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Agronomic performance of green corn at different sowing times and nitrogen doses

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Abstract

The present study aimed to identify the best sowing time and the best nitrogen dose in topdressing of the corn crop for "green ear" consumption. The experiment was conducted between October 2018 and June 2019 in a commercial crop, in Ipameri, Goiás, Brazil. The soil in the experimental area is classified as dystrophic Red-Yellow Latosol with clayey texture. The experimental design used was the randomized blocks, in a 5 x 5 factorial scheme, with five sowing times [1st (10/19/2018); 2nd (11/29/2018); 3rd (01/08/2019); 4th (02/18/2019) and 5th (03/28/2019)], implemented with 40 days intervals, after the first sowing, and five nitrogen doses (0, 50, 100, 150, and 200 kg ha^{-1}), with four replicates. The following factors were evaluated for each sowing time: relative chlorophyll index, leaf dry mass, leaf nitrogen content, plant height, first ear insertion height, ears diameter and length, the total yield of ears with husks, the yield of commercial ears without husks and grain yield. The data were submitted to the analysis of variance (F-test). The sowing times and nitrogen doses in topdressing influenced the leaf nitrogen content, relative chlorophyll index, leaf dry mass, yield, and most of its components. Thus, it can be indicated that the best time for sowing corn for fresh consumption is in October (1st sowing time), and the estimated nitrogen dose in topdressing to obtain the maximum yield is 160 kg ha^{-1} of nitrogen.

Keywords: Zea mays L., production scheduling, nitrogen fertilization, green ears.
Abbreviations: N_nitrogen; O.M_organic matter; P_phosphorus; K_potassium; Ca_calcium; Mg_magnesium.

Introduction

Green corn ear consumption has always been a tradition in Brazil, and nowadays, it is commonly cultivated all Brazilian territory. Both ears and their derived products (pamonha, curau, cakes, juice, etc.) are commercialized throughout the national territory during the entire year (Rocha et al., 2011).
For green corn to have good acceptance in the market, its ears should have a large size and cylindrical shape; the grains should be very garnet, serrated, yellow or orange, tasty, sweet, and soft, added to harvest longevity. The husks number is a relevant characteristic since over 14 can influence industrial performance, and below seven pests attacks can be favored (Souza et al., 2016).
Sowing time is a factor capable of restricting green corn cultivation success since it is associated with meteorological conditions, such as rain, which must occur within plant-required limits and well-distributed not to compromise flowering and grain filling. Besides, air temperature directly influences the growth and duration of the corn crop cycle. Galon et al. (2010) found that corn plant development is favored at temperatures between 24 and 30 °C and temperatures below 15 °C and above 32 °C can decrease the development rate in a corn crop.
Green corn cultivation, a productive and profitable agronomic activity, especially in the Midwest region of the country (Borin et al., 2010), is demanding in the production system, in which nitrogen fertilization is considered indispensable, as it directly impacts on this crop productivity (Carmo et al., 2012).
Nitrogen (N) participates in several physiological processes essential for plant cycles, such as ionic absorption, photosynthesis, and respiration, and its availability can affect plant development (Costa et al. 2015).
Of all the corn required nitrogen, only 5 to 10% is absorbed until floral differentiation (Rezende et al. 2015). Thus, Ribeiro et al. (1999) recommend that most of the N in topdressing should be applied when plants have six to eight well-developed leaves, as it is during this period that productive potential begins to be defined.
In the case of N deficiency, corn plants present yellowing of the older leaves with subsequently generalized chlorosis, reduced plant growth, and deformations at the tips of the ears (absence of grains) can be seen in more severe cases (Repke et al., 2013). Thus, the inadequate supply of N is considered one of the main factors limiting the crop yield

(Kappes et al. 2009). Therefore, it becomes extremely important to evaluate nitrogen doses to identify the one that allows the crop to express its maximum productive potential (Lyra et al. 2014). Jointly with sowing time planning, these two factors are crucial for green corn production success.

Studies have been carried out concerning the agronomic performance of the corn crop (Portela et al. 2016; Santos et al. 2017) in recent years. However, there is little work on green corn in Brazil. Hence, the present study aimed to identify the best sowing time and the best nitrogen dose in topdressing in the corn crop for "green ear" consumption.

