e-ISSN:2706-6800

Response of stored INIAP 650 cassava stems to the application of biostimulants in Santa Ana, Manabí.

Respuesta de varetas de yuca del cultivar INIAP 650 almacenadas a la aplicación de bioestimulantes en el cantón Santa Ana, Manabí

Agustín Álvarez Plúa [1]
María Elena Baque [2]
Washington Narvaez Campana [3]
Fernando Ayón Villao [4]
Julio Gabriel-Ortega [5]

Abstract: With the objective of evaluating the response of cassava (*Manihot esculenta* Crantz) to three storage periods and two biostimulants, an investigation was implemented in the Santa Ana canton of the Manabí province in a completely randomized block experimental design with a 3 x 3 factorial arrangement with three replications and nine treatments, corresponding to factor A: Biostimulants (A1: No biostimulants, A2: biol and A3: leachate) and factor B: Storage (B1: 30, B2: 60 and B3: 90) days. The variables evaluated were number of shoots, percentage of shoots, shoot height (cm), shoot diameter (cm), leaf length (cm), number of roots, root weight (g), root length (cm). The results showed that in the single and main effects the best biostimulant was leachate with an average of 14.26 (cm) for root length. In factor B (storage), the best time to store the cassava rods was 30 and 60 days. It is worth noting that at 30 days, an average of 9.89 was obtained for number of shoots, 98.89% percentage of shoots, 5.28 cm number of shoots, 18.39 (g) root weight, 12.46 (cm) root length. However, a strong interaction was observed between biostimulant factors and days of storage (30 and 60 days) for the variables shoot height, number of shoots, root length and root weight.

Key words: Incidence, storage, sprouting, multiplication, quantitative variables.

Resumen: Con el objetivo de evaluar la respuesta de las varetas de yuca (*Manihot esculenta* Crantz) a tres épocas de almacenamiento y dos bioestimulantes, se implementó una investigación en el cantón Santa Ana de la provincia Manabí en un diseño experimental de bloques completamente aleatorios con arreglo factorial 3 x 3 con tres repeticiones y nueve tratamientos, que corresponde al factor A: Bioestimulantes (A1: Sin bioestimulantes, A2: biol y A3: lixiviado) y el factor B: Almacenamiento (B1: 30, B2: 60 y B3: 90) días. Las

Published
Edwards Deming Higher Technological Institute. Quito - Ecuador

Periodicity
April - June
Vol. 1, Num. 25, 2025
pp. 54-64
http://centrosuragraria.com/index.php/revista

Dates of receipt
Received: January, 2024
Approved: March 5, 2025

Correspondence author
agustin.alvarez @unesum.edu.ec

[1] Mg. Universidad Estatal del Sur de Manabí, Jipijapa, Ecuador. agustin.plua@unesum.edu.ec, https://orcid.org/0000-0003-0176-1314
[2] Agricultural Engineer, Universidad Estatal del Sur de Manabí, Jipijapa, Ecuador. maria.baque@unesum.edu.ec, https://orcid.org/0009-0009-2907-7689
[3] Mg. Universidad Estatal del Sur de Manabí, Jipijapa, Ecuador. washington.narvaez@unesum.edu.ec, https://orcid.org/ 0000-0002-6674-2088
[4] Mg. Universidad Estatal del Sur de Manabí, Jipijapa, Ecuador. fernando.ayon@unesum.edu.ec, https://orcid.org/0000-0003-4772-9344
[5] Phd. Universidad Estatal del Sur de Manabí, Jipijapa, Ecuador. julio.gabriel@unesum.edu.ec, http://orcid.org/0000-0001-9776-9235

variables evaluadas fueron número de brotes, porcentaje de brotes, altura de brotes (cm), diámetro de brotes (cm), largo de hoja (cm), número de raíces, peso de raíces (g), longitud de raíces (cm). Los resultados mostraron que en los efectos simples y principales el mejor bioestimulante fue el lixiviado con un promedio de 14,26 (cm) para longitud de las raíces. El factor B (almacenamiento), el mejor tiempo para almacenar las varetas de yuca fueron a los 30 y 60 días. Cabe resaltar que a los 30 días, se obtuvo un promedio de 9,89 para número de brotes, 98,89% porcentaje de brotes, 5,28 cm número de brotes, 18,39 (g) peso de raíces, 12,46 (cm) longitud de raíces. Sin embargo se observó una fuerte interacción entre los factores bioestimulantes y días de almacenamiento (30 y 60 días) para las variables altura de brote, número de brotes, largo de raíz y peso de raíz.

