Journal of Scientific Research & Reports

27(10): 20-25, 2021; Article no.JSRR.75872
ISSN: 2320-0227

Effect of Different Planting Material on Physiological Parameters and Cassava Mosaic Incidence in Cassava (*Manihot esculenta* Crantz.)

S. Nanthakumar[1*], K. Krithika[2] and M. Prabhu[2]

[1]*Agricultural Research Station, TNAU, Virinjipuram, Vellore District, Tamil Nadu, India.*
[2]*Department of Vegetable Science, Horticultural College & Research Institute, TNAU, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JSRR/2021/v27i1030445
Editor(s):
(1) Dr. Kleopatra Nikolopoulou, University of Athens, Greece.
(2) Dr. Ahmed Mohammed Abu-Dief Mohammed, Sohag University, Egypt.
Reviewers:
(1) P. A. Azeez, India.
(2) Victoria Jovin Mugula, Jordan University, Tanzania.
Complete Peer review History: https://www.sdiarticle4.com/review-history/75872

Original Research Article

Received 12 August 2021
Accepted 22 October 2021
Published 25 October 2021

ABSTRACT

An investigation was carried out to assess the effect of planting materials on physiological parameters, cassava mosaic incidence and yield of Cassava varieties *viz.* H-226 and CO.2 at the Department of Vegetable crops, Horticultural College and Research Institute, TNAU, Coimbatore during September 2010 to June 2011. The experiments were laid out in Factorial Randomized Block Design with four treatments and three replications in two varieties. The results revealed that the tissue culture plants were found be the best in virtue of its high leaf area index, net assimilation rate, dry matter content, tuber yield (26.33 t ha^{-1}) and least incidence of cassava mosaic virus. Among the varieties, CO.2 showed less incidence of CMD. The tissue cultured plants may be recommended to farmers to reduce mosaic disease incidence and get maximum yield in cassava.

Keywords: Cassava; tissue culture; dry matter; physiological parameters.

**Corresponding author: E-mail: snktnau@gmail.com;*

1. INTRODUCTION

Cassava (*Manihot esculenta* Crantz.) is a tropical tuber crop as it is used not only for human consumption but also as a raw material for various industrial products. The production of carbohydrate from unit area of cassava is about 40 per cent higher than rice and 25 per cent more than maize with the result that cassava is the cheapest source of calories for both human and animal feeding [1]. In India, tapioca is grown in an area of 2.8 lakh hectares with an annual production of 96 lakh tonnes and productivity of 34.4 t/ha. [2].

Most important among the biotic factors affecting cassava production are viral diseases, specifically cassava mosaic disease (CMD) which has long been recognized as a major limiting factor. CMD is wide spread in almost all cassava growing areas of India and causes yield losses upto 88 per cent in susceptible varieties and up to 50 per cent in field tolerant varieties. Cassava mosaic disease, primarily transmitted through planting material, can cause yield losses ranging from 2 to 90 per cent [3]. The disease is caused by virus of the genus *Begomovirus* in the family Geminiviride and is transminated by whitefly (*Bemisia tabaci*) and disseminated in the stem cutting used routinely for propagation [4].

It is commercially propagated by stem cuttings, which has led to accumulation of viral and bacterial diseases which reduce the productivity In order to increase the productivity and quality of the crop, it is important to identity elite planting materials for rapid multiplication without sacrificing the yield of the crop and at the same time it should be economically viable. Tissue culture can be used for intensive propagation of new varieties and species [5], to eliminate virus and pathogen (bacteria and fungus) which can seriously affect the plant yield and quality Considering above facts, a present study on effect of different sources of planting materials on physiological parameters and cassava mosaic incidence in Cassava was carried out.

2. MATERIALS AND METHODS

The present investigation was carried out at College Orchard of Tamil Nadu Agricultural University, Coimbatore during September 2010 to June 2011. The maximum temperature of the location fluctuated between 25.5 ^{0} C and 34.4 ^{0} C, with a minimum temperature ranged between 16.5^0 C and 23.4^0 C. Relative humidity ranged from 30 to 93 percent. The soil of the experimental field was Clay Loam in texture and the pH ranged between 8.0- 8.5. The experiment was laid out in Factorial Randomized block design with a plot size of 4m x 3m and replicated thrice. The promising cassava varieties H-226 (V_1) released by the Central Tuber Crops Research Institute, Thiruvananthapuram and CO-2 (V_2) released from Tamil Nadu Agricultural University, Coimbatore were taken up for present study with planting materials *viz.,* Tissue cultured plants (T_1), two budded setts from tissue cultured grown plants (T_2), Six budded setts from normally field grown plants (T_3) and two budded setts from normally field grown plants (T_4). The setts with different nodes were planted, watered daily and kept under shadenet for 25 days in the nursery and then they were transplanted in the main field. In the case of tissue culture plants were kept under shadenet for secondary hardening. Two months old plants were planted in the main field. Well decomposed farm yard manure was applied at the rate of 25t/ha. as a basal dose before final ploughing and basal dose of 45:80:120 kg/ha. N, P_2O_5 and K_20 was applied. Then the tissue cultured plants and setts were planted at a spacing of 90 x 75 cm at the ridges. The procedures followed for recording various physiological parameters are as follows.