Results and discussion

Project climate data

It is possible to observe in Figure 1 maximum and minimum temperatures and rainfall volume during all months of this experiment. Rainfall distribution was irregular, reaching the highest accumulated rainfall of 51.5 mm during the experiment conduction in November 2018. February had the highest rainfall volume with 48.5 mm, from January to May 2019. There was no rainfall on the corn crop in June.

The daily average temperature during the experiment was 25 °C (Figure 1), which is considered excellent for developing of the studied crop. According to Galon et al. (2010), the ideal temperature range for the corn crop growth and development is from 24 to 30 °C.

Development and production components

The analysis of variance for leaf nitrogen content, relative chlorophyll index, plant height, first ear insertion height, and leaf dry mass are shown in Table 1. It can be noticed the interaction between sowing times and nitrogen doses in topdressing in all presented variables.

The results of the analysis of variance for leaf nitrogen content indicate significant interaction only for the 3rd and 4th sowing time (Figure 2a). For these two sowing times, the quadratic regression model was statistically adjusted, with a maximum point for the 3rd sowing time of 82.22 kg ha^{-1} of nitrogen, with values for leaf nitrogen content of 36.75 g kg^{-1} of dry matter (Figure 2a). On the other hand, the 4th sowing time showed a maximum value of leaf nitrogen content of 44.79 g kg^{-1} of dry matter, for the estimated nitrogen dose of 70.12 kg ha^{-1} (Figure 2a).

The obtained results are superior to those recommended by Malavolta (2006) and Petean et al. (2019), which indicate that for adequate development and production of the corn crop, leaf nitrogen content must be between 27 and 35 g kg^{-1} of dry matter, indicating that the plants were well nourished. These results were observed for doses considered low (from 70 to 83 kg ha^{-1} of nitrogen), because of the dissolution of the nitrogen in topdressing by the rain right after the applications on the field, enabling the existence of dissolved N in the soil for plants (Figure 1). Tasca et al. (2011) stated that the increased loss of nitrogen fertilizers through the volatilization of ammonia has a linear relationship with the increase in the dose of nitrogen applied to the soil.

It was also possible to verify significant interaction for the 1st, 2nd, 3rd, and 4th sowing time when evaluating the relative chlorophyll index. The first sowing time data were adjusted to a positive linear regression model, while the others were fitted to the quadratic regression model, as shown in Figure 2b. Nitrogen as a participant in the synthesis and structure of chlorophyll molecules, when increasingly supplied to plants, provides an increase in chlorophyll content and intensity of green color in the plant leaves (Fontes and Araújo, 2007).

For the 2nd, 3rd, and 4th sowing time, values of relative chlorophyll index of 44.19; 36.15, and 41.76 RCI were found for estimated nitrogen doses of 106.56; 168.25, and 112.75 kg ha^{-1}, respectively (Figure 2b). Nevertheless, the highest values of relative chlorophyll index (2nd and 4th sowing time) were obtained when a lower dose of nitrogen was used; when compared to the 3rd sowing time, this fact may be due to the high rates of rainfall that took place during these sowing times, as shown in Figure 1.

The relative chlorophyll index can be used as an indicator of plant nutrition since it is related to the nutritional status of plants. Argenta et al. (2003) established that corn plants with a relative chlorophyll index greater than 58 SPAD have an adequate level of nitrogen. However, the values measured in the present study were lower than those cited by these authors, which demonstrates that it is necessary to consider other factors such as the variability of hybrids, phenological stage in which the evaluation was carried out, sampled leaf, among others. Thus, it becomes difficult to compare the relative chlorophyll indexes measured in different studies, conducted with different managements and edaphoclimatic conditions.