Palabras clave: Incidencia, almacenamiento, brotes, multiplicación, variables cuantitativas.

Introduction

Cassava is native to South America, as it has been domesticated for more than 5000 years and is currently cultivated extensively in tropical and subtropical areas around the world (Paredes *et al.*, 2022). Suarez and Mederos (2011) mention that its genetic center of origin is in the Amazon Basin and indicate that the scientific name of cassava was originally given by Crantz in 1766. In Ecuador, about 96 210 t are produced, of which 8 502 t correspond to the province of Manabí according to official data from the National Institute of Statistics and Census (INEC, 2023). In addition, it can be indicated that cassava cultivation is widespread nationwide, with the provinces of greatest production being Manabí, Cotopaxi, Santo Domingo de los Tsachilas, Los Ríos, Esmeraldas, Pichincha, Guayas, Loja and Morona Santiago (Corozo, 2020). The quality of yucca "seed" depends on its maturity, thickness, number of buds per stake and size. While Arismendi (2001) mentions that the selection of the cassava sticks for planting, those of good thickness should be selected, because they resist adverse weather conditions for a longer time and guarantee a good percentage of "germination", on the other hand, more vigorous cassava plants are obtained. To avoid mechanical damage and rubbing between the stem bundles and not to generate bud damage, they should be stored in the following way; in vertical position and verify the tropism of the buds that should point upwards in the same position as it grows in the field, therefore, in this way the loss of planting material by sprouting is reduced (Rodriguez *et al.*, 2021). During the storage of the rods there

are some problems such as dehydration, bud re-sprouting and attack by some pests, so, to avoid losses, a part of the crop can be left unharvested and the branches can be placed in a vertical position inside, therefore, the appropriate environment for this process is the one generated by the plantation itself (Rodriguez, 2021). Valverde-Lucio *et al.* (2020) describes that "Biostimulants are formulated products of biological origin that improve plant productivity". Biostimulants have the potential to act on plant physiology through different nutrient pathways to improve crop vigor, yields, quality and shelf life, post-harvest conservation (Tarazona, 2020). In the province of Manabí and especially in the canton of Santa Ana, cassava is grown by small farmers with low economic income, because it is produced in poor soils or marginal lands, so they use as planting material, stems (pieces of stems), in many cases are fresh and in others have a long storage period, whose sprouting is significantly affected, thus causing a decrease in the number of plants at the field level. Ortega & Velásquez (2006), indicate that farmers store whole cassava stems in bundles and put them in the shade, in order to avoid dehydration until the moment of planting. Therefore, inadequate storage causes to the planting material, loss of germination power, vigor, weight of the stems, bud sprouts, presence of pests, diseases and dehydration of the cuttings, added to the negative effect of abiotic factors that exert on the stored stems, which ultimately causes a decrease in the quality of the stems. Therefore, the objective of this research was to evaluate the response of cassava (*Manihot esculenta* Crantz) stems to three storage periods and two biostimulants.

Methodology

Location

The research was carried out on the slope of the Santa Ana canton, province of Manabí (PDyOT, 2015). Most of the canton is located in the very dry tropical bioclimatic zone, with a temperature that ranges between 18 and 22ºC and has an average annual rainfall of 711.8 mm

Study factors

The research was bifactorial. The study factors were: Factor A: biostimulants and Factor B: days of storage.

entrosur e-ISSN:2706-6800
INSTITUTO TECNOLÓGICO CORPORATIVO EDWARDS DEMING®

Treatments

The treatments were: biostimulants (A1: no biostimulants, A2: biol and A3: bovine manure leachate) in three storage periods (B1: 30, B2: 60 and B3: 90 days).