2.1 Dry Matter Content

The individual plants were harvested from sampling which is randomly selected and the tubers, leaves, petiole and stem were separated. They were dried in open air for 48 hours. Then, they were kept in hot air oven at 90^0 C for 48 hours until constant weights were obtained. The dry matter content of tubers, leaves, petiole and stem were calculated and expressed in per cent.

2.2 Leaf Area Index (LAI)

Lead area was measured with automatic portable area meter, Model LI-3000. Leaf Area Index was calculated by adopting the following formula and recorded [6].

$$\text{LAI} = \frac{\text{Total Leaf Area/plant}}{\text{Area covered by plant}}$$

2.3 Net Assimilation Rate (NAR) (mg cm^{-2} day^{-1})

NAR was calculated by using the following formula and expressed in mg per cm^2 per day [7].

$$NAR = \frac{W2 - W1}{t2 - t1} X \frac{\text{Log e L2} - \text{Log e L1}}{L2 - L1}$$

Where, L_1 and L_2 are the leaf area at the time t_1 and t_2 and W_1 and W_2 are the dry weight at the time t_1 and t_2.

2.4 Relative Growth Rate (RGR) (mg g^{-1} day^{-1})

The RGR was determined on the basis of the formula suggested by Williams (1946) and expressed in mg per g per day.

$$RGR = \frac{\text{log e W2} - \text{log e W1}}{t2 - t1}$$

Where, W_1 - Whole plant dry weight at t_1, W_2 - Whole plant dry weight at t_2, (t_1 - t_2) - time interval in days between stages.

2.5 Crop Growth Rate (CGR) (g m^{-2} day^{-1})

CGR is the rate of increase of dry weight per unit land area per unit time and expressed in g per m^2 per day.

$$CGR = \frac{(W2 - W1)}{p\ (t2 - t1)}$$

Where, W_1 and W_2 = Whole plant dry weights (g) at time t_1 and t_2 respectively, t_2 and t_1= Time interval (days), p = Ground area occupied by the plant (m^2).

2.6 Chlorophyll Content (mg g^{-1})

Chlorophyll 'a', 'b', and total chlorophyll content were estimated by following the method [8]. A representative sample of leaf tissue 250 mg was weighed and grounded with 10ml of 80 per cent acetone using a pestle and mortar. The homogenised sample was centrifuged at 3000 rpm for 10 min. The supernatant was collected and volume was made up to 25ml with 80 per cent acetone. The optical density (OD) value of the extract was measured at 645 and 663 nm using 80 per cent acetone as the blank in the spectrophotometer. The contents of 'a', 'b' and total chlorophyll were calculated using the following formulae,

Chlorophyll 'a' = 12.7 (A_{663}) – 2.69 (A_{645}) x v / 1000 x w

Chlorophyll 'b' = 22.9 (A_{645}) – 4.68 (A_{663}) x v / 1000 x w

Total chlorophyll = 20.2 (A_{645}) – 8.02 (A_{663}) x v / 1000 x w

Where, A= absorbance at specific wave lengths, V = Final volume of chlorophyll extract in 80 per cent acetone and W = Fresh weight of leaves extracted (g).

The results were expressed as chlorophyll mg g^{-1} of leaf tissues on fresh weight basis.

Cassava mosaic disease incidence was counted from infected plants in a plot. The cassava mosaic incidence was calculated by the formula.

$$\text{CMD incidence (\%)} = \frac{\text{No of plants infected}}{\text{Total no of plants/plot}} X\ 100$$

The yield of tubers is recorded at the time of harvest. The data recorded on various parameters were statistically analysed by applying the technique of analysis of variance suggested by Panse and Sukhatme [9].

3. RESULTS AND DISCUSSION

3.1 CMD Incidence (%)

The treatmentT_3 (Six budded setts from field grown plants) recorded the highest CMD incidence (49.97 %) and the least CMD incidence (2%) was recorded by T_1 (tissue cultured plants). Among the varieties, H-226 (V_1) recorded the higher CMD incidence (45.64%) and CO.2 (V_2) recorded the lesser CMD incidence as 12.16% (Table 1).