Analysis concerning plant height showed an interaction between the five sowing times and nitrogen doses, and then the data were adjusted to quadratic regression (Figure 2c). For the 1st, 2nd, and 3rd sowing times, plant height was above two meters, presenting 2.54, 2.27, and 2.33 m, for the estimated nitrogen doses of 158.82, 116.17, and 106.66 kg ha^{-1}, respectively. These results are similar to those observed by Soratto et al. (2010), who identified plants with a height of 2.20 m when using the highest nitrogen dose, 120 kg ha^{-1}, when evaluating alternative sources and doses of nitrogen in corn. According to Cadore et al. (2016), plants with an adequate supply of nitrogen show greater vegetative development, as the macronutrient directly influences cell division and expansion.

As for the 4th and 5th sowing times, it can be noticed a reduction in plant height and an increase in the estimated dose when compared to the 2nd and 3rd sowing times. The corn plants were 1.87 and 1.98 m tall, corresponding to estimated nitrogen doses of 135.71 and 155 kg ha^{-1} for the 4th and 5th sowing time, respectively. This fact can be explained by the rain interval (summer) during March, April, and May (Figure 1), thus causing a period of water deficit. This insufficiency directly affects corn plant height, as it causes the closure of stomata, reduced transpiration and photosynthesis, and consequently, decreased photoassimilates production, which is responsible for plant growth (Nascimento et al. 2017).

When evaluating the first ear insertion height, it was possible to discover a significant effect only for the first sowing time (Figure 3a). The data is adjusted to positive linear regression within a variation range from 1.20 to 1.37 cm. This result is similar to those found by Carmo et al. (2012) and justified by Repke et al. (2013). They demonstrated that nitrogen availability in the soil directly influences the height of plants and the height of the insertion of the first ear, as this nutrient is responsible for vegetative development.

It is observed that quadratic regression models were best suited for the 2nd, 3rd, 4th, and 5th sowing time (Figure 3b), with no considerable effect for the 1st sowing time concerning the leaf dry mass.

With an estimated nitrogen dose of 170 kg ha^{-1} in the 2nd sowing time, 15.49 g of leaf dry mass was obtained, and concerning the 3rd sowing time, 19.06 g of leaf dry mass was found for an estimated nitrogen dose of 155.33 kg ha^{-1}. As stated in Sousa et al. (2017), N is the chemical element that determines the corn crop development. It directly influences an increment in leaf area and, therefore, dry matter mass production.

Regarding the 4th and 5th sowing time, there was a reduction in the dry mass of 14.54 and 14.21 with estimated nitrogen doses of 134 and 107.66 kg ha^{-1}, respectively, compared to the 2nd and 3rd time (Figure 3b).

As reported by Fiorini et al. (2018), corn sown from January to March may show great differences in vegetative growth, mainly due to climatic conditions such as rainfall, temperature, and solar radiation. In the initial phase of plants cultivated in the 4th and 5th sowing times, there was a period of constant rainfall, which resulted in low levels of sunlight, a factor that contributed to the low shoot dry matter.

The analysis of variance for ear length, ear diameter, the total yield of ears with husks, the yield of commercial ears without husks, and grain yield are presented in Table 2. It can be verified a significant effect of the two factors evaluated separately on parameters like ear diameter, the total yield of ears with husks, and the yield of commercial ears without husks. An interaction between sowing times and nitrogen doses was found for grain yield (Table 2).

When evaluating ear length, no interaction between sowing times and nitrogen doses was observed, neither a substantial isolated effect for these variables. The ears' length average values varied between 19.15 and 19.75 cm for the sowing times and 18.54 and 19.01 cm for nitrogen doses in topdressing.

Considerable effects on the ear diameter of the two studied factors (sowing times and nitrogen doses) were found separately. In this sense, we were able to fit the sowing times data to a negative linear regression model, with a reduction from 43.44 to 37.83 mm of ear diameter in the 5th sowing time, representing a 12.92% decrease when compared to the first sowing time (Figure 4a).

The reduction in the ear diameter values took place according to the sowing dates and is associated with decreased rainfall and summer periods throughout this experiment (Figure 1). According to Souza et al. (2016), plants exposed to these climatic conditions have rapid development of reproductive structures, as they start to invest in the specie's protection and proliferation to the detriment of grain yield, which consequently reduces the length, diameter, and weight of the ears.