Statistical analysis

The research was implemented in a completely randomized block experimental design in a 3 x 3 factorial arrangement with three replications and nine treatments (Gabriel *et al*., 20 22).

On the basis of the defined model, analyses of variance were performed to test hypotheses about fixed effects, as well as comparisons of treatment means using Tukey's test at 5%. The analysis of variance was also used to estimate the variance components for the random effects. The indicated analyses were performed in Infostat software (InfoStat, 2020).

Study variables

The following variables were evaluated: number of shoots (NDB), percentage of shoot bud break (PDB), shoot height (ADB), shoot diameter (DDB), leaf length (LDH), root weight (PDR) and root length (LDR). The study variables were evaluated at three storage dates: 30 days, 60 days and 90 days. Once the rods were treated with biostimulants and without biostimulants, they were stored as 1 m rods in groups or bundles of 10 stems, and then cut at 20 cm and transplanted in polyethylene plastic bags for later evaluation.

Research management

The land was prepared where the 1 m long sticks were stored, then the selection of the cassava sticks was made, and then the container was prepared with the biostimulants for the immersion of the sticks. The substrate was also prepared with local soil, sand and organic matter in a 2:1:1 ratio, for filling the bags, in which the cassava rods were planted, and in which the irrigation and weed control was carried out every 15 days.

Results

The analysis of variance (Table 1) for simple factors such as Factor A showed highly significant differences ($P<0.01$) for LDR. For Factor B (Storage) there were highly significant differences ($P<0.01$) for NDB, PDB, ADB and PDR; and significant differences ($P<0.05$) for LDH,

Table 1. *Analysis of variance for morpho-agronomic characters of cassava.*

Fv	gl	Mean squares							
		NDB	PDB	AD	DD	LDH	NDR	PDR	LDR
Rep	2	1,37	137,04	0,18	0,00	8,35	1,21	0,14	19,96
Factor A	2	2,48	248,15	0,31	0,00	14,84	1,36	0,03	62,45**
Factor B	2	15,59**	1559,26**	12,66**	0,05**	38,93*	11,05*	4,39**	16,79*
A x B	4	1,43	142,59	0,16	0,01	1,89	38,88**	1,05	26,14**
Error	16	1,83	182,87	0,36	0,01	6,44	21,31	0,54	2,71
Total	26								
CV		14,9	14,9	20,04	27,95	31,41	26,03	20,86	14,29

*: Significant at P<0.05, **: Highly significant at P<0.01, Ns: Not significant. NDB: Number of shoots, PDB: Percentage of sprouting, ADB: Shoot height (cm), DDB: Shoot diameter (cm), LDH: Leaf length (cm), NDR: Number of roots, PDR: Root weight (g), LDR: Root length (cm).

NDH and LDR. The interaction showed highly significant differences (P<0.01) for NDR and LDR. Coefficients of variance (CV%) ranged from 15 to 28%.

The analysis of means by Tukey determined that there were interactions of the evaluated factors, so that the simple and main effects are no longer significant. In this study it was observed that there were significant differences (P<0.05) for the interactions in the ADB, NDB, LDR and PDR; where the best treatment for ADB was the interaction A0B3 (23.52 cm), for NDB the best treatment was for A0B1 (7.85), for LDR and PDR the best interaction was for A2B1 with 21.67 cm and 17.77 g respectively.

The simple and main effects of Factor B (days of storage) for the variables NDB, PDB, and LDH, showed significant differences (P<0.01) for 30 days with 9.89 shoots and 9.78 shoots, respectively; and, for the 60 days with 9.78 shoots and 97.97%, respectively. For the LDH variable, the best response was obtained with the 60-day treatment with 10.20 cm.

