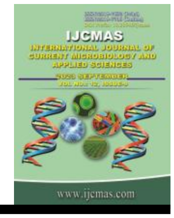
Int.J.Curr.Microbiol.App.Sci (2023) *12*(09): 33-38

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 12 Number 9 (2023)**
Journal homepage: http://www.ijcmas.com



Original Research Article https://doi.org/10.20546/ijcmas.2023.1209.004

Effect of Micronutrients on Growth, Tuber Yield and Quality of Cassava (*Manihot esculenta* Crantz)

Janaki Maradana[1]*, P. Ashok[2] and A. Pavani Priyanka[1]

[1]AICRP on Tuber Crops, Dr. YSRHU - Horticultural Research Station, Peddapuram, Kakinada - 533 437, Andhra Pradesh, India
[2]Horticultural Research Station, Dr. YSRHU - HRS, Venkataramannagudem, Andhra Pradesh, India

**Corresponding author*

A B S T R A C T

Cassava is one of the important tuber crops grown in marginal lands for its edible tuberous roots. Besides macro nutrient deficiencies, some micronutrient deficiencies are observed in cassava. To overcome those micronutrient deficiencies as well as to increase the cassava tuber yield and tuber quality, a field experiment was laid out during 2014-15, 2015-16 and 2016-17 at Dr. YSRHU - Horticultural Research Station, Peddapuram with eight treatments in randomized block design with three replications. The results revealed that the significant differences were observed between the treatments for all studied characters. The maximum plant height and stem girth were observed in T_7 (POP + $MgSO_4$ @ 20 kg ha^{-1} + $ZnSO_4$ @12.5 kg ha^{-1} + Borax @10 kg ha^{-1} @ 20 kg ha^{-1} + $FeSO_4$ (0.5 % stake dipping)). The maximum tuber yield per hectare and starch content were also recorded in T_7 with 42.59 t/ha and 27.63 per cent followed by T_6 (POP + $MgSO_4$ + $ZnSO_4$ + Borax) with 38.29 t/ha and T_5 (POP + $FeSO_4$ (0.5 % stake dipping) with 27.26 per cent respectively. The highest B:C ratio was recorded for T_7 whereas it was lowest for T_8 (Absolute control).

Keywords

Cassava, Micro nutrient, Growth, Tuber yield and starch content

Article Info

Received: 16 July 2023
Accepted: 22 August 2023
Available Online: 10 September 2023

Introduction

Cassava (*Manihot esculenta* Crantz) is also called as tapioca belongs to Euphorbiaceae family well known for its tuberous roots and sixth most important source of calories in the human diet. It is a perennial shrub and a tuberous root crop and is a native of Tropical America and was introduced from Brazil into India by the Portuguese in the 17th century (Suganya *et al.*, 2020). This crop has enormous potential for staple food, industries *viz.* sago, flour, starch, dextrin, confectionery, pharmaceutical, adhesives, explosives, paper, cookies, textile, bio ethanol, wood, bio-degradable bags) and animal feed. It is highly drought tolerant crop and can be successfully grown in marginal soils where many crops are not able to grow well and it is a rain fed crop not required regular irrigation and also most suitable crop for agency areas. This crop is grown in varied agro ecological environments and production systems ranging from highland densely populated regions to lowland drier areas prone to droughts or floods (Ugwu *et al.,* 2019). It requires minimum care during entire period of cultivation with application of recommended doses of fertilizers which tends to suitable crop for many small and marginal farming communities.

