Technical note

Effect of nitrogen fertilization on corn cultivation in La Carlota, Balzar canton, Ecuador

Efecto de la fertilización nitrogenada en el cultivo de maíz, La Carlota, cantón Balzar, Ecuador

Efeito nitrogen fertilization em milho em La Carlota, cantão de Balzar, Equador

Klever Fernando Cevallos Cevallos
Leontes Leônidas Zambrano Barcos*
Dioselina Clemencia Navarrete Chevez
Juana Estefanía Cisneros Fariño
Marcos Paul Chila Zambrano
José Antonio Burgos Cevallos

La Universidad Agraria del Ecuador Av. 25 de Julio y Pío Jaramillo, Guayaquil, Ecuador

Received: 13-10-2025
Accepted: 10-01-2026
Published: 30-01-2026

Rev. Fac. Agron. (LUZ). 2026, 43(1): e264312
ISSN 2477-9407
DOI: https://doi.org/10.47280/RevFacAgron(LUZ).v43.n1.XII

Crop production
Associate editor: Dr. Jorge Vilchez-Perozo
University of Zulia, Faculty of Agronomy
Bolivarian Republic of Venezuela

Keywords:
Corn
Chemical element
Yield

Abstract

Corn (*Zea mays* L.) is produced in various countries, constituting a source of income for many families; for Ecuador, it represents an item with social and economic benefits. The objective of this research was to evaluate nitrogen fertilization in corn cultivation in La Carlota, Balzar canton, Ecuador. A randomized block experimental design was used with four treatments nitrogen fertilization (200, 300, 400 $kg.ha^{-1}$) and control, (no application) and five replications. The variables evaluated were stem diameter, plant height, ear diameter, ear length, ear weight and yield per hectare. The results reflected that significant differences were observed ($p<0.05$) of 200 $kg.ha^{-1}$ with respect to the other treatments. Therefore, it is important not to apply lower amounts or exceed the amount of N required per plant in each corn production unit.

*Corresponding author: lzambrano@uagraria.edu.ec

Resumen

El maíz (*Zea mays* L.) se produce en diversos países, constituyendo una fuente de ingresos para muchas familias; para Ecuador representa un rubro con beneficios sociales y económicos. El objetivo de la investigación fue evaluar la fertilización con nitrógeno en el cultivo de maíz en La Carlota, cantón Balzar, Ecuador. Se utilizó un diseño experimental en bloques al azar con cuatro tratamientos de fertilización con nitrógeno (200, 300, 400 kg.ha^{-1}) y testigo, (sin aplicación) y 5 repeticiones. Se evaluaron las variables diámetro del tallo, altura de la planta, diámetro, longitud y peso de la mazorca y rendimiento por hectárea. Se encontró diferencias significativas ($p<0.05$) para 200 kg.ha^{-1} con respecto a los otros tratamientos; por lo que es importante no aplicar cantidades inferiores, ni excederse de la cantidad de N a aplicar por planta de maíz.

Palabras clave: maíz, elemento químico, rendimiento.

Resumo

O milho (*Zea mays* L.) é produzido em vários países, constituindo uma fonte de renda para muitas famílias; para o Equador, representa um item com benefícios sociais e econômicos. O objetivo desta pesquisa foi avaliar a fertilização nitrogenada no cultivo de milho em La Carlota, cantão Balzar, Equador. Foi utilizado um delineamento experimental em blocos casualizados com quatro tratamentos do fertilização nitrogenada (200, 300, 400 kg.ha^{-1}) e controle, (sem aplicação) e 5 repetições. As variáveis avaliadas foram diâmetro do caule, altura da planta, diâmetro da espiga, comprimento da espiga, peso da espiga e rendimento por hectare. Os resultados refletiram que foram observadas diferenças significativas ($p < 0,05$) de 200 kg.ha^{-1} em relação aos outros tratamentos. Portanto, é importante não aplicar quantidades menores ou exceder a quantidade de N necessária por planta em cada unidade de produção de milho.

Palavras-chave: milho, elemento químico, produtividade.

Introduction

Corn (*Zea mays* L.) is produced in various countries and is a source of income for many of them. For Ecuador, it represents a commodity with social and economic benefits, according to the Food and Agriculture Organization of the United Nations [FAOSTAT] (2022). Corn in Ecuador is grown at different altitudes and under different soil and weather conditions (Antúnez, 2023). According to Hasang *et al*. (2021), corn has been growing in Ecuador's agricultural sectors, with consumption for the feed industry and as grain.