Table 2. *Mean analysis of morphological variables evaluated.*

Bistimulants	NDB	PDB	ADB	DDB	LDH	NDB	LDR	PDR
Factor A	**N.S**	**N.S**	**N.S**	**N.S**	**N.S**	**N.S**	**N.S**	*
With Biol	9,67	96,67	10,36	0,36	8,5	4,18	13,78	9,00 c
Without biostimulant	9,89	88,89	11,12	0,41	7,76	4,73	12,61	11,31 b
Leachate	8,67	86,67	8,4	0,33	6,99	4,39	13,24	14,26 a
DSH	1,65	16,45	6,77	0,21	3,09	1,4	6,49	2,00
factor B	*	*	*	**N.S**	**	**	**	*
30 Days	**9,89 a**	**98,89 a**	7,63 b	0,40	8.01 ab	5,28a	18,39 a	12,46a
60 days	**9,78 a**	**97,97 a**	19,14 a	0,41	**10,20 a**	3,74b	12.47ab	12,15a
90 Days	7,56 b	75,56 b	3,13 b	0,3	6,04 b	4.28ab	8,78 b	9,96b
DSH	1,65	16,44	7,77	0,21	3,09	1,40	6,49	2,00
Interaction	**N.S**	**N.S**	**	**N.S**	**N.S**	**	**	**
A0B1	10,00	100,00	3,72b	0,41	6,97	**7,85a**	18.83ab	9,94c
A0B2	10,00	100,00	2,70b	0,44	10,75	2,67b	11.67ab	11.44bc
A0B3	6,67	66,67	**23,52a**	0,38	5,55	3,67b	7.33 ab	12.56 bc
A1B1	10,00	100,00	8.59 ab	0,3	9,49	3,33 b	14.67 ab	9,66 c
A1B2	10,00	100,00	18.82 ab	0,42	11,05	4,22b	11.67 ab	9,11 c
A1B3	9,67	97,97	3,72 b	0,31	7,95	5.00 ab	14.00 ab	8,20 c
A2B1	9,33	93,33	7,17 b	0,50	7,56	4.67ab	**21,67 a**	**17,77 a**
A2B2	9,00	90,00	15.09 ab	0,37	8,58	4,33b	13.07ab	15.88 ab
A2B3	7,00	70,00	2,69 b	0,22 a	4,61	4,17 b	5,00 b	9,11 c
DSH	3,90	39,28	16,17	0,51	7,37	3,35	15,5	4,78

*= Significant at 5%, **=Highly significant 1%, NS= Not significant. NDB: Number of shoots, PDB: Percentage of sprouting, ADB: Shoot height (cm), DDB: Shoot diameter (cm), LDH: Leaf length (cm), NDR: Number of roots, PDR: Root weight (g), LDR: Root length (cm).

In the present investigation, it was observed that the application of biostimulants contributed to improve root length; vermicompost leachate and bovine manure were the best treatments. Results agree with those reported by Veobides et al., (2023), who found that basil plants treated by foliar spray with dilutions of vermicompost humic

extract (VHE) of bovine manure and subjected to low water supplies, favorably stimulated root length under abiotic stress conditions. Perez (2018), on the other hand, found that the application of vermicompost humic acids to rice (Oriza sativa L.) plants produced a significant increase in root length under water stress conditions.

In the research carried out by Moncayo (2022), he agrees with regard to the variable root length, where higher average values were obtained with the application of biostimulants, obtaining in the first range of significance treatment 1 or biol 1 at a dose of 1 (B1D1), in the second range treatment 4 (B2D1), for the third range of significance treatment 7 (B3D1), in the fourth range treatment 0 or control, in the fifth range treatment 2 (B1D2), in the sixth range treatment 3 (B1D3), in the seventh range treatment 3 (B1D3), in the seventh range treatment 5 (B2D2) and treatment 6 (B2D3), in the fifth rank treatment 2 (B1D2), in the sixth rank treatment 3 (B1D3), in the seventh rank of significance treatment 5 (B2D2) and treatment 6 (B2D3), while in the last level treatments 8 and 9, (B3D2) and (B3D3), respectively, therefore the best result was obtained as treatment 1 (B1D1) or biol 1 prepared based on 10 % of dry matter at a dose 1 of 10 % biol 1 and 90 % of water with a length of 27.67 cm.