Nitrogen doses data were fitted to a quadratic regression model, with the largest ear diameter (41.10 mm) being observed for the estimated nitrogen dose in topdressing of 149.44 kg ha^{-1} (Figure 4b). Superior results were found by Freire et al. (2010). They reported a diameter of 49.5 mm for an estimated nitrogen dose of 136 kg ha^{-1} when evaluating the economic yield and the yield components of green ears according to the nitrogen fertilization.

The length and diameter of ears are very important traits for corn green ear commercialization that must be considered. Following Albuquerque et al. (2008) and Cardoso et al. (2011), for ears to be considered commercial and accepted by consumers, it must be longer than 15 cm and have more than 3 cm of diameter. Results found in this work agree with what is mentioned in the literature, and therefore, can be classified as commercial ears.

The total yield of ears with husks showed notable effects for sowing times and nitrogen doses separately. Sowing times negatively influenced the total yield of ears with husks as the corn was cultivated, decreasing 28.53%, from 15,451.5 to 11,043.5 kg ha^{-1} (Figure 5a). Better results were obtained by Santos et al. (2015), who found an ear with husks mass of 17,000 and 16,000 kg ha^{-1}, grown in a conventional system, in 2010 and 2011, respectively.

When evaluating the influence of the nitrogen dose, the quadratic regression model was the best-fitted (Figure 5b). The maximum total yield of ears with husks found was 13,271.71 kg ha^{-1} for the estimated nitrogen dose of 160.93 kg ha^{-1}. Similar results were reported by Freire et al. (2010), who achieved a production value of 13,520 kg ha^{-1} when applied an estimated nitrogen dose of 157 kg ha^{-1}.

A significant independent effect of the tested factors was also verified for the yield of commercial ears without husks. Regarding sowing times influence, there was a reduction in the yield of commercial ears without straw from 9,696.5 to 6,415.5 kg ha^{-1}, representing a 33.84% decrease as the sowing time was delayed and the total yield of ears with husks (Figure 5c).

A reduction of the total yield of ears with husks and commercial ears without husks, according to the sowing times, is associated with reduced water availability that took place throughout the experiment development (Figure 1). As stated by Souza et al. (2016), it can be said that the plants started to invest in husks production and not in grains to raise grain protection, thus guaranteeing the perpetuation and proliferation of the specie, which consequently reduced the weight of the ears.

Also, Zhou et al. (2017) declared that variations in air temperature and radiation throughout the year could reduce radiation use efficiency, which directly influences the filling parameters of corn grains, thus affecting the weight of the kernels and, consequently, the weight of ears; the harvest period is reduced, as the ears reach the point of physiological maturation faster.

The data of nitrogen doses in topdressing fertilization fitted a quadratic regression with a yield of commercial ears without husks values of 8190.13 kg ha^{-1} for an estimated nitrogen dose of 134.63 kg ha^{-1} (Figure 5d). These results prove to be efficient when confronted to those observed by Costa et al. (2015) that identified yield of ears without husks of 6,500 kg.ha^{-1} for estimated nitrogen doses between 153 and 138 kg ha^{-1} when evaluating the performance of corn hybrids AG 1051 and P30F53Y respectively, for fresh consumption once submitted to nitrogen doses.

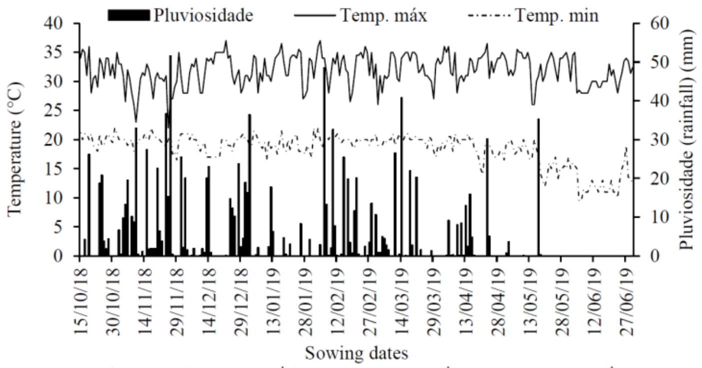
Considerable interaction was observed when evaluating grain yield. Data were fitted to positive linear regressions for the 1st and 3rd sowing times, and a quadratic regression for the 5th period (Figure 6).

