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Growth Analysis of Cassava in Semi-Arid region using Novel Subsurface Porous Vessel Irrigation Method

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• Abstract

Four varieties of Cassava namely Sree Jaya, and Sree Vijaya of six-month duration and Sree Reksha and Sree Pavithra of ten month duration were tested for their site suitability in semi-arid Jodhpur in the Kharif season of year 2020. The initial plant growth physiology studies of these varieties are presented in this article. Irrigation was provided using the novel sub-surface porous vessel technique in order to ensure conservation agriculture practices and low evapo-transpiration. Parameters like height, stem diameter, number of leaves, leaf length, leaf width, average day and night temperature are measured and studied. A novel multi-parameter lognormal regression model for prediction of height of the cassava plant is derived. Studied has shown that day temperature negatively influenced plant height in varieties of Sree Vijaya and Sree Reksha.

• Introduction

Cassava root is major source of food for over 500 million people in tropical region [1] and source of 37% calories of food intake in Africans, 11 % in Latin America and 6% in Asia as per studies of 1982 [2] Cassava shows high resistance to plant disease and suitable for extreme drought conditions and nutrition deficient soil. [1,2] . In India cassava is considered as poor man's vegetable as consist ample amount of starch. Area under cassava cultivation is around 240,000 ha with annual productivity of 6.7 million tons which is highest worldwide in terms of productivity per hectare. Major areas of cassava cultivation lie in Tamil Nadu and Kerala which account for more than 50% of national production [6] . On a worldwide basis it Cassava is ranked as the sixth most important source of calories in the human diet [7] and it has huge potential for use as high energy food,as well as industrial raw material for sweeteners and ethanol [8] .In order to provide an alternate source of good nutrition in Jodhpur, which falls under semi-arid climate , initial development of cassava was studied for 60 days with use of novel sub surface porous vessel (SSPV) [9].

Specie Name	Maturity Period	Special features
Sree Jaya	6 month	Conical tubers with purplish rind, white flesh colour, excellent cooking quality
Sree Vijaya	6 month	High yielding variety , High starch content, excellent cooking quality
Sree Pavithra	10 month	Excellent cooking quality, good starch content and low cynogenic glucoside
Sree Reksha	10 month	High yield variety , resistant to cassava mosaic virus

Table 1: The Cassava species that were provided by Central Tuber Crops Research Institute, CTCRI, Trivandrum, Kerala, India.

• Methods and Analysis Framework

1. Traditionally propagation method: Cassava varieties were propagated by cutting stem of mature plant into sticks of 18-20 cm length and planting them vertically in soil in early July 2020 [6].
2. Mini or Micro set propagation method: In this method the stem of tender cassava is cut into 3-4 cm pieces each containing more than 2 buds. They are placed horizontally over the soil surface and covered with soil layer of 2 cm over it. New sapling starts to appear in a week and they are transplanted into field at the end of 3 weeks [7].
3. Irrigation: Novel sub-surface porous vessel (SSPV) irrigation method was used to irrigate soil compost mounds on which cassava was propagated [8]. As shown in Figure below , the locally prepared frustum shaped SSPV with capacity of 9 liter and average flow rate of 1000 ml per hour is used for irrigation. The SSPV is filled every third or fourth day as per requirements. Sub surface porous vessels improve water application efficiency and soil mounds help in restricting water in root zone [9].

Fig. 1: SSPV

Fig. 2: Compost Mound

Fig. 3: Cassava (Sree Jaya (M) with SSPV

4. Multi-parameter multivariate regression molding:

Regression analysis is used to predict the value of one or more responses from a set of predictors. We first revisit the multiple linear regression model for one dependent variable and then move on Cassava plant growth is dependent of various factors .Regression is used to predict the height of the cassava plant as a function of all the different independent parameters. Here independence is mathematically realized using vector analysis.

Fig. 4a: Big Mound with SSPV irrigation and Cassava Stem planted at first week of Kharif

Fig. 4 b: Cassava (Sree Vijaya) plant after 2 months

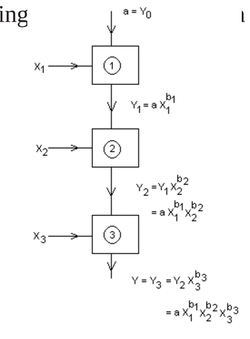

Fig. 5 Log normal modeling strategy

Principal component analysis is used to elaborate the importance of the influences of temperature, humidity on the leaf physiology, plant stem diameters as well as height of the plant for each of the 4 varieties grown in Jodhpur, Rajasthan.

• Results

• Number of plants grown and propagation rate of Sree Jaya, Sree Vijaya, Sree Reksha and Sree Pavithra are shown in Fig. 6.Here M denotes micro set propagation method. Sree Pavithra did not shown any propagation during the experiments , hence excluded for further calculation.

