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Agronomic response of a maize hybrid (Zea mays L.) at different planting densities

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***Abstract*---**The experiment was carried out at the "La María" Campus of the State Technical University of Quevedo, located in the Mocache canton, province of Los Ríos. This consisted of the establishment of experimental lots of the simple maize hybrid called "Centella", classified as high yielding and medium segmentation, subjected to different planting densities, which corresponded to the following treatments: T1 (60 x 25 cm), T2 (70 x 25 cm) and T3 (80 x 25 cm). A Completely Randomized Design (CRD) with five replications was used to evaluate them; the comparison between means was carried out using Tukey's test ($P \leq 0.05$). The variables studied were: plant height (cm), stem diameter (cm), ear insertion height (cm), number of grain rows in the ear, ear length (cm), ear diameter (cm), weight of 100 grains, grain yield (kg/ha), phenology and economic analysis. The treatments showed statistical similarity in all agronomic performance variables and most of the productive parameters, except for grain

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yield, where T1 stood out over the other treatments with a record of 9282.21 kg/ha. On the other hand, in the economic analysis it was found that, even though T1 showed higher net income, the treatment that presented the greatest feasibility was T2, with a b/c ratio of 2.86. Finally, for phenology, it was found that the duration of the vegetative stages did not vary between treatments. Finally, it was concluded that the densities studied were statistically influential at the productive and economic levels.

Keywords---Zea mays L., single hybrid, planting spacing, yield, profitability.

Introduction

Corn (*Zea mays* L.) is one of the crops with the largest production and distribution worldwide, with a presence in a wide range of producing countries, among which Ecuador stands out (Fernandez *et al.*, 2018). This country provides ideal soil and climate conditions for obtaining better yields (León *et al.,* 2018). This aspect is partially exploited by farmers, especially in the coastal region, where according to the National Institute of Statistics and Census (INEC) the production of this grass is concentrated, with Los Ríos (40.31%), Manabí (28.64%), and Guayas (16.10%) being the provinces with the highest participation in the area sown at the national level (INEC, 2021). However, taking into consideration the average annual production per hectare in the country (3.6 MT/ha) in comparison to other Latin American countries such as Mexico (4.06 MT/ha) and Brazil (5.77 MT/ha) (FAOSTAT, 2021), it is evident that there are problems in the technical and agronomic management by producers, which in addition to other aspects affect the development of the crop, preventing the full exploitation of the productive potential of the materials used for planting (Choriego, 2018).

To increase the productivity per useful plot of these materials in Ecuador, the producer must take into account factors related to plant stress, given by the competition of resources such as light, water and nutrients; indispensable for the development of the plant and responsible for stimulating the apical dominance of the same against the development of weeds (Ramírez *et al.*, 2020). In this sense, planting density and spatial arrangement of the plantation play a key role, since the variation in the distance between plants and rows determine the level of access to these resources, and these, in turn, generate differential behaviors in the leaf area index values and the productive capacity of each of the individuals (Prieto & Aguayo, 2014). As a general rule, it is known that the increase in population densities (decrease in the space between plants and/or rows), allows better use of photosynthetically active radiation (located in wavelengths from 400 to 700 nm), which is mostly used by plants, resulting in a more efficient use of the land, which together with the accumulation of biomass allows the producer to increase grain yields (Sánchez *et al.*, 2011); however, beyond the optimal density, it is capable of causing adverse effects such as higher sterility, lower grain quantity and grain weight per year due to overpopulation (Quiroz *et al.*, 2017).

For the aforementioned reasons and because of the modifications inserted in the recently introduced corn genotypes and commercialized in the local market, among which the hybrids widely used by farmers stand out, whose most representative characteristics are lower plant height and ear insertion, lower sterility and duration of the flowering-spike subperiod, etc., it is considered necessary to reevaluate the suggested planting spacings and densities for crop establishment in each production zone (Martínez *et al.*, 2017). Therefore, the objective of this experiment was to evaluate the incidence of the spacing factor on the productivity, profitability and phenological components of the Centella corn hybrid in the agro-climatic conditions of the Mocache canton, province of Los Ríos.

Materials and Methods

The experiment was carried out at the “La María” Campus of the UTEQ, located in the Mocache canton of the province of Los Ríos, whose geographical coordinates are 01°04'46'' South latitude and 79° 30'09'' West longitude. The meteorological conditions present at the site are shown below (Table 1).