In the 1st and 3rd sowing times, it is possible to observe that the grain yield values of 5,245 and 3,450 kg ha^{-1}, a growth of 52.44 and 30.07%, respectively, when using the 200 kg ha^{-1} nitrogen dose, compared to the control plants (without adding N coverage). A quadratic regression fit was verified for the 5th sowing time, with maximum grain yield of 2960.14 kg ha^{-1} when treated with an estimated nitrogen dose of 134.26 kg ha^{-1} (Figure 6). Furthermore, a reduction in grain yield was observed as the sowing times were delayed, thus indicating the formation of light grains. This

Table 1. Summary of the analysis of variance of leaf nitrogen content (LNC), relative chlorophyll index (RCI), plant height (PH), first ear insertion height (FEI), and leaf dry mass (LDM) of the green corn crop according to the sowing dates and nitrogen doses in topdressing. Ipameri-GO, 2019.

Source of variation	P-value					
	DF	LNC	RCI	PH	FEI	LDM
Sowing times (T)	4	<0.01**	<0.01**	<0.01**	<0.01**	<0.01**
Doses (D)	4	<0.01**	<0.01**	<0.01**	<0.01**	<0.01**
Block	3	0.07ns	0.07ns	0.30ns	0.25ns	0.12ns
T x D	16	<0.01**	<0.01**	<0.01**	<0.01**	<0.01**
	Square mean					
Error	72	5.05	4.01	<0.01	<0.01	0.67
Averages	-	34.38	38.92	2.09	1.20	13.75
CV (%)	-	6.54	5.15	1.41	2.24	5.96

*significant by the F-test (p <0.05); **significant by the F-test (p <0.01); nsnot significant.



1st time: 10/19/2018; 2nd time: 11/29/2018; 3rd time: 01/08/2019; 4th time: 02/18/2019 and 5th time: 03/28/2019

Fig 1. Maximum and minimum temperature, and pluviosidade in the experimental area, in Ipameri, GO, from October 2018 to June 2019.