Cassava is highly responsive to manures and fertilizers including secondary and micronutrients (Susan John *et al.,* 2011). The micronutrients *viz.* Mg, Zn, B and Fe have play a vital role for growth and yield of cassava, which is generally grown in poor to marginal soils where micronutrient deficiency is common. The application of micronutrients in combination of Mg, Zn, B and Fe along with recommended doses of FYM and NPK had a positive effect on growth, yield and quality attributes of cassava rather than application of micro nutrients alone (Suganya *et al.,* 2020). When the plants suffer from malnutrition, they show symptoms of being unhealthy. Too little or too much of any one nutrient can show the deficiency or toxicity symptoms like stunted growth, reduced internodal length, chlorosis, yellowing of leaves, thin or thick stem, short petioles, inter venal chlorosis, small younger leaves *etc.* (Howeler, 1985). In cassava the micronutrients deficiencies such as iron, zinc, manganese, copper and boron are most common in soils of high pH values as the availability of these elements are decreased rapidly by precipitation or soil adsorption reactions which intensify at high pH values (Howeler *et al.,* 1982). The micronutrients are also required in small amount to enhance the actions of some enzymes which aid in the growth and yield of major food crops (Fageria *et al.,* 2002). So that, the application of micronutrients (iron, boron, manganese, zinc, copper, chlorine and molybdenum) along with primary nutrients (nitrogen, phosphorus, potassium) and secondary nutrients (sulfur, calcium, magnesium) is also very important for cassava to avoid the deficiencies as well as to carry out the their regular physiological processes and metabolisms (photosynthesis *etc.*), crop growth, highest tuber yield and tuber quality. Therefore, the present investigation was carried out to know the effect of different micronutrients and their combinations on growth, tuber yield and quality of cassava tubers.

Materials and Methods

The field experiment was laid out with short duration cassava variety (Sree Vijaya) to study the effect of micro nutrients on growth, tuber yield and quality of cassava tubers during 2014-15, 2015-16 (Dr. YSRHU - Horticultural Research Station, Venkataramannagudem) and 2016-17 (Dr. YSRHU - Horticultural Research Station, Peddapuram) with eight treatments in Randomized Block Design (RBD) with three replications. The treatment details *viz.* POP recommendation (NPK+FYM) specific to the location (T_1), POP + Soil application of $MgSO_4$ @ 20 kg ha^{-1} (T_2), POP + Soil application of $ZnSO_4$ @ 12.5 kg ha^{-1} (T_3), POP + Soil application of Borax @ 10 kg ha^{-1} (T_4), POP + $FeSO_4$ (0.5 % stake dipping) (T_5), POP + $MgSO_4$ @ 20 kg ha^{-1} + $ZnSO_4$ @ 12.5 kg ha^{-1} + Borax @ 10 kg ha^{-1} @ 20 kg ha^{-1} (T_6), POP + $MgSO_4$ @ 20 kg ha^{-1} + $ZnSO_4$ @ 12.5 kg ha^{-1} + Borax @ 10 kg ha^{-1} @ 20 kg ha^{-1} + $FeSO_4$ (0.5 % stake dipping) (T_7) and Absolute control (T_8). The soils are sandy loam soils with pH of 7.2. $MgSO_4$, $ZnSO_4$ and Borax were applied after top dressing of NPK fertilizers and within 2 months of planting of cassava. $FeSO_4$ was given as stake dipping for 15 minutes and foliar application (0.5% $FeSO_4$ solution) 3-4 times at weekly intervals on appearance of the symptoms.

The planting was taken up during third week of June and the harvesting was done during the third week of January. The setts of 20 cm length of short duration variety Sree Vijaya were prepared and treated with chemical solution of 2 ml of Dimethoate and 3 g Mancozeb for 5 min. and planted in raised nursery beds in side by side and watered regularly. The well rooted and sprouted setts were transplanted to well prepared main field after 7-8 days of planting at a spacing of 90 cm x 90 cm. The recommended dose of FYM @ 12.5 tonnes/ha and fertilizers of NPK @ 60:60:60 kg /ha in the form of urea, single super phosphate and murate of potash respectively were applied. Entire dose of P was applied as basal while N and K were applied in three equal splits @ 30, 60 and 90 DAP and the crop was raised as per the recommended package of practices.