Table 1
Weather conditions at “La María” Campus

Meteorological data	Average values
Temperature (°C)	24,2
Relative humidity (%)	77,4
Precipitation (mm per year)	1537
Heliophany (daylight hours per year)	823
Ecological zone	Humid-tropical Forest (bh-T)

Experiment Management

A 966 m2 plot of land was delimited, where after weeding and manual plowing of the soil, the plots corresponding to the experimental units of the trial were randomly distributed. As for planting, seeds of the Centella hybrid were used as planting material, which were deposited manually and directly in the field in winter stage conditions (the year 2020) and at the densities programmed for each of the treatments (60 cm x 25 cm; 70 cm x 25 cm and 80 cm x 25 cm). Regarding lot management, conventional weed control was carried out with the use of selective pre- and post-emergent herbicides to avoid collateral damage. Since the trial was carried out in winter conditions, water supply to the crop was carried out under rainfed conditions; in turn, a fertilization plan was implemented consisting of the use of complete fertilizer 10-30-10 at the recommended doses at 8 and 23 days after sowing (dds), as well as the use of urea at 15, 32 and 42 dds. Regarding phytosanitary management, it was necessary to apply a series of insecticides, bactericides and fungicides to control pests and diseases. Finally, harvesting was carried out manually once the entire plantation had reached physiological maturity.

Research Design and Statistical Analysis

A completely randomized design (CRD) with three treatments and five replications was applied. An ANOVA was used for data analysis, while Tukey's test ($P \leq 0.05$) was used for the comparison of means. The statistical software packages InfoStat v2020 and Minitab 19 were used for this purpose.

Data Processing

Table 2 describes each of the planting spacings (treatments) used on the high-yielding, medium-segment Centella hybrid.

Table 2
Description of treatments

N°	Treatments	Planting distances	Repetitions
1	Hybrid (Centella)	60 cm x 25 cm	5
2	Hybrid (Centella)	70 cm x 25 cm	5
3	Hybrid (Centella)	80 cm x 25 cm	5

Variables studied

- **Plant height (cm).** Data were randomly selected and recorded for six individuals (plants) per repetition, taking into account the distance from the base of the stem to the apex of the upper leaf. The records were made at 15, 30 and 45 dds.
- **Stem diameter (cm).** Data collection was carried out on six randomly selected individuals per replicate, 15 days apart (15, 30 and 45 dds).
- **Cob insertion height (cm).** Data were recorded from six randomly selected plants per replicate, taking into account the distance between the ground and the node of the highest cob. The recording was carried out at 60 dds.
- **Number of rows of cobs.** Ten ears were randomly collected per experimental unit and the number of rows of each of these was quantified. The recording was made at physiological maturity.
- **Cob length (cm).** Data from 10 ears per experimental unit were randomly selected and recorded, taking into account the distance from the base of the stalk to the apex of the ear. The recording was made at physiological maturity.
- **Cob diameter (cm).** Ten ears were randomly selected per experimental unit and the space corresponding to the third half of the ear was recorded. The recording was made at physiological maturity.
- **Weight of 100 grains (g).** From the 10 cobs collected per experimental unit for the recording of the above variables, 100 grains were extracted at random and their weight was recorded.
- **Grain yield (kg/ha).** The weight of the grains harvested from the plants that made up the different experimental units (useful plot) was recorded at 13% moisture and 1% impurities. The following equation was used:

Equation 1

$$\text{PU (13\%)} = \frac{\text{Pa}(100 - \text{Ha})}{100 - \text{Hd}}$$

PU = Uniform Weight at 13% humidity
Pa = Current weight
Ha = Current humidity
Hd = Desired humidity

Phenology

Each phenological stage was recorded, as well as the daily heat units, to determine the thermal integration of the Centella hybrid in the agro-climatic conditions and management received at the “La María” Campus.

Correlation of variables with performance

A correlation coefficient was used to determine which variables had the greatest and least influence on performance.