3.2 Dry Matter Content

A significant difference was observed among the treatments in the dry matter production of leaves, petioles, stem and tubers. Among the treatments, T_1 (tissue cultured plants) recorded the highest per cent dry matter content of leaves (36.58), petioles ((35.41), stem (37.51) and tuber (38.60) which was followed by T_3 (Six budded setts from normally field grown plants). Considering, the two varieties, CO.2 (V_2) recorded the highest per cent dry matter content of leaves (36.51), petiole (35.84) stem (37.58), tuber (38.81) and least per cent dry matter content of leaves (34.70), petiole (34.70), stem (36.11) and tuber (37.13) was observed in H-226 (V_1). The interaction between the treatments and the varieties revealed that T_1 (tissue cultured plants) along with CO.2 (V_2)

recorded higher per cent dry matter content of leaves (37.23), petiole (36.20), stem (38.11) and tuber (39.52 followed the minimum per cent dry matter content of leaves(33.65 per cent), petiole (33.79 per cent), stem (35.47 per cent) and tuber (36.62 per cent) was recorded by T_4V_1 (Two budded setts from field grown plants) along with H-226) (Table 2).

3.3 Physiological Parameters

Among the treatments, Tissue culture plants (T_1)recorded the highest Leaf Area Index (0.58), net assimilation rate (0.0541 mg cm^{-2} day^{-1}), RGR (7.39 mg g^{-1} day^{-1}) and CGR (18.01 g m^{-2} day^{-1}) followed by T_3, T_2 and T_4. The variety CO.2 (V_2) recorded the highest Leaf Area Index (0.58), net assimilation rate (0.0548 mg cm^{-2} day^{-1}), RGR (6.32 mg g^{-1} day^{-1}), CGR (18.22 g m^{-2} day^{-1}) followed by H-226(V_1). The interaction between treatments and cultivars showed that the highest Leaf Area Index (0.87) NAR (0.0793mg cm^{-2} day^{-1}) and RGR (7.80 mg g^{-1} day^{-1}) and CGR (18.67 g m^{-2} day^{-1}) was recorded in CO.2 and T_1 (tissue cultured plants) followed by H-226 along with T_4 (Two budded setts from field grown plants). Higher amount of chlorophyll 'a' (0.81mg g^{-1}), chlorophyll b (0.53 mg g^{-1}) and total chlorophyll content (1.40 mg g^{-1}) was observed in T_1 followed by T_3, T_2 and T_4. Among the two varieties, CO.2 (V_2) resulted in the highest chlorophyll 'a' content (0.84 mg g^{-1}), chlorophyll b (0.59 mg g^{-1}) and total chlorophyll content (1.47 mg g^{-1} which was followed by H-226(V_1). The interaction between varieties and treatments had significant influence on chlorophyll content. Among the interactions CO.2 (V_2) along with T_1 (tissue cultured plants)recorded the maximum content of chlorophyll 'a' (0.86 mg g^{-1}), chlorophyll 'b' (0.62 mg g^{-1}), total chlorophyll content (1.51 mg g^{-1}) (Table 3).

3.4 Yield

The treatmentT_1 (Tissue cultured plants) registered significantly higher tuber yield (5.6 kg/plant and 63.20 kg/plot) followed by T_3 (Six budded setts from field grown plants). Among the two varieties, CO.2 (V_2) gave a yield of 5.12 kg/ plant and 64.96 kg/plot when H-226 (V_1) gave (3.48 kg/ plant). Within the interaction effect, CO.2 (V_2) along with T_1 (Tissue cultured plants) gave the maximum tuber yield per plant (6 kg) and tuber yield per plot (70.22 kg) The lowest tuber yield per plant (3.4 kg)and yield per plot (43.80 kg) was recorded in H-226(V_1) along with T_4 (Two budded setts from field grown plants) (Table 4).

Table 1. Effect of different planting materials on Cassava Mosaic Disease (CMD) % in cassava

Treatment	90 DAT		180 DAT		270 DAT	
	V_1	V_2	V_1	V_2	V_1	V_2
T_1	1.10	0.00	2.20	0.90	3.00	1.00
T_2	21.33	1.01	22.43	2.50	23.30	3.33
T_3	45.50	10.45	55.20	15.50	78.33	22.33
T_4	44.90	10.33	49.90	15.22	77.93	22.01
Mean	18.20	5.44	33.43	8.53	45.64	12.16
SE±	0.19	0.22	0.44	0.52	1.01	1.18
CD at 5%	0.45	0.51	0.90	1.10	1.30	1.65

Table 2. Effect of different planting materials on Dry matter content (%) in cassava