Randomly selected three plants from each treatment were tagged in each replication and recorded the data for growth, yield, CMD and quality characters and the mean values were calculated. The observations studied *viz.* growth parameters (plant height (cm), stem girth (cm), no. of retained leaves, no. of fallen leaves) at 90, 180 DAP and at harvest; the yield & yield parameters (no. of tubers per plant, tuber length (cm), tuber girth (cm), tuber yield (t/ha)) at harvest and quality parameters (starch content (%) and HCN (ppm)). The data on various yield and quality parameters were analyzed by adopting the statistical methods of Panse and Sukhatme (1985).

The percentage of starch content was calculated by using the method outlined by Moorthy and Padmaja (2002). The hydrogen cyanide content (HCN) in tubers was estimated by the method given by Indira and Sinha (1969) and expressed in ppm.

Results and Discussion

Growth parameters

The pooled data (Table 1) over three years revealed that there are significant differences were observed between the treatments for plant height (3 MAP and at harvest), stem girth (6 MAP and at harvest), no. of retained leaves (at harvest) and rest of the characters were showed non-significant. Maximum plant height (59.63 cm @ 3 MAP, 188.46 cm @ 6 MAP and 222.51 cm at harvest) was observed in T_7 (POP + $MgSO_4$ @ 20 kg ha^{-1} + $ZnSO_4$ @ 12.5 kg ha^{-1} + Borax @ 10 kg ha^{-1} @ 20 kg ha^{-1} + $FeSO_4$ (0.5 % stake dipping)) which was on par with other treatments except T_8 at 3 MAP and followed by T_3 with 211.56 cm at harvest. Ugwu *et al.,* (2019) also reported the highest plant height with Fe application. The maximum stem girth was also observed in T_7 at 3 MAP (5 cm) and 6 MAP (8.39 cm) whereas T_6 has recorded the highest stem girth (9.51 cm) at harvest followed by T_7 with 9.43 cm. While the no. of retained leaves were highest in T_6 (POP + $MgSO_4$ @ 20 kg ha^{-1} + $ZnSO_4$ @ 12.5 kg ha^{-1} + Borax @ 10 kg ha^{-1} @ 20 kg ha^{-1}) at harvest with 155.46 leaves followed by T_7 with 142.13 leaves.

Yield and quality parameters

The pooled data (Table 2) over three years revealed that there are significant differences were observed between the treatments for all the studied characters. The number of tubers per plant were highest in T_7 with 9.58 tubers which is on par with T_1 (POP recommendation specific to the location) and T_6 with 8.28 tubers and 8.95 tubers respectively. The maximum tuber length was observed in T_6 with 35.79 cm which is on par with T_1, T_3 (POP + Soil application of $ZnSO_4$ @ 12.5 kg ha^{-1}) and T_7 with 32.45 cm, 32.29 cm and 32.29 cm respectively.

The tuber girth was also highest in T_6 (17.30 cm) which is on par with the rest of treatments except T_5 and T_8. The tuber yield per hectare was highest in T_7 with 34.33 t/ha which is on par with the T_6 with 32.06 t/ha. Similar results were also reported by Kanto *et al.,* (2011); Mousavi *et al.,* (2012) and Suganya *et al.,* (2020). The increased tuber yield was also associated with the corresponding significant increase in number of tubers per plant, tuber length and tuber girth (Suganya *et al.,* 2020).

The highest starch content was observed in T_7 with 28.28 per cent followed by T_5 (POP + $FeSO_4$ (0.5 % stake dipping)) with 27.42 per cent. These results are in conformity with earlier findings of Parkes *et al.,* (2012) and Suganya *et al.,* (2020). The HCN content was lowest in T_8 (Absolute control) with 68.25 ppm which is on par with the T_5 with 72.67 ppm. Magnesium fertilization significantly enhanced the production of tubers (9.4%) compared to the non-Mg supplemented treatment (Wang *et al.,* 2020).