Economic analysis

Total costs. All values disbursed for the execution of operations related to planting, application of inputs (including the cost of each of these) and harvesting by treatment were recorded. Income. To determine this item, the records achieved in grain yield at 13% moisture and 1% impurities were taken into account. Subsequently, the income achieved per treatment was estimated based on the official price of a hundredweight of corn in 2020, which was $14.60. Benefit/cost ratio. The b/c ratio was obtained from the difference between net income and total costs per treatment. The following equation was used:

Equation 2

$$Relación \frac{B}{C} = \frac{Ingresos\ netos}{Costos\ totales}$$

Results and Discussion

Plant height (cm)

For the variable plant height at 15, 30 and 45 days after planting, ANOVA showed that there were no significant statistical differences between treatments ($P>0.05$). With respect to plant height at 15 days, with a coefficient of variation of 6.88%, statistically similar values were found in treatments T1, T2 and T3 with 24.62, 24.86 and 23.78 cm, respectively. The same occurred at 30 days, with a coefficient of variation of 5.62%, with 68.36, 69.12 and 66.76 cm for T1, T2 and T3, respectively. At 45 days, the statistical pattern was maintained, with a coefficient of variation of 12.36%, with values for T1, T2 and T3 of 196.44, 202.40 and 184.32 cm respectively (Table 3).

Table 3
Plant height (cm) at 15, 30 and 45 after planting. UTEQ Campus "La María" Mocache, province of Los Ríos, winter 2020

Plant height (cm)						
Treatments	15 dds		30 dds		45 dds	
T1 (60 cm x 25 cm)	24,62	a	68,36	a	196,44	a
T2 (70 cm x 25 cm)	24,85	a	69,12	a	202,40	a
T3 (80 cm x 25 cm)	23,78	a	66,76	a	184,32	a
C.V. (%)	6,88		5,62		12,36	

Equal letters are not significant according to Tukey's test (P>0,05).

The data achieved are opposed to those recorded in other research (Intriago & Torres, 2018; Mera & Montaño, 2015), which report an increase in plant height as row/plant spacing decreases and plant population per hectare increases. Sánchez *et al.* (2011) affirms that planting densities have a significant influence on genotypes (G x D interaction), so it is usual to detect statistical differences in this variable. On the other hand, an excessive increase in plant height due to an increase in crop density could affect plant growth and leaf expansion, since reducing their capacity to receive photosynthetically active radiation, it would cause a drastic decrease in biomass accumulation, which is reflected in crop productivity losses (Chérrez, 2015; Guamán *et al.*, 2020). Therefore, the use of materials of smaller stature is increasingly in demand, since it also has advantages such as a decrease in the percentage of root and stem lodging (Bastidas *et al.*, 2015) and greater practicality in harvesting (Saavedra & Kehr, 2018).

Stem Diameter (cm)

As for the variable stem diameter at 15, 30 and 45 days and according to ANOVA, no significant statistical differences were found between treatments (P>0.05). Values at 15 days were 0.33, 0.31 and 0.34 mm for T1, T2 and T3, respectively, with a coefficient of variation of 10.66%. At 30 days, values of 2.29, 2.35 and 2.36 cm for T1, T2 and T3 respectively, with a coefficient of variation of 5.92%. Finally, at 45 days, values of 2.64, 2.58 and 2.65 cm were obtained for T1, T2 and T3, with a coefficient of variation of 8.11% (Table 4).

Table 4
Stem diameter (cm) at 15, 30 and 45 days after planting. UTEQ campus "La María" Mocache, Los Ríos province, winter 2020

Stem diameter (cm)						
Treatments	15 days		30 days		45 days	
T1 (60 cm x 25 cm)	0,33	a	2,29	a	2,64	a
T2 (70 cm x 25 cm)	0,31	a	2,35	a	2,58	a
T3 (80 cm x 25 cm)	0,34	a	2,36	a	2,65	a
C.V. (%)	10,66		5,92		8,11	

Equal letters are not significant according to Tukey's test (P>0,05).
Letras iguales no son significativas según la prueba de Tukey (P>0.05).

These values are a discrepancy with the results obtained by authors such as López cited by Chumpitaz (2018), who evidenced a thickening of the stalks of maize plants due to the increase in the distance between rows/plants. This has been corroborated by several authors such as Demétrio *et al.* (2008), and Farinelli *et al.* (2012, cited by Chura *et al.* (2019), who found a decrease in the diameter of maize stalks with population increase. This suggests that at ideal planting densities, plants do not suffer abruptly from the intraspecific competition, so that the access and supply of vital resources available and essential for development are adequately distributed among plants, which allows a greater translocation of nutrients in plant organs, including the stalk.