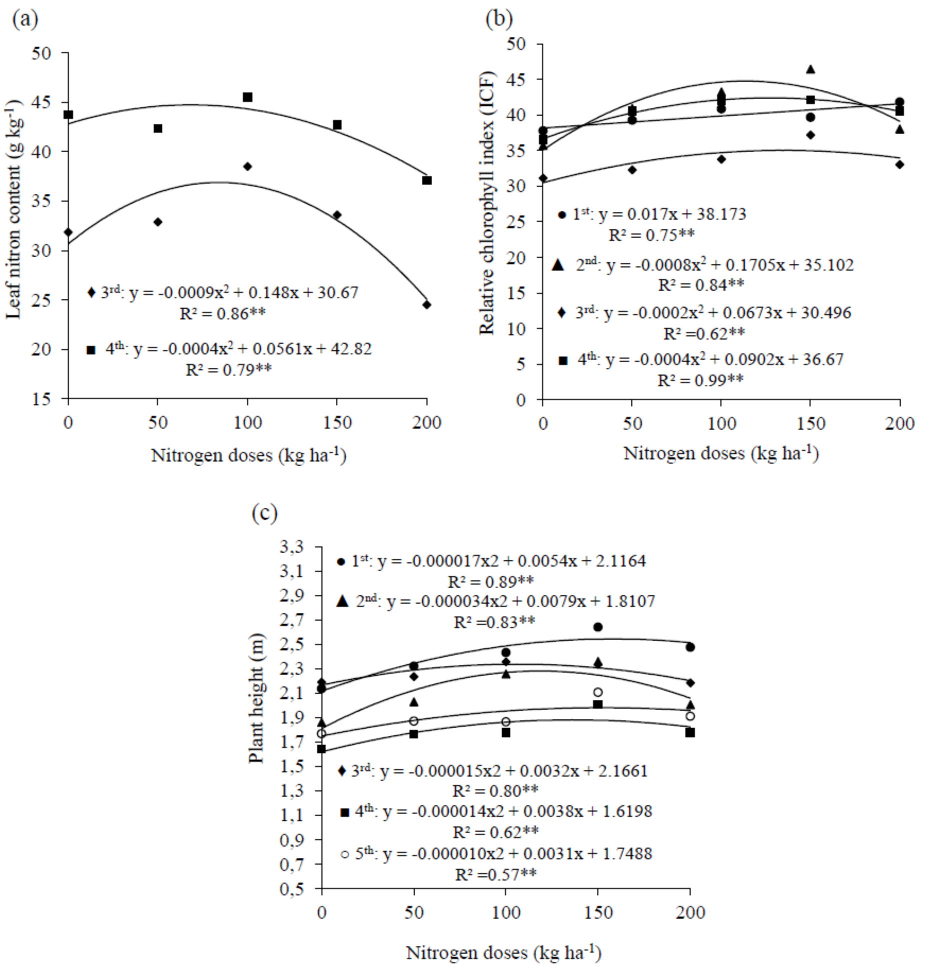


Fig 2. Interaction between sowing times and nitrogen doses for leaf nitrogen content: LNC (a), relative chlorophyll index: RCI (b), and plant height: PH (c) of the green corn crop according to the nitrogen doses in topdressing fertilization. Ipameri-GO, 2019. *significant at 5% probability; **significant at 1% probability. [1st (10/19/2018); 2nd (11/29/2018); 3rd (01/08/2019); 4th (02/18/2019) and 5th (03/28/2019)].

Table 2. Summary of the analysis of variance of ear length (EL), ear diameter (ED), total ear yield with husks (TEY), the yield of the commercial ear without husks (CEY), and grain yield (GY) of the green corn crop according to the sowing dates and nitrogen doses in topdressing. Ipameri-GO, 2019.

Source of variation	P-value					
	DF	EL	ED	TEY	CEY	GY
Sowing Times (T)	4	0.08[ns]	<0.01**	<0.01**	<0.01**	<0.01**
Doses (D)	4	0.2[ns]	<0.01**	<0.01**	<0.01**	<0.01**
Block	3	0.8[ns]	0.26[ns]	0.30[ns]	0.20[ns]	0.11[ns]
T x D	16	0.2[ns]	0.18[ns]	0.08[ns]	0.15[ns]	0.02*
	Square mean					
Error	72	0.54	2.21	1363993	1131747.3	489044.6
Averages	-	18.85	40.28	12693.7	7846.2	3174.3
CV (%)	-	3.90	3.69	9.20	18.56	22.03

*significant by the F-test ($p < 0.05$); **significant by the F-test ($p < 0.01$); [ns]not significant

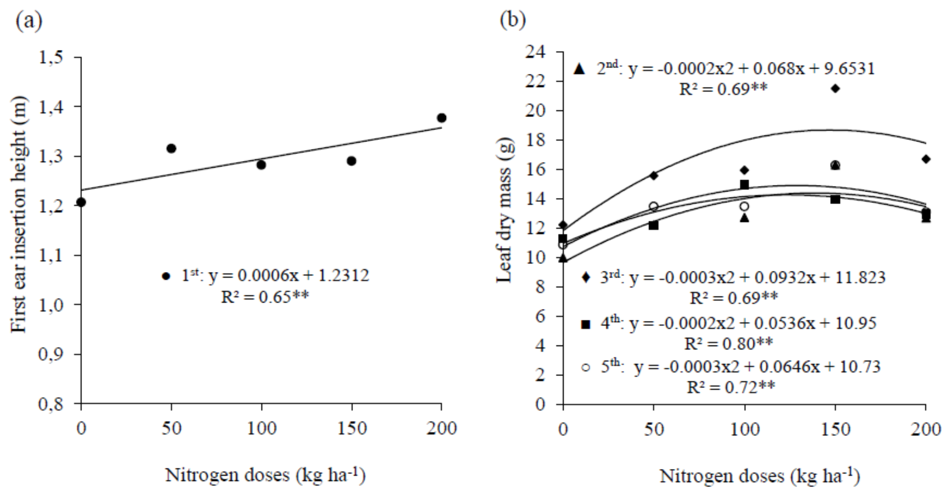


Fig 3. Interaction between sowing times and nitrogen doses for first ear insertion height (a) and leaf dry mass (b) of the green corn crop according to the nitrogen doses in topdressing fertilization. Ipameri-GO, 2019. *significant at 5% probability; **significant at 1% probability. [1st (10/19/2018); 2nd (11/29/2018); 3rd (01/08/2019); 4th (02/18/2019) and 5th (03/28/2019)].