In another context, nitrogen (N) is the element most in demand by corn plants, with reports indicating that N absorption in this crop increases from 30 days after sowing to 100 days, with absorption between 140 kg.ha^{-1} N to 180 kg.ha^{-1} of N (Davies *et al*., 2020). Likewise, Caviedes (2022) indicated that, in much of Ecuador, one of the main limitations of corn cultivation is its low yield, making it necessary to review fertilization programs among several factors. Sraffa (2024) indicated that the law of diminishing returns explains that by increasing the use of fertilizer (in this case), while keeping other factors fixed, the increase in total production becomes smaller and may even decrease.

In this regard, it is necessary to determine the appropriate dose of N to achieve acceptable yields in corn production units. Therefore, the objective of the research was to evaluate N fertilization in corn cultivation in La Carlota, Balzar canton, Ecuador.

Materials and methods

The research was conducted at the El Maizal production unit, La Carlota campus, Balzar canton, Guayas province, geographical coordinates 1°09'32"S and 79°46'25"W; with rainfall of 1,500 mm per year, altitude of 65 m above sea level, and average annual temperature of 26.5 °C (INAMHI, 2022).

Experimental design

The research was applied in nature. The experimental design used was randomized blocks; four treatments and five replicates with a replicated Latin square design (Table 1).

Table 1. Treatments evaluated in La Carlota, Ecuador.

Treatments	Nitrogen dose (kg.ha^{-1})
T1	100
T2	200
T3	300
T4	No application (control)

Urea fertilizer was used as the source of N (46 % of N), divided into three applications at 30, 45, and 60 days after sowing, placing the fertilizer next to each plant.

Experimental unit

Emblema 777 hybrid corn seed, marketed by INTEROC (Guayaquil, Ecuador), was sown.

Experiment management

The respective soil samples were taken and then sent to the Pichilingue Tropical Experimental Station, with the following results: loamy texture; pH: 5.2; organic matter: 4.2 (medium); N: 19.8 ppm (low); P: 20 ppm (low), and K: 0.74 meq.100 g^{-1} (high). An area of 0.25 ha was planted, placing one corn seed per point, 0.2 m between plants, and 0.8 m between rows. Distribution in the field was random within each block and repetition, with an area of 3 x 3 m for a surface area of 9 m^2, for a total of 20 plots. A gravity irrigation system with furrows was used, with an estimated irrigation rate of 1 mm of water per plant, every other day.

Weekly manual weed control was carried out on the streets, rows, and around each plant to reduce competition for water, light, nutrients, space, among other things. Inspections were carried out to identify insects and diseases; the presence of *Spodoptera frugiperda* was observed and controlled with 1 % *Bacillus thuringiensis*. The corn cobs were harvested 120 days after planting. The harvest index used was the darkening of the stigmas of the female flowers (cobs), dryness to the touch, and easy detachment of the cob (Antúnez *et al*., 2023).

Variables evaluated

Stem diameter

A measuring tape (rubber) was used to measure the stem at a height of 30 cm from the ground, 110 days after sowing. It was expressed in cm.

Plant height

Measuring up to the point of cob insertion 110 days after sowing. The value was expressed in cm.

Diameter of the cob

The measurement was taken with the same measuring tape, at the middle third of the cob. The value was expressed in cm.

Length of the cob

This was measured at harvest time using a rubber tape measure. The value was expressed in cm.

Weight of the cob

The cobs were weighed on an electronic scale (KERN, model PCB 350-3), and expressed in grams.

Yield per hectare

After obtaining the average cob weight values, they were multiplied by the number of cob per plant and by the total number of corn plants, and then expressed in kg.ha^{-1}.

Data processing and analysis techniques

The results obtained were transcribed into Excel and processed using InfoStat (2017), performing an analysis of variance (ANOVA) on the variables indicated to demonstrate the effect of the treatments. When significant, Tukey's mean comparison test was performed ($p<0.05$).

Results and discussion

Stem diameter and plant height

Significant differences ($p<0.05$) were found between T2 (200 kg N.ha^{-1}) and the other treatments, with T4 (control) showing the lowest values (Table 2).

Table 2. Effect of nitrogen fertilization on stem diameter, plant height, stem length, and stem diameter in La Carlota.

Treatments Nitrogen dose (kg.ha^{-1})	Stem diameter (cm)	Plant height (cm)	Length of the cob (cm)	Diameter of the cob (cm)
100 (T1)	1,6b	117b	13b	3,6b
200 (T2)	1,9a	126a	18a	4,4a
400 (T3)	1,6b	118b	13b	3,7b
0 (T4, control)	1,2c	101c	11c	3c

Different letters in the variables differ statistically for the Tukey test ($p<0.05$).

.