However, significant increases were also observed for number of shoots, percentage of shoot shoot shoot, number of roots and root length. The best treatments were at 30 and 60 days, with a root weight of 18.39 g. Dalmacio (2020) ratified the mentioned results when he applied 2.0 liters of biol and 0.5 liters fertigation, every 14 days, obtaining 406 g beets and indicated that it is the best natural fertilizer and the cheapest in the world with which good results are obtained, The most important aspect of the generation of this methodology was the use of organic fertilizers because it allowed improving the crop diameter, using the appropriate doses of bistimulants, because they complement the nutritional requirements of the crop.

In the study on cassava, in the variable percentage of sprouts, significant differences were observed at 30 and 90 days after the application of biostimulants with respect to those studied by Gómez (2022), which showed that the number of sprouts was higher when using 25 L/ha of humic acids, reaching a height of 3.67 meters, and the treatment without control in the number of sprouts and using 0 L/ha of humic acids reached 3.42 meters,67 meters and the treatment without control in the number of shoots and using 0 L/ha of humic

entrosur e-ISSN:2706-6800
INSTITUTO TECNOLÓGICO CORPORATIVO EDWARDS DEMING®

acids 3.42 m being statistically different from all the others, the treatments where control was exercised on the number of shoots presented the best yields, except for the treatment without control in the number of shoots applying 25 L/ha of humic acids that also showed the highest values.

On the other hand, Vasquez (2011), explains that the response to the addition of biol is direct, since the higher the dose of foliar organic fertilizer, the greater the positive response for the agronomic characteristics evaluated, with a concentration of 25% (2.5 liters of Biol plus 7.5 liters of water), and is an alternative foliar organic fertilizer for the production of green matter forage and cassava dry matter.

While, Rojas et al., (2019), in their research achieved favorable results in the use of biostimulants such as bovine biol at 5%, bovine biol at 10% and earthworm leachate at 50% with yields of 18.00 t ha-1, 15.72 t ha-1 and 16.44 t ha-1 respectively, suggesting that they are an alternative for foliar applications for cassava crop.

Conclusions

The biostimulants have an effect on the variables studied, with vermicompost leachate having the best effect on root length. As for the best storage times for the rods, they were 30 and 60 days, which allowed quality rods with a greater possibility of rooting.

References

Arismendi, L. (2001). Cultural practices, storage and processing of the cassava crop Manihot esculenta Crantz. In: Associate professor promotion work. Universidad de Oriente. School of Agronomic Engineering. 2nd Ed. Caracas Venezuela: Jusepín. Retrieved from file:///C:/Users/HP/Downloads/Dialnet-InvestigacionSobreElCultivoDeLaYucaManihotesculent-2221453.pdf.

Corozo, L. Héctor, E. Macías, F. Vásquez, B. Pinargote, B. Cobeña, G. Mendoza, A. & Arteaga, F. (2020). Micropropagation of two Ecuadorian varieties of cassava (*Manihot esculenta* CRANTZ). Technical University of Manabí, Portoviejo, Ecuador.

Dalmacio, C. C. T. (2020). Biol Dosage and Fertigation with Efficient Microorganisms on the yield of Beetroot (*Beta vulgaris* L.), in Edaphoclimatic Conditions of Cáhuac-Yarowilca 2019. [Thesis, Universidad Nacional Hermilio Valdizán]. https://hdl.handle.net/20.500.13080/6181

Gabriel, J., Valverde, A., Indacochea, B., Castro, C., Vera, M., Alcívar, J. & Vera, R. (2022). Experimental designs: Theory and practice for agricultural experiments (2nd Ed.). Editorial MAWIL, Universidad Estatal del Sur de Manabí. Quito, Ecuador. https://doi.org/10.26820/978-9942-602-26-8

Gómez M.D. (2022). Effects of sprout number management and humic acid application on growth and yield in cassava crop; [Thesis, Universidad Rafael Landívar]. http://recursosbiblio.url.edu.gt/tesisjcem/2014/06/17/Gomez-Marcos.pdf

InfoStat (2020). Software for statistical analysis. https://www.infostat.com.ar/

INEC (2018). Statistics of cassava production and planting areas in Manabí. Informe Técnico de Estadística de Siembra y Producción de yuca en Manabí. National Institute of Statistics and Census (INEC), Quito, Ecuador.

