Impact of *Sri Lankan cassava mosaic virus* infection on the tuber yield, starch and protein content of cassava tubers of three popular varieties of Tamil Nadu

Buvaneswari, S.[1*], S.Rageshwari[2], M.Deivamani[3], G.Janavi[2], and R.Rabindran[2]

[1] JSA College of Agriculture Technology, Tittagudi, Tamil Nadu, India.
[2]Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.
[3]Tapioca and Castor Research Station, Yethapur, Tamil Nadu, India.
*Corresponding author's E-mail: bhuvana.ag84@gmail.com

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ABSTRACT

Cassava is an important crop cultivated in most of the districts of Tamil Nadu, the starch content of cassava is high when compared with any other crops. The yield of cassava is drastically reduced due to infection with *Sri Lankan cassava mosaic virus*. In order to study the real impact of this virus on the yield, starch and protein contents of tubers, three field studies were conducted during two years from 2010-2012. Three different varieties namely H226, CO2 and Kunguma rose varieties were used for the study. Field trial was conducted at ARS Vaigai Dam TNAU Farm, Singampettai, SPAC Factory land (Erode district) with infected and healthy cassava plants (virus eliminated and indexed) for three consecutive seasons. During 2010 the trial with cv. CO2 in an area 0.5ac (25 cents healthy and 25 cents infected) was conducted and during second season (Oct-Nov planting) at SPAC Farm, Singampettai, Eroded district. The trial with Kunguma Rose (local) was conducted during first season (June-July 2011) at SPAC Farm, Singampettai, in an area of 0.5 Ac (25 cents healthy and 25 cents virus infected) and the trial with *cv* H226 was conducted at ARS, Vaigai Dam, Theni District during Feb 2012 in an area of 0.5 ac (25 cents infected and 25 cents healthy). The observation was recorded on the tuber yield and it was observed that there was a drastic reduction in the yield to the tune of 70, 37.6 and 79.9 per cent in *cv* CO2, Kunguma rose and H226 respectively. Qualitative yield loss was also recorded for the three varieties. The starch content of the tubers was found to be reduced to the tune of 10.4, 23.2 and 20.4 per cent in the *cv* CO2, Kunguma rose and H226 respectively. The protein content for all the varieties was found to be reduced to the tune of 0.15 per cent as in comparison with tubers collected from healthy plants.

Key words: Cassava mosaic disease, tuber yield, starch content, protein analysis.

Cassava is a major industrial crop in India. Cassava cultivating area, production and productivity in India is 0.24 million ha, 6.7 million tonnes and 27.92 t/ha respectively (FAO, 2005). Cassava (*Manihot esculenta* crantz) also commonly known as Tapioca, continues to be a crop of food security for the millions of people especially in the developing countries of the globe. The crop has been cultivated in India for more than a century. Cassava was introduced into India by the Portuguese when they landed in the Malabar region, presently part of Kerala state during the 17th century, from Brazil. It is an important tuber crop cultivated in Tamil Nadu, Kerala, Andhra Pradesh, Karnataka and Assam. In Tamil Nadu, it is being cultivated in all the districts except Sivagangai and Ramnad. However, due to its industrial prominence, it is being cultivated intensively in Coimbatore, Cuddalore, Dharmapuri, Erode, Namakkal, Krishnagiri, and Viluppuram districts. Cassava mosaic disease (CMD) has emerged as one of the serious limiting factors in tuber production of cassava. In Tamil Nadu, it was first reported by (Alagianagalingam and Ramakrishnan, 1966) but it was known to be present earlier by Abraham in 1956. Production of sago and starch industries increased appreciably in Tamil Nadu after 1970's because food security was achieved considerably and also factors like suitable climate for drying of starch, low labour costs and export potentiality