Treatment	Leaves		Petiole		Stem		Tuber	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
T_1	35.94	37.23	34.62	36.20	36.92	38.11	37.68	39.52
T_2	34.23	36.12	33.91	35.81	35.83	37.47	36.90	38.39
T_3	34.84	36.81	34.13	36.01	36.23	37.92	37.33	39.19
T_4	33.79	35.90	33.65	35.33	35.47	36.85	36.62	38.15
Mean	34.70	36.51	34.07	35.84	36.11	37.58	37.13	38.81
SE±	0.19	0.22	0.12	0.18	0.15	1.17	0.13	0.19
CD at 5%	0.56	0.49	0.38	0.41	0.41	0.46	0.40	0.48

Table 3. Effect of different planting materials on physiological parameters (%) in cassava

Treatment	LAI		Net Assimilation Rate (mg cm^{-2} day^{-1})		Relative Growth Rate (mg g^{-1} day^{-1})		Crop Growth Rate (g m^{-2} day^{-1})		Chlorophyll 'a' (mg g^{-1})		Chlorophyll 'b' (mg g^{-1})		Total chlorophyll (mg g^{-1})	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
T_1	0.30	0.87	0.0438	0.0645	6.99	7.80	17.35	18.67	0.76	0.86	0.44	0.62	1.29	1.51
T_2	0.13	0.63	0.0388	0.0508	4.86	5.79	17.08	18.28	0.71	0.83	0.39	0.58	1.13	1.46
T_3	0.20	0.73	0.0411	0.0539	5.57	6.47	17.34	18.28	0.74	0.85	0.43	0.60	1.24	1.50
T_4	0.37	0.10	0.0224	0.0501	4.15	5.25	17.17	17.67	0.70	0.82	0.39	0.58	1.12	1.44
Mean	0.25	0.58	0.0365	0.0548	5.39	6.32	17.23	18.22	0.72	0.84	0.41	0.59	1.19	1.47
SE±	0.11	0.12	0.0030	0.0042	0.10	0.08	0.04	0.05	0.021	0.031	0.002	0.003	0.005	0.007
CD at 5%	0.16	0.20	0.0065	0.0091	0.14	0.19	0.08	0.12	0.047	0.066	0.004	0.006	0.010	0.015

Table 4. Effect of different planting materials on yield in cassava

Treatment	Number of tubers/plant		Tuber yield /plant (kg)		Tuber yield /plot (kg)		Tuber yield (t/ha.)	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
T_1	7.66	10.66	5.2	6	56.18	70.22	23.41	29.25
T_2	5.49	6.66	3.8	4.9	47.08	63.26	19.61	26.35
T_3	7.33	9.66	4.9	5.5	53.78	66.46	22.40	27.69
T_4	5.33	6.33	3.4	4.1	43.80	59.92	18.25	24.96
Mean	6.45	8.32	3.48	5.12	50.21	64.96	20.91	27.96
SE±	0.30	0.42	0.25	0.34	0.08	0.17	0.19	0.32
CD at 5%	0.64	0.91	0.52	0.70	0.20	0.24	0.31	0.47

4. CONCLUSION

Among the planting materials, tissue cultured plants showed least incidence of cassava mosaic disease and the cv. CO.2 had minimum incidence of cassava mosaic disease in plants. Among the four planting materials, tissue culture plants recorded the highest leaf area index, crop growth rate, net assimilation rate which may be attributed to the early vigorous growth and increased leaf area. The chlorophyll content increased in tissue culture plants compared to other planting materials. The plants raised from tissue cultured plants recorded significantly higher tuber yield which is due to the fact that tissue culture plants establish more quickly, grow more vigorously and taller, have a shorter and more uniform production cycle. The findings of this study, create awareness the farmers to use tissue cultured plants to produce higher yield and reduce mosaic disease incidence in cassava.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Tonukari NJ. Cassava and the future of starch. Electronic Journal of Biotechnology. 2004;7(1): 2.
2. FAO. FAO production year book; 2010.
3. Singh. Indian Vegetables. Anmol publications Pvt. Ltd.; 2008.
4. Pita JS, Fondong VN, Sangare A, Nape GWO, Orwal S, Fanquet CM. Recombination, pseudorecombination and synergism of geminivirus are determinant keys to the epidemic of severe cassava mosaic disease in Uganda. Journal of General Virology. 2001;82:655 – 665.
5. Faria RT, Illg RD. Micropropagation of *Zingiber spectabile* Griff. Scientia Horticulturae. 1995;62:135 - 137.
6. Watson DJ. Comparative physiological studies on the growth of field crops. I. Variation in net assimilation rate and lead area between species and varieties and within and between years. Ann. Bot. 195611:41 – 46.
7. Williams RF. The physiology of plant growth with special reference to the concept of net assimilation rate. Ann. Bot. 1946;10:41 - 71.
8. Yoshida S, Forno DA, Cock JH. Laboratory manual for physiology studies of rice. IRRI Publication, Philippines. 1971;36-37.
9. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. 2nd Edition, Indian Council of Agricultural Research, New Delhi; 1967.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/75872