0.28 mg/g respectively.

### *Sampling material*

Three different cultivars of potato, which differed in susceptibility to 'Late blight', *viz.*, 'SSC 1174' (highly resistant), 'Kufri Jyoti' (resistant) and 'Up-to-date' (highly susceptible), were selected. The experimental plot was divided into three subplots of the area 10 m × 10 m each. Each subplot was used for each potato cultivar. Plants were raised from the tubers of similar sizes which were planted on 1st March of each year (1980 and 1981) and most of the plantlets emerged by 15th March.

Table 1. Percentage VA-mycorrhizal infection with respect to differing age group in three different cultivars of potato in 1980

| Potato cultivar | Age of the plants in days | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 8 | 12 | 15 | 19 | 30 | 45 | 60 | 75 | 90 |
| SSC 1174 | Nil | 10.00 | 35.00 | not recorded | 47.00 | 60.41 | 48.00 | 58.18 | 77.50 |
| Kufri Jyoti | Nil | 5.00 | 33.00 | not recorded | 57.00 | 61.54 | 56.51 | 58.46 | 60.00 |
| Up-to-date | Nil | Nil | Nil | 15.00 | 30.00 | 44.54 | 42.00 | 43.24 | 37.50 |

Table 2. Percentage VA-mycorrhizal infection with respect to differing age group in three different cultivars of potato in 1981

| Potato cultivar | Age of the plants in days | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 8 | 12 | 15 | 30 | 45 | 60 | 75 | 90 |
| SSC 1174 | 12.96 | not recorded | 37.50 | 57.50 | 60.00 | 75.00 | 80.00 | 80.00 |
| Kufri Jyoti | 6.15 | not recorded | 31.50 | 67.50 | 80.00 | 80.00 | 86.50 | 76.66 |
| Up-to-date | Nil | 3.08 | 10.00 | 32.50 | 22.50 | 42.50 | 50.00 | 30.00 |

*Collection of samples*

Plants were sampled after emergence at 5, 8, 12, 15, 19 (in 1980 only) 30 and then after every fifteen days until they were 90 days old. At each sampling date, five plants of each cultivar were sampled randomly. The intact root system along with the rhizospheric soil was brought to the laboratory where roots were separated from the soil. The separated roots of all the replicates were mixed to form a composite sample and were sliced into segments of 1 cm length, and similarly the rhizospheric soils were mixed to form a composite sample of soil. The pH and moisture content of the soil were assessed immediately. Percentage VA-mycorrhizal infection was estimated after staining by following the method of Phillips and Hayman[13]. Besides this, number of arbuscules/cm root and number of vesicles/cm root were also calculated, which represented the average number of each arbuscles and vesicles.

Besides pH and moisture content, organic matter (%), total nitrogen (%), available phosphorus (ppm) and exchangeable potassium (mg/g) of the soil were also estimated for each sample. Then correlation coefficient (r) was found out between percentage VA-mycorrhizal infection and the physico-chemical properties of the rhizospheric soil.

**Results and discussion**

No colonization by the fungus was observed until some days after the emergence of the young plants when hyphae were frequently observed in the root cortex. The first mycorrhizal infection was observed in 12 days and 8 days old plantlets in 'SSC 1174' and 'Kufri Jyoti' in 1980 and 1981 respectively. Whereas in 'Up-to-date' the same was observed in 19 and 12 days old plantlets in 1980 and 1981 respectively (Tables 1 and 2). After the initiation, the mycorrhizal infection increased rapidly. Lag periods at the beginning of the infection process have also been reported[2,16,17]. As suggested by Sutton[17], the time required for spore germination, germ tube elongation and root penetration obviously contribute to the delay. The mycorrhizal infection increased with the age of the plant except a decrease in 60 days old plants in both the cultivars 'SSC 1174' and 'Kufri Jyoti' in 1980 and 90 days old plants in