Magnesium has played the key role in several biological processes *viz.* protein and chlorophyll synthesis, CO_2 fixation in photosynthesis, photophosphorylation, phloem loading, translocation of assimilates in leaves (Cakmak and Yazici, 2010), transportation of photosynthetic assimilates from leaves to sink organs (such as tuberous roots) and stored as starch (Lemoine *et al.*, 2013) to increase crop yield under sufficient Mg status (Laing *et al.*, 2000). Zinc is an essential element required for many enzymatic reactions (Fergeria *et al.*, 2010) and protein synthesis (Mousavi *et al.*, 2012). The zinc and iron are the essential elements for cassava growth, tuber yield and its quality as they have played an important role in balancing of crop nutrition (Mousavi *et al.*, 2011). Zinc is required for the activity of carbonic anhydrase and auxin (Indole acetic acid, IAA) biosynthesis whereas Fe is required for biosynthesis of chlorophyll and high photosynthetic rate (Suganya *et al.*, 2020). Appropriate sufficient supply of Fe fertilizer based on balanced nutrition may contribute to reducing cassava yield gaps thereby increase cassava root production (Kabata-Pendias, 2011).

Table.1 Effect of micro nutrients on growth parameters of cassava at 3 months after transplanting (MAT), 6 months after transplanting (6 MAP) and at harvest – Pooled data over 3 years (2014-15 to 2016-17)

Treatment	Plant height (cm)			Stem girth (cm)			No. of retained leaves			No. of fallen leaves		
	3 MAT	6 MAT	At harvest	3 MAT	6 MAT	At harvest	3 MAT	6 MAT	At harvest	3 MAT	6 MAT	At harvest
T_1	55.17	171.22	203.55	4.79	7.69	8.46	64.65	117.67	132.20	8.34	123.80	200.89
T_2	53.00	173.29	208.92	4.50	7.83	8.50	63.43	103.47	124.27	7.95	106.51	216.50
T_3	53.34	171.45	211.56	4.67	7.72	8.67	67.34	113.07	131.04	8.13	114.37	183.34
T_4	52.53	167.28	201.10	4.56	7.66	8.54	62.44	114.27	137.99	9.90	115.82	213.20
T_5	55.53	175.17	203.10	4.89	7.77	8.17	54.89	98.33	118.98	8.00	90.58	190.50
T_6	54.62	183.05	210.79	4.58	8.20	**9.51**	63.07	112.72	**155.46**	9.91	129.05	216.33
T_7	**59.63**	**188.46**	**222.51**	**5.00**	**8.39**	9.43	57.47	115.78	142.13	8.26	97.48	207.60
T_8	41.65	147.30	161.69	3.79	6.27	7.25	52.19	77.82	89.27	6.91	93.22	157.63
CD (P=0.05)	8.42	N/A	10.43	N/A	0.60	0.43	N/A	N/A	18.12	N/A	N/A	N/A
SE(d)	3.89	10.62	4.82	0.33	0.28	0.20	6.03	12.35	8.37	1.05	13.70	20.41
C.V.	8.95	7.55	2.91	8.68	4.42	2.84	12.17	14.18	7.95	15.21	15.41	12.61

Table.2 Effect of micro nutrients on yield parameters of cassava – Pooled data over 3 years (2014-15 to 2016-17)

Treatment	No. of Tubers / plant	Tuber length (cm)	Tuber girth (cm)	Tuber yield (t/ha)	Starch (%)	HCN (ppm)
T_1	8.28	32.45	17.27	28.35	26.07	90.21
T_2	6.88	31.68	16.04	26.82	24.92	91.85
T_3	7.66	32.29	16.46	27.67	26.76	97.58
T_4	7.72	28.92	15.86	29.54	26.59	78.89
T_5	7.80	30.23	15.44	26.77	27.42	72.67
T_6	8.95	**35.79**	**17.30**	32.06	25.60	90.32
T_7	**9.58**	32.29	17.11	**34.33**	**28.28**	82.76
T_8	5.19	27.00	13.00	16.09	25.00	**68.25**
C.D.	1.60	3.98	1.82	4.61	0.65	10.08
SE(d)	0.74	1.84	0.84	2.13	0.30	4.66
C.V.	11.63	7.18	6.43	9.41	1.40	6.78