The application of N had a positive effect on crop development, with the highest stem diameter values obtained for T2 (200 kg N.ha^{-1}) at 1.9 cm. The results obtained coincided with the research of León et al. (2022) with 1.8 cm. Likewise, 200 kg N.ha^{-1} presented plant height values of 126 cm, coinciding with Pereira et al. (2023), who reported corn plant height values between 122 cm and 137 cm. In this context, Sraffa (2024) indicates that, by increasing fertilizer use, the increase in total production may decrease.

In this regard, the results of the soil sample analysis show that the N element had a low value; however, the application of 200 kg N.ha^{-1} had a positive effect as nitrogen fertilization on stem diameter and plant height, with the best yields. It is important to note that N in corn plants accumulates in stems and leaves, promoting photosynthesis. For stem diameter and plant height, the highest dose of N did not necessarily reflect the best results.

It is interesting to note that N should be applied in fractions (as was done in this study) to reduce losses, but not to fertilize, since, as can be seen in T4, the non-application of N resulted in the lowest values for all variables.

Corn cob diameter and length

Significant differences ($p<0.05$) were observed between T2 (200 kg N.ha^{-1}) and the rest of the treatments for corn cob diameter and length (Table 2). The application of 200 kg N.ha^{-1} resulted in an scorn cob diameter of 4.4 cm, which coincides with the 4.7 cm reported by Mestanza et al. (2025). Raasch *et al*. (2016) point out that corn cob diameter is affected by different doses of N.

The corn cob length for T2 was 18 cm, coinciding with the research by Mestanza et al. (2025), who reported 17.28 cm for this variable. Morales *et al.* (2022) obtained values of 11.9 cm. In contrast, Antúnez *et al*. (2023) indicate in their research that increasing the N dose did not result in significant increases on corn cob length.

The corn cob length of a corn plant could be associated with the application of N during the corn crop cycle, coupled with the fact that N is the main nutrient required by corn plants, limiting plant development, stem length, and diameter, and participating in processes such as photosynthesis and water absorption.

Corn cob weight

There were significant differences ($p<0.05$) between T2 and the other treatments, with T4 (control) having the lowest stem weight (Table 3).

Table 3. Corn cob weight and yield per hectare in La Carlota, Ecuador.

Treatments N dose (kg.ha^{-1})	Corn cob weight (g)	Yield (kg.ha^{-1})
100 (T1)	360b	2.861b
200 (T2)	420a	4.620a
400 (T3)	370b	3.180b
0 (T4, control)	220c	1.320c

Different letters in the variables differ statistically for the Tukey test ($p<0.05$).

A decrease in corn cob weight was observed when the N dose was increased. T2 (200 kg N.ha^{-1}) showed a significant difference compared to the other treatments; this corroborates the existence of a positive effect when applying N, and a negative effect without its application on corn cob weight. Cervantes *et al*. (2018) found no differences in the development of corn plants when fertilizing with 60 to 350 kg.ha^{-1} of N.

There was an effect of nitrogen fertilization on corn cultivation; this result seems to indicate that excess N negatively affects corn plants; the application of N in increasing doses led to a decrease in yield, which could be due to a nutritional imbalance caused by the application of N with respect to other elements in corn cultivation. Possibly, the excessive application of N led to the law of diminishing returns, since as the N dose increased, the weight of the cob decreased.

Yield per hectare

Significant differences ($p<0.05$) were observed between T2 (200 kg N.ha^{-1}) and the other treatments, with T4 (control) showing the lowest yield per hectare (Table 3). For 200 kg N.ha^{-1}, a yield of 2,861 kg.ha^{-1} was observed, which is higher than that reported by Lugo *et al*. (2022), who evaluated increasing doses of nitrogen in corn cultivation and reported values of 2,157 kg.ha^{-1} of corn with a dose of 105 kg.ha^{-1} of N.

In this sense, the existence of a negative effect of N application treatments on corn plant yield is corroborated, possibly explained by the induction of a nutritional imbalance. Therefore, the application of adequate amounts of N is necessary to obtain an adequate nutritional balance.

Because N is essential for the formation of proteins, chlorophyll, and enzymes, which are key to photosynthesis, improving the

production of photoassimilates; The results suggest that N utilization should be taken into account to avoid limitations such as in the case of T4 (without N application), which presented the lowest results for the variables studied, affecting the productive potential of corn plants; or in the case of T3 (400 kg $N.ha^{-1}$), which used a higher amount of N but did not obtain the highest values, including yield per hectare.

Therefore, nitrogen fertilization had an effect on corn cultivation; finding the appropriate amount of N application is of utmost importance to achieve the highest yields, seeking to reduce losses, since, as observed in the research, excessive N application caused a decrease in yield.