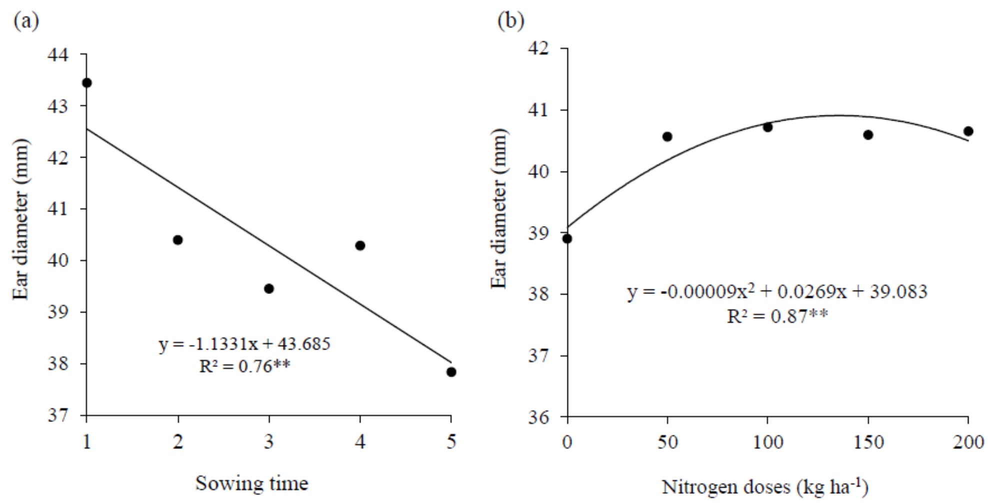


Fig 4. Ear diameter according to the sowing time (a) and nitrogen doses in topdressing fertilization (b) of green corn crop. Ipameri-GO, 2019. *significant at 5% probability; **significant at 1% probability.