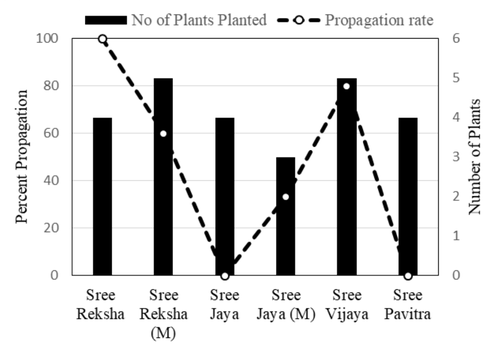

Fig. 6: Percent Propagation of each Cassava Variety grown with SSPV hybrid irrigation Method.

A multiplicative model was used to predict the relationship between height of cassava plant (cm) and other parameters.

$$h = \alpha X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} X_5^{\beta_5} X_6^{\beta_6} X_7^{\beta_7} \quad \text{Eq. 1}$$

Where h: height of cassava (cm), β coefficients, X1: Number of leaves, X2: Diameter (mm), X3: Temperature of day,X4: Temperature of night, X5 : Leaf length,X6: leaf width, X7, time. The number of leaves at any instant in varieties of Sree Jaya, and Sree Reksha negatively influenced plant height . This was not true in case of Sree Vijaya.

Table 2: Summary of the modeling using Eq.1 for all the three Cassava species grown using conventional and Microset (M) technique.

Cassava Species	α	β1	β2	β3	β4	β5	β6	β7	S	R2
										%
Sree Jaya (M)	0.141	-0.03	0.094	0.074	-0.11	0.657	0	2.18	0.064	98.2
Sree Reksha (M)	0.167	-0.121	0.103	-0.079	0.334	-0.08	0.106	1.896	0.1269	93.19
Sree Reksha	0.165	-0.118	0.138	0.018	0.121	0.076	-0.002	2.539	0.1842	83.93
Sree Vijaya	0.163	0.052	-0.14	-0.082	0.079	-0.15	-0.376	2.713	0.0979	94.55

Sree Jaya Microset

Here lnh, lnl, lnd, lntd, lntn, lnll, lnlw are lognormals of height, length, diameter, temperature of day, temperature of night, length of leaves, width of leaves

Fig. 7 The Loading plot for parameters for Sree Jaya growth in the Kharif Season

Sree Reksha Microset

Here lnh, lnl, lnd, lntd, lntn, lnll, lnlw are lognormals of height, length, diameter, temperature of day, temperature of night, length of leaves, width of leaves

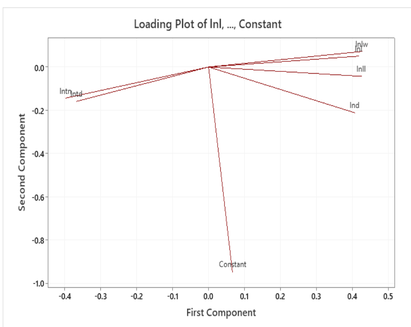

Fig. 8 The Loading plot for parameters for Sree Reksha (M) growth in the Kharif Season

Sree Reksha (Conventional)

Here lnh, lnl, lnd, lntd, lntn, lnll, lnlw are lognormals of height, length, diameter, temperature of day, temperature of night, length of leaves, width of leaves

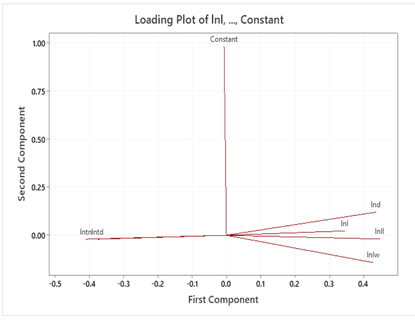

Fig. 9 The Loading plot for parameters for Sree Reksha (conventional) growth in the Kharif Season

Sree Vijaya (Conventional)

Here lnh, lnl, lnd, lntd, lntn, lnll, lnlw are lognormals of height, length, diameter, temperature of day, temperature of night, length of leaves, width of leaves

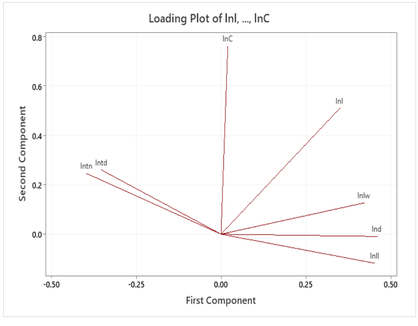

Fig. 10 The Loading plot for parameters for Sree Vijaya (conventional) growth in the Kharif Season

Conclusion

In arid and semi-arid areas such as Rajasthan (Jodhpur to be specific) the very low temperatures at night and the very high temperatures in the day highly influence the growth (here height) in a negative manner. The above stated observation can be very well verified from the loading plots that we have plotted.

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