Table.3 Economics of micro nutrient studies in Cassava

S. No.	Treatment details	B:C ratio
1	T_1 : POP recommendation (NPK+FYM) specific to the location	1.56
2	T_2 : POP + Soil application of $MgSO_4$ @ 20 kg ha^{-1}	1.83
3	T_3 : POP + Soil application of $ZnSO_4$ @ 12.5 kg ha^{-1}	1.54
4	T_4 : POP + Soil application of Borax @ 10 kg ha^{-1}	1.99
5	T_5 : POP + $FeSO_4$ (0.5 % stake dipping)	1.96
6	T_6 : POP + $MgSO_4$ @ 20 kg ha^{-1} + $ZnSO_4$ @ 12.5 kg ha^{-1} + Borax @ 10 kg ha^{-1} @ 20 kg ha^{-1}	1.93
7	T_7 : POP + $MgSO_4$ @ 20 kg ha^{-1} + $ZnSO_4$ @ 12.5 kg ha^{-1} + Borax @ 10 kg ha^{-1} @ 20 kg ha^{-1} + $FeSO_4$ (0.5 % stake dipping)	**2.23**
8	T_8 : Absolute control	0.91

B: C Ratio

Among the eight treatments, T7 (POP + $MgSO_4$ @ 20 kg ha^{-1} + $ZnSO_4$ @ 12.5 kg ha^{-1} + Borax @ 10 kg ha^{-1} @ 20 kg ha^{-1} + $FeSO_4$ (0.5 % stake dipping)) has recorded the highest B : C ratio with 2.23 (Table 3) followed by T_4 (1.99), T_5 (1.96) and T_6 (1.93). Among the eight treatments, the tuber yield per hectare was highest in T_7 (POP + $MgSO_4$ @ 20 kg ha^{-1} + $ZnSO_4$ @ 12.5 kg ha^{-1} + Borax @ 10 kg ha^{-1} @ 20 kg ha^{-1} + $FeSO_4$ (0.5 % stake dipping)) with 34.33 t/ha which is on par with the T_6 (POP + $MgSO_4$ @ 20 kg ha^{-1} + $ZnSO_4$ @ 12.5 kg ha^{-1} + Borax @ 10 kg ha^{-1} @ 20 kg ha^{-1}) with 32.06 t/ha. The highest starch content was also observed in T_7 with 28.28 per cent. Therefore, the soil application of FYM @ 12.5 t/ha, N:P:K @ 60:60:60 kg/ha (POP) along with $MgSO_4$ @ 20 kg ha-1, ZnSO4 @ 12.5 kg ha^{-1}, Borax @ 10 kg ha^{-1} @ 20 kg ha^{-1} and $FeSO_4$ (0.5 % stake dipping) can be recommended for getting highest tuber yield and highest starch content besides alleviating micronutrient deficiency.

References

Cakmak, I. and Yazici, A. M. 2010. Magnesium: a forgotten element in crop production. *Better Crops*. 94: 23–25.

Fageria, N. K., Baligar, V. C. and Clark, R. B. 2002. Micronutrients in crop production. *Advances in agronomy*. 77: 185-268. https://doi.org/10.1016/S0065-2113(02)77015-6

Fageria, N. K., Baliger, V. C. and Jones, C. A. 2010. Growth and mineral nutrition of field crops. CRC Press, Florida. https://doi.org/10.1201/b10160

Howeler, R. H. 1985. Mineral nutrition and fertilization of cassava. (In) *Cassava: Research Production and Utilization). Technical Report*, UNDP-CIAT Cassava Program, Cali, Colombia. pp. 249–320.

Howeler, R., Edvards, D. G. and Asher, C. J. 1982. Micronutrient deficiencies and toxicities of cassava plants grown in nutrient solutions. I. Critical tissue concentrations. *J. Plant Nut.* 5(8): 1059- 1076. https://doi.org/10.1080/01904168209363038

Indira, P. and Sinha, S. K. 1969. Calorimetric method for determination of HCN in tubers and leaves of cassava. *Indian Jounal of Agricultural Science*. 39(11): 1021-1023.