Cob Insertion Height (cm)

According to the height of ear insertion concerning ANOVA, no significant statistical differences were found between treatments (P>0.05). Values of 141.00, 138.60 and 144.40 cm were obtained for T1, T2 and T3, respectively, with a coefficient of variation of 3.37% (Table 5).

Table 5
Insertion height (cm) of the ear at 125 days after planting. UTEQ campus "La María" Mocache, province of Los Ríos, winter 2020

Treatments	Cob insertion height (cm)	
T1 (60 cm x 25 cm)	141,00	a
T2 (70 cm x 25 cm)	138,60	a
T3 (80 cm x 25 cm)	144,40	a
C.V. (%)	3,37	

Equal letters are not significant according to Tukey's test (P>0,05).

The height of ear insertion is an aspect of great economic relevance since it determines the susceptibility of the plant to lodging (Chura *et al.*, 2019); therefore, many producers want a lower height and thus reduce the risk of tipping (Quevedo *et al.*, 2015). In this case, none of the treatments showed statistically lower values between planting densities; however, Mera & Montaño (2015) in their research observed that as the population of plants per unit area increased, the greater the height of ear insertion, which is intrinsically related to plant height.

Number of rows of cob grains

According to ANOVA and with a coefficient of variation of 6.44%, there were no significant statistical differences between treatments (P>0.05), since T1, T2, and T3 unanimously presented an average of 13 rows per ear (Table 6).

Table 6
Number of rows of grain in the ear. UTEQ campus "La María" Mocache, Los Ríos province, winter 2020

Treatments	Number of rows of grain in the cob	
T1 (60 cm x 25 cm)	13	a
T2 (70 cm x 25 cm)	13	a

T3 (80 cm x 25 cm)	13	a
C.V. (%)	6,44	

Equal letters are not significant according to Tukey's test (P>0,05).

Because of these results, Quevedo *et al.* (2015) state that yield components such as the number of rows per ear is not significantly influenced by the number of plants per linear meter (density), which agrees with Quiro (2017), who indicates that the number of rows is genetically determined in high-yielding hybrids and that these do not suffer variations due to plant density.

Cob length (cm)

Concerning the ear length variable, the ANOVA determined statistical equality between treatments (P>0.05), giving results for T1 of 17.15 cm, T2 of 17.58 cm and T3 with 17.33 cm, with a coefficient of variation of 3.52% (Table 7).

Table 7
Cob length (cm). UTEQ campus "La María" Mocache, province of Los Ríos, winter 2020

Treatments	Cob length (cm)	
T1 (60 cm x 25 cm)	17,15	a
T2 (70 cm x 25 cm)	17,58	a
T3 (80 cm x 25 cm)	17,33	a
C.V. (%)	3,52	

Equal letters are not significant according to Tukey's test (P>0,05).

According to Martínez *et al.* (2017), productive components such as ear length and diameter are sensitive to increasing population densities. This is supported by several authors referenced in the work of Quiro (2017), who, through their respective studies, concluded that both ear length and ear diameter decrease as population density increases. However, that scenario was not witnessed in this research, since all the evaluated distances registered statistically similar values.

Cob Diameter (cm)

For the cob diameter variable, there were no significant statistical differences between treatments (P>0.05). Results were obtained for T1 with 4.43 cm, T2 with 4.45 cm and T3 with 4.35 cm, with a coefficient of variation of 1.86% (Table 8).

Table 8
Cob diameter (cm). UTEQ campus "La María" Mocache, Los Ríos province, winter 2020

Treatments	Cob diameter (cm)	
T1 (60 cm x 25 cm)	4,43	a
T2 (70 cm x 25 cm)	4,45	a
T3 (80 cm x 25 cm)	4,35	a
C.V. (%)	1,86	

Equal letters are not significant according to Tukey's test (P>0,05).

The statistical parity observed between treatments in this variable is similar to those recorded by Martínez *et al.* (2017), who found no significant differences in cob diameter concerning the spacing factor. However, there are studies such as that of Mera and Montaño (2015), and Quiro (2017), who observed variations in both ear diameter and ear length at different planting densities.

Weight of 100 grains (g)

As for the variable weight of 100 grains, the ANOVA showed statistical equality between treatments ($P>0.05$). This resulted in T1 (41.42 g), T2 (41.02 g), and T3 (40.84 g) and a coefficient of variation of 5.37% (Table 9).