prompted the development of cassava based industries which prompted this crop as a commercial crop. At present, there are approximately 800 cassava based industries in Tamil Nadu and the area under the crop as per 2003-2004 was 95,000 ha. Rice and wheat form a major part of the staple food for Asians and both these crops dominate the Asian countries, however Asian continent is the second largest in terms of area (19 per cent) and production (29 per cent) of cassava with a productivity of 16.76 t/ha. Tamil Nadu has an area of 95,000 ha (40 per cent of the total area under cassava in India) and 60 per cent of cassava produced is utilized industrially to produce starch, sago and other value added products. This crop encounters number of biological constraints, but cassava mosaic disease dominates the list of such constraints. In India, Mathew (1989) reported the overall incidence of CMD as 30 per cent in Tamil Nadu and 23 per cent in Kerala which was very high compared with Andhra Pradesh (less than 1per cent) and Karnataka (5per cent). In India, the disease can cause a yield loss of 17-88 per cent depending on the cultivars grown (Malathi *et al*., 1985). Manivasagam *et al.* (2006) reported that, all the areas under cassava cultivation in Tamil Nadu were recorded with the maximum incidence of CMD and the disease incidence was more than 90 per cent in most of the areas surveyed. However, Gupta *et al.*, 2003 reported 100 per cent disease incidence in India. Cassava Mosaic Disease (CMD) is the common disease observed in cassava which causes yield loss. The whitefly *Bemisia tabaci* is a vector that transmits the disease in field in the early stages. This CMD reduces the starch content of the tubers thereby the quality of the tubers are also reduced. Cassava mosaic disease has emerged as one of the serious limiting factors in tuber production of cassava. In Tamil Nadu the major varieties cultivated are CO2, Kunguma rose and H226. Thus, the qualitative and quantitative yield loss was studied for the major varieties cultivated along Tamil Nadu to study the impact of the disease.

MATERIALS AND METHODS

Field trial was conducted at ARS Vaigai Dam, TNAU Farm, Singampettai, SPAC Factory land (Erode district) with infected and healthy cassava plants (virus eliminated and indexed) for three consecutive seasons. The study was undertaken in SPAC farm in Singampettai of Erode district and Agricultural Research Station (ARS), Vaigai dam, Theni district in 0.5 acres of area for each variety. Three different varieties namely H226, CO2 and Kunguma rose varieties were used for the study. Cassava plants of different varieties were planted consecutively for three seasons. Cassava stems healthy and cassava mosaic disease infected plants were harvested separately and the yield per plant was weighed individually and the mean was acquired. The result was obtained by two methods are 1. estimation of weight loss and 2. estimation of starch and protein.

1. Estimation of weight loss

The Cassava mosaic disease impact on yield loss in SPAC farm in Singampettai of Erode district and ARS, Vaigai dam in Theni District in 0.5 acres of area for each variety. In two places, cassava fields were selected and in each field, the parameters like CMD severity score, plant growth and yield data were recorded. Yield loss was expressed as a percentage of the diseased plants yield compared to asymptomatic plants yield.

2. Estimation of starch and protein

The harvested tubers were processed for the analysis of starch and protein content by Phenol Sulphuric acid method and Kjeldahl method under laboratory conditions.

a. Estimation of starch by Phenol sulphuric acid method

The tubers are dried and powdered to separate the starch content. Materials used were Phenol 5 per cent, Sulphuric acid 96 per cent and standard glucose stock. The tubers were dried and powdered and used for analysis. Hundred mg of the powdered sample were taken in boiling tube. The samples were kept for 3 h in boiling water bath with 5 ml of 2.5 N HCl. The samples were cooled to room temperature and sodium carbonate was added until the effervescence ceases. The sample volume was made upto 100 ml and centrifuged. 0.2, 0.4, 0.6, 0.8 and 1 ml of the working standards were pipette out in separate test tubes along with a blank solution. The volume was made up to 1 ml using distilled water. After adding one ml of phenol to each tube, 96 per cent of sulphuric acid was added

and shaken well. Continuously shake the tubes for 10 min and the tubes were placed in water bath at 25- 30^{o} C for 20 min and the absorbance were read at 490 nm and the observations were converted to percentage.

b. Estimation of protein by Kjeldahl method

One gram of the sample was weighed and placed in digestion flask along with 15 ml of concentrated sulphuric acid. To this flask seven grams of potassium sulphate and copper was added and heated at 370^{o}C to 400^{o}C. Heating was done till white fumes are produced and the heating was continued for about 60-90 min. The flasks were cooled using 250 ml of water. The pH of the samples was increased by using 45 per cent NaOH. Distillation was done to separate the ammonia from the digestion mixture and the ammonia was trapped in distilled water with a trapping solution (15 ml HCl in 70 ml water). Dye was added to the trapping solution. This solution was titrated against NaOH till the solution turns orange. Then volume was recorded and calculation was performed for estimation of protein and converted to percentage.