Kabata-Pendias, A. 2010. Trace Elements in Soils and Plants, 4th Edition, Taylor & Francis Group, Boca Raton London New York. https://doi.org/10.1201/b10158

Laing, W., Greer, D., Sun, O., Beets, P., Lowe, A. and Payn, T. 2000. Physiological impacts of Mg deficiency in Pinus radiata: growth and photosynthesis. *New Phytol*. 146: 47–57. https://doi.org/10.1046/j.1469-8137.2000.00616.x

Lemoine, R., Sylvain La, C., Rossitza, A., Fabienne, D., Thierry, A., and Nathalie, P. 2013. Source-to-sink transport of sugar and regulation by environmental factors. *Front.*

Plant Sci. 4: 272–292. https://doi.org/10.3389/fpls.2013.00272

Moorthy, S. N. and Padmaja, G. 2002. A rapid titrimetric method for the determination of starch content in cassava tubers. *J. Root Crops*. 28: 30-37.

Mousavi, S. R., Shanhsavari, M. and Rezaei, M. 2011. A General overview on manganese (Mn) importance for crops production. *Aust. J. Basic & Appl. Sci.* 5(9): 1799-1803.

Mousavi, S. R., Galavi, M. and Rezaei, M. 2012. The interaction of zinc with other elements in plants: a review. *Intl J Agr. Cro. Sci.* 4(24): 1881-1884.

Panse, V. G. and Sukhatme, P. V. Statistical methods for agricultural workers. ICAR, New Delhi. 1985, pp. 134-192.

Parkes, E. Y., Allotey, D. F. K., Lotsu, E. and Akuffo, E. A. 2012. Yield performance of five cassava genotypes under different fertilizer rates. *Inte. J. Agric. Sci.* 2(5):173-177.

Suganya, S., Jegadeeswari, D. and Chitdeshwari, T. 2020. Tuber Yield and Starch Content as Influenced by Different Grades of Micronutrient Mixture at Different Levels in Cassava under Irrigated Condition. *Int.J.Curr.Microbiol.App.Sci.* 9(05): 3140-3147. https://doi.org/10.20546/ijcmas.2020.905.372

Susan, K. J., Ravindran, C. S., Suja, G., Prathapan, K., Naskar, S. K. and James, G. 2011. Response of cassava to zinc: Two decades experience in an Ultisol of Kerala, India. *In*: Extended Abstracts, 3rd International Zn Symposium, Hyderabad, India, 10-14 October, 2011, pp. 27-28.

Kanto, U., KanapolJutamanee, Osotsapar, Y., Sukanya, J. and Chongrak, K. 2011. Effect of Swine Manure Extract by Foliar application and Soil drenching on Dry matter and Nutrient uptake of Cassava. *Kasetsart J.* 45: 995-1005.

Ugwu, C. C., Eteng, E. U. and Asawalam, D. O. 2019. Evaluation of cassava yield response to iron rates grown in a tropical rain forest soils of South-eastern Nigeria. Direct *Research Journal of Agriculture and Food Science.* Vol.7 (8): 229-235. https://doi.org/10.5281/zenodo.3370228

Wang, Z., Mahmood Ul Hassan, M. U., Nadeem, F., Wu, L., Zhang, F. and Li, X. 2020. Magnesium Fertilization Improves Crop Yield in Most Production Systems: A Meta-Analysis. *Frontiers in Plant Science*. 10:1727 (1-10). https://doi.org/10.3389/fpls.2019.01727

How to cite this article:

Janaki Maradana, P. Ashok and Pavani Priyanka, A. 2023. Effect of Micronutrients on Growth, Tuber Yield and Quality of Cassava (*Manihot esculenta* Crantz). *Int.J.Curr.Microbiol.App.Sci.* 12(09): 33-38.
doi: https://doi.org/10.20546/ijcmas.2023.1209.004