Table 9
Weight of 100 grains (g). UTEQ campus "La María", Los Ríos province, winter 2020

Treatments	Weight of 100 grains (g)	
T1 (60 cm x 25 cm)	41,42	a
T2 (70 cm x 25 cm)	41,02	a
T3 (80 cm x 25 cm)	40,84	a
C.V. (%)	5,37	

Equal letters are not significant according to Tukey's test (P>0,05).

Although no statistical differences between treatments were observed, it can be appreciated that numerically there was a tendency to increase grain weight as the spacing between rows at planting was shortened, so that the grains corresponding to T1 (60 cm between rows) were heavier than those recorded by T3. This behavior has been observed by several authors such as Cordido (2013) and Rossatto (2018) who in their respective investigations observed a more effective grain filling at shorter plant spacing.

Grain Yield (kg/ha)

The ANOVA showed that there were significant statistical differences between treatments ($p<0.05$), reaching a remarkable record in the case of T1 with 9282.21 kg/ha, followed by T2 with 8334.64 kg/ha and T3 with 6474.83 kg/ha, with a coefficient of variation of 5.43% (Table 10).

Table 10
Grain yield. UTEQ "La María" campus, Los Ríos province, winter 2020

Treatments	Grain yield (kg/ha)	
T1 (60 cm x 25 cm)	9282,21	a
T2 (70 cm x 25 cm)	8334,64	b
T3 (80 cm x 25 cm)	6474,83	c
C.V. (%)	5,43	

Different letters are significantly different according to Tukey's test (P<0,05).

The data suggest that shorter planting distances allow for reaching higher harvest volumes, which is consistent with other studies such as Quevedo *et al.* (2015), who, although they did not find statistical differences in this variable, found an increasing trend in yield as the number of individuals per surface area increased. However, these same authors warn that very high densities could result in counterproductive effects, where, due to overpopulation and the effect of intraspecific competition, yields decline.

Phenology

According to the thermal integral determined by the sum of the daily heat, units showed that the Centella hybrid, under the agroclimatic conditions of the Mocache canton, Los Rios province, and the agronomic management received, began the VE stage (emergence) at 5 days with 109.7° accumulated heat units, then at 12 days the V2 stage began corresponding to the exit of the first pair of true leaves, continued its growth until reaching 45 days, where the Vn stage began, which is defined by the accumulation of biomass. Subsequently, at 50 days the lot reached the Vt stage (the last branch of the panicle visible), while at 55 days the flowering stage (R1) began. Finally, the hybrid reached physiological maturity at 125 days (R6) (Table 11).

Table 11
Accumulated degree days in the phenological stages of the hybrid. UTEQ campus

Date	Day	°C average	°C base	°C sum daily	sum	Phenological stages
04/01/2020	0	30,3	10	20,3	20,3	Sowing
09/01/2020	5	27,2	10	17,2	109,7	VE
16/01/2020	12	26,2	10	16,2	223,3	V3
19/01/2020	15	26,8	10	16,8	272,5	V4
26/01/2020	22	25,8	10	15,8	385,2	V6
05/02/2020	32	27,5	10	17,5	551,1	V8
18/02/2020	45	27,1	10	17,1	761,4	Vn
23/02/2020	50	27,5	10	17,5	843,8	VT
28/02/2020	55	27,8	10	17,8	928,1	R1
06/03/2020	62	25,0	10	15,0	1042,1	R2
08/05/2020	125	27,3	10	17,3	2110,5	R6

"La María" Mocache, Los Ríos province, winter 2020.

Correlation of Variables with Performance

The correlation coefficient matrix (Figure 1) shows that, among the variables studied, plant height at 45 dds and stem diameter at 30 dds had a very strong positive correlation with grain yield (kg/ha) with an R value of 0.74 and 0.93, respectively. While the variables with the lowest incidence were: plant height at 15 dds and ear insertion height, with values of -0.60 and -0.69, respectively.