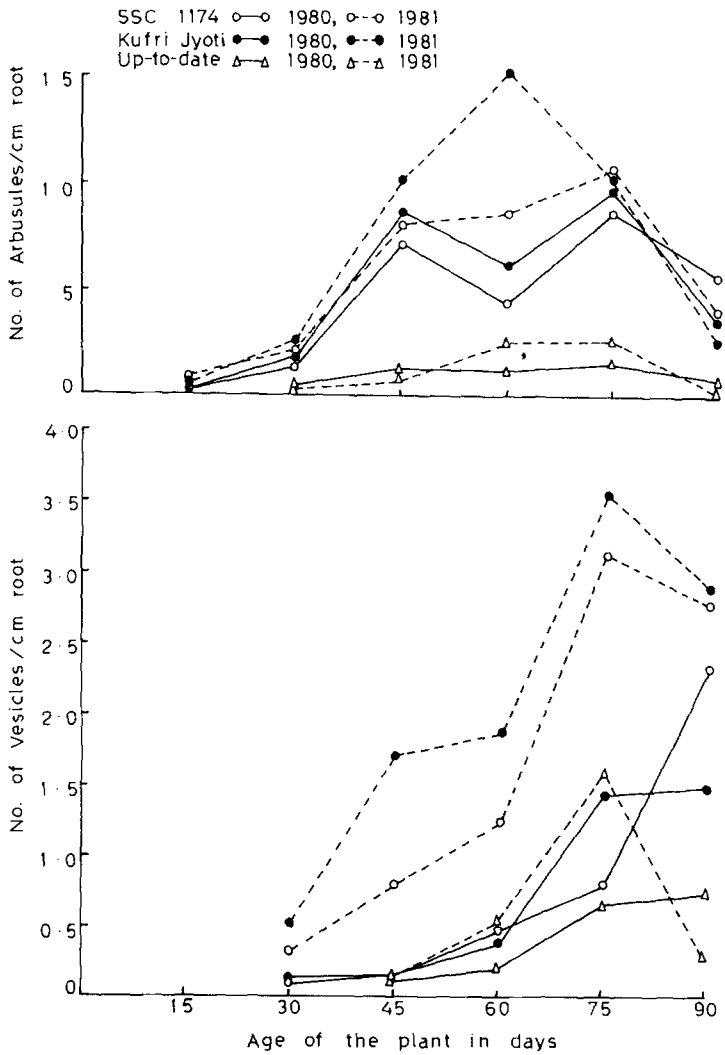


Fig. 1. Number of arbuscules and vesicles per cm of root in different age groups, in three different cultivars of potato.

case of 'Kufri Jyoti' in 1981. The same trend was observed in 'Up-to-date', except a decrease in 60 and 90 days plants in 1980 and 45 and 90 days old plants in 1981 (Tables 1 and 2). Hayman[4] also reported an increase in the mycorrhizal infection with the age of the host plant.

The arbuscules were first observed in 15 days old plantlets in 'SSC 1174' and 'Kufri Jyoti' but in 30 days old ones in 'Up-to-date', which increased in number with the age of the host plant upto 75 days and then decreased subsequently (Fig. 1). Whereas vesicles were first observed in 30 days old plants in both the resistant cultivars and in 45 days old plants in the susceptible one, which increased steadily with the age of the plant except a decrease in 90 days old plants in 1981 (Fig. 1). In general the arbuscular peak was observed earlier than the vesicular peak, which supports the observation of Khan[10].

The mycorrhizal infection was positively correlated with moisture content and organic matter but negatively correlated with total nitrogen and available phosphorus (Table 3). Johnston[7] and Sabet[15] also reported increased mycorrhizal colonization with the addition of

Table 3. Correlation coefficient (r) between the percentage VA-mycorrhizal infection and the physico-chemical properties of the rhiospheric soil

| | | Rhizospheric soil properties | | | | | |
|---|---|---|---|---|---|---|---|
| | Year | pH | Moisture content (%) | Organic matter (%) | Total nitrogen (%) | Available phosphorus (ppm) | Exchangeable potassium (mg/g) |
| r value | 1980 | 0.686** | 0.573* | 0.168 | − 0.125 | − 0.319 | 0.313 |
| | 1981 | − 0.246 | 0.531* | 0.520* | − 0.386 | − 0.265 | 0.014 |

Data of the three cultivars of potato were combined to calculate r.

* Significant at 5% level.

** Significant at 1% level.

organic matter. Jensen and Jakobsen[6] have observed an inverse relationship between mycorrhizal infection and soil-P and -N levels. With pH and exchangeable potassium, the mycorrhizal infection showed a positive correlation in 1980 but a negative one in 1981 (Table 3). Probably individual species of mycorrhizal fungi might respond differently to some specific soil factors, and the relationship is based on the dominance of specific type of mycorrhizal fungi. Evidence for specificity of certain mycorrhizal fungi to soil pH has already been reported[9].

It can be concluded from the present study that the establishment and development of VA-mycorrhizal fungi were early and rapid in the resistant cultivars, 'SSC 1174' and 'Kufri Jyoti' compared to the susceptible one, 'Up-to-date'. Further studies on disease incidence have to be done to find out an explanation for this.

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