Moncayo, E. G. (2022). Effect of rabbit manure biol on the development of hydroponic green forage of maize (*Zea mays* L.) [Thesis, Universidad Central del Ecuador]. http://www.dspace.uce.edu.ec/handle/25000/27060

Ortega, E., & Velásquez, E. (2006), Guía para la producción de semillas asexual de yuca, Obtención y manejo de estacas de calidad para la producción integral de yuca. Research Fonaiap-Research Center. Agropecuarias del Estado Monagas, Maturin. ISBN: 980-318-044-4. http://www.sian.inia.gob.ve/FonaiapDivulga/fd53/yuca.htm

Paredes, N., Lima, L. V., Caicedo, c., Fernández, F., Subia, C., Tinoco, L., & Monteros-Altamirano, A. (2022). *Guia para la producción y manejo integrado del cultivo de yuca para la amazonia ecuatoriana.* Ecuador: First Edition, 2021

©Ministerio de Agricultura y GanaderíaAv. Amazonas y Eloy Alfaro.

Perez, J.J.R. (2018). Effect of a natural biostimulant as a salt stress attenuator in basil (Ocimum basilicum L.) varieties.; Available from: http://dspace.cibnor.mx:8080/handle/123456789/2183

Rodríguez E, Garavito L, Cardona O, Germán G, & Cañar D. (2021) Technical manual for mass propagation of cassava vegetative seed by mini cuttings in the field. (Colombia): agrosavia, 2021.Pag, 18.

Rodríguez, E. G. (2021). Technical manual for mass propagation of cassava vegetative seed by mini cuttings in the field. Mosquera, Colombia: AGROSAVIA.MAGAZINE???VOLUME, NUMBER AND PAGES MISSING.

Rojas, P. F. (2019). Evaluation of liquid organic fertilizers in cassava (Manihot esculenta Crantz) AND castella bean [Vigna unguiculata (L.) Walp] crops. [Thesis, Institution for Teaching and Research in Agricultural Sciences]. http://hdl.handle.net/10521/4210

Suárez, L., & Mederos, V. (2011). Notes on the cultivation of cassava (Manihot esculenta Crantz). Current trends. Cultivos Tropicales, 2011, vol. 32, no. 3, p. 27-35. ISSN 0258-5936

Tarazona, A. (2020). Biostimulants: What they are and what they are used for. Retrieved from https://www.antoniotarazona.com/bioestimulantes-que-son-y-para-que- sirven/

Valverde-Lucio, Y., Moreno-Quinto, J., Quijije-Quiroz, K., Castro-Landín, A., Merchán-García, W., & Gabriel-Ortega, Julio. (2020). Biostimulants: An innovation in agriculture for coffee (*Coffea arabica* L) cultivation. *Journal of the Selva Andina Research Society*, *11*(1), 18-28. http://www.scielo.org.bo/scielo.php?script=sci_arttext&pid=S2072-92942020000100003&lng=es&tlng=es.

Vásquez, D. J. (2011) Evaluation of four doses of biol (foliar organic fertilizer) and its effect on the agronomic characteristics of cassava (Manihot esculenta) forage, clone piririca in the Zungarococha farm. [Thesis, Universidad Nacional de la Amazonia Peruana].

https://repositorio.unapiquitos.edu.pe/bitstream/handle/20.500.12737/1856/Jos%c3%a9_Caratula_Titulo_2011.pdf?sequence=3&isAllowed=y

Veobides-Amador, H., Guridi-Izquierdo, F., Cartaya-Rubio, O., Vázquez-Padrón, V., Alarcón-Santos, O. A., & Martínez-Balmori, D. (2023). Effect of a vermicompost extract on Lactuca sativa L. grown under low water supplies. Tropical Crops, 43(2), 09.

entrosur e-ISSN:2706-6800

INSTITUTO TECNOLÓGICO CORPORATIVO EDWARDS DEMING®