	Altura (15 días)	Altura (30 días)	Altura (45 días)	Diámetro (15 días)	Diámetro (30 días)	Diámetro (45 días)	Altura de inserción a la mazorca	Número de hileras de mazorca	Longitud de la mazorca	Diámetro de la mazorca	Peso de 100 granos	Rendimiento
Altura (15 días)	1											
Altura (30 días)	0,94701076	1										
Altura (45 días)	-0,02272251	0,29960045	1									
Diámetro (15 días)	-0,64046403	-0,85320554	-0,75323693	1								
Diámetro (30 días)	-0,46581005	-0,15690052	0,89524064	-0,38124643	1							
Diámetro (45 días)	-0,53342764	-0,77684891	-0,8335065	0,99124071	-0,5	1						
Altura de inserción a la mazorca	-0,07222431	-0,3887602	-0,99548978	0,81223957	-0,84893098	0,88216315	1					
Número de hileras de mazorca	0,64046403	0,85320554	0,75323693	-1	0,38124643	-0,99124071	-0,81223957	1				
Longitud de la mazorca	0,0642459	0,16444937	0,32101983	-0,28887171	0,25550463	-0,30710902	-0,32636066	0,28887171	1			
Diámetro de la mazorca	0,46552433	0,41495766	-0,09118824	-0,2362278	-0,28819521	-0,18012201	0,04679843	0,2362278	0,15597606	1		
Peso de 100 granos	-0,10811696	-0,08433006	0,05866184	0,02606899	0,10010989	0,01011941	-0,04826417	-0,02606899	0,16469504	-0,23826709	1	
Rendimiento	-0,60386797	-0,3369841	0,74480288	-0,17485121	0,92837769	-0,29642197	-0,68574657	0,17485121	0,27886812	-0,26237958	0,03512738	1

Figure 1. Correlation analysis between variables

Economic Analysis

Total costs

Table 12 shows the total costs achieved by the treatments evaluated.

Table 12
Total costs. UTEQ campus "La María" Mocache, Los Ríos province, winter 2020

Name	Cost per ha (T1)	Cost per ha (T2)	Cost per ha (T3)
Centella Hybrid	193,75	174,38	155
Muriate of potassium	66	66	44
Gesaprim	18	18	9
Omega/Prol	10,5	10,5	6,5
King	8	8	4
Solaris	16	16	16
Radiant	16	16	16
Nos Toc	24	24	12
Shrapnel	30	15	15
Topgun	45	45	45
Siapton	15	15	15
Complex	16	16	16
Urea	114	95	76
10-30-10	132	110	88
Cerillo	8,5	8,5	5,5
Agry-Gentoplus	11	11	11
optiwater	8	8	8
Semeprid	27	27	18
Arpon	7	7	3,5
Total	$772	$690,38	$563,5

Income

The treatment that reported the highest income was T1 with $2970.30, followed by T2 with $2667.08 and lastly T3 with $2071.95 (Table 13).

Table 13
Income. UTEQ campus "La María" Mocache, province of Los Ríos, winter 2020

Treatments	Yields (kg/ha)	Price per kg	Income
T1 (60 cm x 20 cm)	9282,21	$ 0.32	$ 2970,30
T2 (70 cm x 20 cm)	8334,64	$ 0.32	$ 2667,08
T3 (80 cm x 20 cm)	6474,83	$ 0.32	$ 2071,95

Benefit/cost ratio

Finally, with regard to the benefit/cost ratio, Table 14 shows the value obtained by each treatment evaluated. There is a slight advantage for T2 with a B/C ratio of 2.86, followed by T1 with 2.85, leaving T3 with an average profitability of 2.68 in last place.

Table 14
Benefit/cost ratio. UTEQ "La María" Mocache campus, Los Ríos province, winter 2020

Treatments	Income	Total costs	Net income	Relation B/C
T1 (60 cm x 20 cm)	$ 2970,30	$ 772,00	$ 2198,3	2,85
T2 (70 cm x 20 cm)	$ 2667,08	$ 690,38	$ 1976,7	2,86
T3 (80 cm x 20 cm)	$ 2071,95	$ 563,50	$ 1508,45	2,68

Conclusions

- In this experiment, it was found that a smaller distance between rows increased the yields achieved. Such is the case of T1, which obtained higher values than the other treatments with 9282.21 kg/ha.
- The duration of the vegetative stages studied did not vary between treatments.
- The correlation coefficient showed that the variables that had the greatest influence on yield were plant height at 45 dds and stem diameter at 30 dds, so that the variation in yields achieved by the treatments is directly attributed to the planting distances used.
- Finally, through the economic analysis, it was determined that the treatment with the best benefit/cost ratio was T2 with 2.86. However, it is important to note that in terms of net profits, T1 outperformed the other treatments.

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