As in previous cases, it can be observed that the highest dose of N did not yield the best results in terms of yield per hectare. Therefore, the availability of N and other factors such as imbalances or excesses of this element, which directly influence production, must be taken into account.

Conclusions

When evaluating N fertilization in corn cultivation, it was observed that the dose of 200 kg $N.ha^{-1}$(T2) had a positive influence on corn plant growth, with greater stem diameter, plant height, stem diameter, ear length, ear weight, and yield per hectare. Higher doses had a negative effect on corn crop growth and yield.

Literature cited

Antúnez, O., Sabino, J., Hernández, C. & Espinoza, M. (2023). Rendimiento del maíz (*Zea mays* L.) en respuesta a la fertilización con nitrógeno, fósforo y silicio al suelo. Terra Latinoam, 41, e1682. https://doi.org/10.28940/terra.v41i0.1682

Caviedes, M. (2019). Producción de semilla de maíz en el Ecuador: retos y oportunidades. *Avances en Ciencias e Ingeniería*, *11*(1), 116–123. https://doi.org/https://doi.org/10.18272/aci.v11i1.1100

Cervantes, F., Cadenas, J., Raya, J., Andrio, E., Rangel J., Guevara, L., Rodríguez, S. & Mendoza, M. (2018). Respuesta del *Silk Balling* a humedad edáfica y densidad de población en líneas de maíz. *Revista Mexicana De Ciencias Agrícolas*, *6*(1), 231-241. https://doi.org/10.29312/remexca.v6i1.753

Davies, B., Coulter, J. & Pagliari, P. (2020). Timing and rate of nitrogen fertilization influence maize yield and nitrogen use efficiency. *Plos one*, *15*(5), e0233674. https://doi.org/10.1371/journal.pone.0233674

Hasang, E., García, S., Carrillo, M., Durango, W. & Cobos, F. (2021). Sustentabilidad del sistema de producción del maíz, en la provincia de Los Ríos (Ecuador), bajo la metodología multicriterio de Sarandón. *Journal of the Selva Andina biosphere*, *9*(1), 26-40. https://doi.org/10.36610/j.jsab.2021.090100026.

Instituto Nacional de Meterología e Hidrología [INAMHI]. (2022). Boletín agroclimático decadal, boletín informativo No. DEI-BAD-30-2020. Guayaquil: Instituto Nacional de Meteorología e Hidrología (INAMHI). https://www.inamhi.gob.ec/

InfoStat. (2017). InfoStat Software Estadístico. https://www.infostat.com.

León, R., Avellán, B., Torres, A. Ardisana, E., & Fosado, O. (2022). Densidad de siembra y comportamiento morfo-fisiológico y productivo del maíz híbrido INIAP H-603. *Cultivos Tropicales*, *43*(4), e10, 2022. https://www.redalyc.org/journal/1932/193279117010/html/

Lugo. P, López A., Martínez, L., Morel, L., Da Silva, M., Servin, A., Sánchez, R, & Melgarejo, M. (2022). Formas de aplicación y dosis de nitrógeno en la producción de maíz chipá de la variedad guaraní v253. *Ciencia Latina Revista Científica Multidisciplinar*. *6*(1), 43-46. https://doi.org/10.37811/cl_rcm.v6i1.1803

Mestanza, C., Cedeño, P., Veliz, D., Vásquez, S. & Pinargote, J. (2025). Distanciamiento de siembra en *Zea mays* L. durante la época seca y lluviosa en la costa central del Ecuador. *La Granja. Revista de Ciencias de la Vida*, *41*(1), 151-161. https://doi.org/10.17163/lgr.n41.2025.10

Morales, M., Quevedo, J. & García, R. (2022).Evaluación de sistemas de siembra de alta densidad en maíz. *Revista Científica Agrosistemas 10*(3), 88-99. https://aes.ucf.edu.cu/index.php/aes/article/view/566/539

Organización de las Naciones Unidas para la Agricultura y la Alimentación [FAOSTAT] (2022). División de Estadísticas de producción del cultivo de maíz. http://faostat.fao.org/DesktopDefault. asp291

Raasch, H, Schoninger, R, Noetzold, D, Costa, J. & Días, S. (2016). Doses de nitrogênio em cobertura no milho de segunda safra em Nova Mutum - MT. *Revista cultivando o saber*. *9*(4), 517-529. https://cultivandosaber.fag.edu.br/index.php/cultivando/article/view/743

Sraffa, P. (2024). Las leyes de los rendimientos en condiciones de competencia. El Trimestre Económico, *91*(361), 215–232. https://doi.org/10.20430/ete.v91i361.2197