RESULTS AND DISCUSSION

The experimental trial was conducted at ARS, Vaigai Dam, TNAU Farm (Theni district), Singampettai, SPAC Factory land in Erode district with infected and healthy cassava plants (virus eliminated and indexed) for three consecutive seasons with three cultivars *viz.*, H226, CO2 and Kunguma rose. During 2010 the experiment with cultivar CO2 was conducted and an area of 0.5ac (25 cents healthy and 25 cents infected) following the second season (Oct-Nov planting) at SPAC Farm, Singampettai, Erode district. During 2011, the trial conducted with Kunguma Rose (local) cultivar for the first season (June-July 2011) at SPAC Farm, Singampettai, in an area of 0.5 Ac (25 cents healthy and 25 cents virus infected) and the trial with cultivar H226 was conducted at ARS, Vaigai Dam, Theni District during Feb 2012 in an area of 0.5 ac (25 cents infected and 25 cents healthy). The field trial of cassava *var* CO2 the percentage of cassava mosaic disease infected plants was 27.36 per cent and the yield obtained from healthy plant was 3392 MT whereas the yield obtained from infected plants were 969 kg. The percentage in yield reduction was around 28 per cent. The average starch recorded in the tubers from infected plants was 21.5 per cent as against 28 per cent in tubers collected from healthy plants. This estimation was done by the starch factory (SPAC) located at Poonachi, Erode district (Table 1). The weight the variety CO2 produces higher yield of tubers from healthy cuttings when compared to infected plants whereas the starch and the protein content was higher in case of variety H226 when comparing with the yield of infected plants. The increase in starch per hectare of healthy tuber in Kunguma rose cultivar is 23.2 per cent followed by H226 cultivar where the starch increases by 20.04 per cent. The laboratory analysis revealed that the infected cassava tubers recorded 22.21 per cent of starch as against to 24.42 per cent in tubers collected from healthy plants. The per cent reduction in starch was to the tune of 9 per cent (Table 2).

Cost benefit ratio:

950 healthy plants yield = 3392 kg of tubers
690 infected cassava plants = 969 kg of tubers
Yield of tubers from one plant = 3.5 kg (healthy plants).
Yield of tubers from one plant = 1.4 kg (infected plants).
Starch from 3392 kg of tubers from healthy plants = 949.7 kg
Starch from 969 kg of tubers from infected plants = 208.335 kg

For ¼ acre of cassava field

Starch yield from healthy plant = 4745/ 100 = 47.45* 200 (Rs) = Rs.9490.
Starch yield from infected plant = 1359 / 100 = 13.59 * 200 (Rs) = Rs. 2718
For 0.25 acre of healthy plant with no investment the profit is Rs. 9490 and it is Rs. 2718 in case of infected cassava plants. The healthy cuttings can also be sold as a propagation material in at the rate of Rs. 1 for one healthy stem. Cassava tuber yield losses due to cassava mosaic disease in India have been reported to vary from negligible to 84% (Thottappilly et al., 2003) but the magnitude of the loss may depend on cultivar type and time of infection (Thankappan and Chacko, 1976; Malathi et al., 1985; Nair and Malathi, 1987; Jeeva, 1997). However, it is unclear whether the recorded losses are due to ICMV or SLCMV, or both viruses, in mixed infected plants because most of the yield loss

studies relied on natural infections under field conditions.

CONCLUSION

The results of the experiment conclude that Due to SLCMV infection the tuber yield was reduced to the tune of 28 per cent to 30 per cent and the starch content was deducted as 21.5 per cent in tubers of infected plants when compared with tubers of healthy plants (28 per cent) at factory level and the 22.21 per cent in laboratory and the protein content detected was 0.39 per cent under laboratory conditions. The loss obtained was about Rs.7000 per acre due to the cultivation of SLCMV infected cassava plants. The yield loss estimation both quantitative and qualitative is unique and first of its kind with SLCMV on Indian varieties. The profit from 0.25 acre was estimated to be Rs. 9490 from uninfected healthy plants.

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