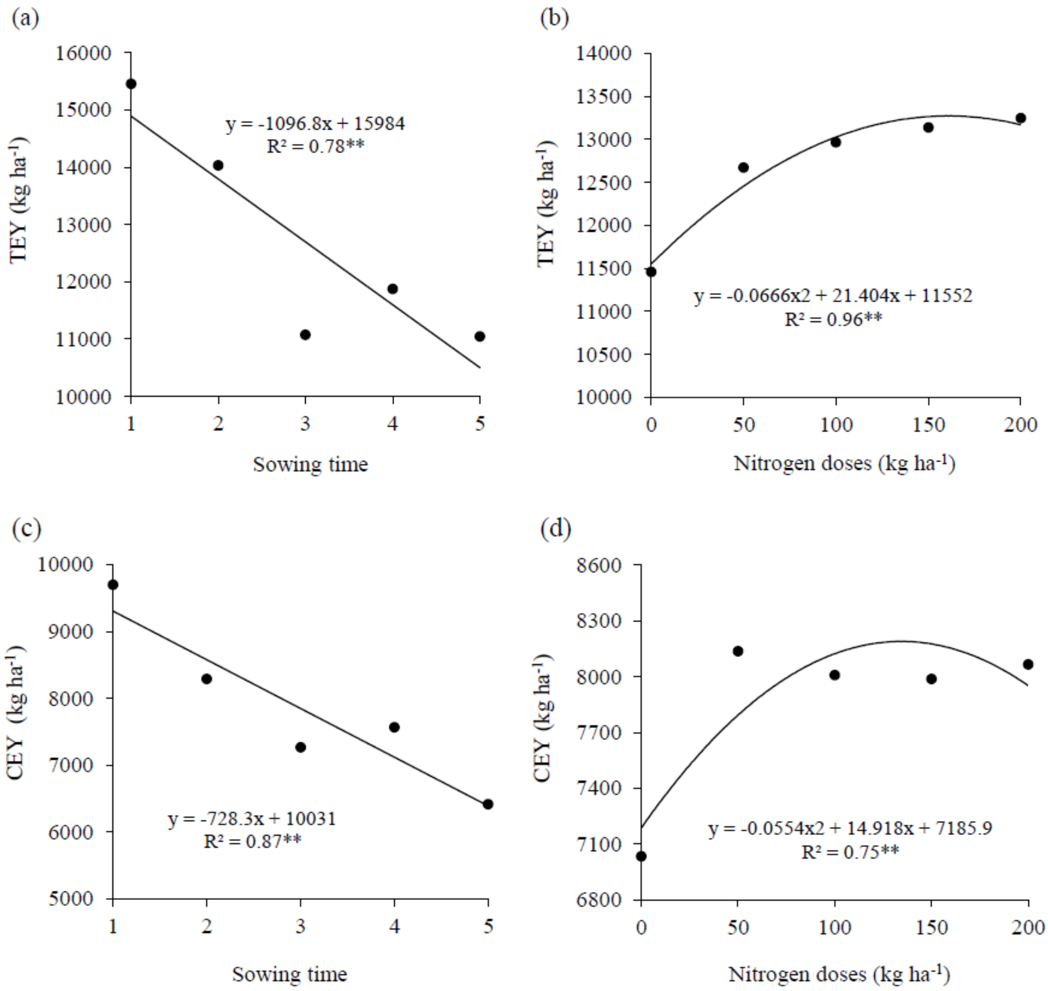


Fig 5. Total ear yield with husks (TEY) and yield of the commercial ear without husks (CEY) for sowing time (a, c) and nitrogen doses (b, d) in topdressing of the green corn crop. Ipameri-GO, 2019. *significant at 5% probability; **significant at 1% probability.

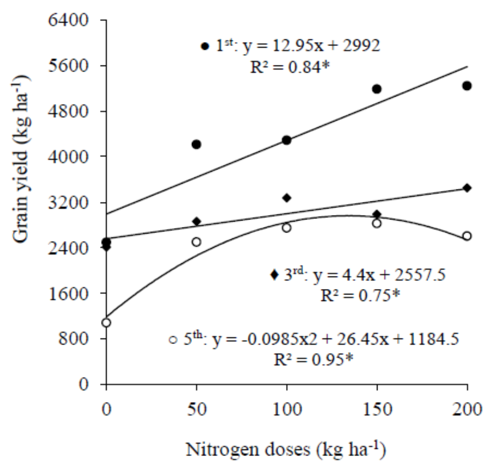


Fig 6. Interaction between sowing times and nitrogen doses for grain yield of the green corn crop according to the nitrogen doses in topdressing fertilization. Ipameri-GO, 2019. *significant at 5% probability; **significant at 1% probability. [1st (10/19/2018); 3rd (01/08/2019); and 5th (03/28/2019)].

fact is attributed to the reduction of photosynthetic activity and the translocation of carbohydrates from the stem and leaves to the grains, coinciding with the grain filling period (Galon et al. 2010).

Therefore, from the results gathered in this work, it can be asseverated that climatic conditions such as temperature and water availability are parameters that must be taken into account in the cultivation of green corn, as they greatly influence the crop yield at different sowing times. Nitrogen fertilization must also be considered, as this chemical element, besides being indispensable for some plant functions, directly relates to the yield of the corn crop.

Materials and methods

Location and installation of experiment

The experiment was carried out between October 2018 and June 2019 in a commercial field, on the experimental farm of the State University of Goiás, Ipameri University Unit, in Ipameri-GO, at 17°71'53'' S, 48°13'30'' W, and 800 m of altitude.

The region's climate, according to the Köppen-Geiger classification (Cardoso et al. 2014), is classified as a tropical climate (Aw-type) with a dry season in winter. The soil of the experimental area is classified as a Latossolo Vermelho-Amarelo distrófico with a clay texture (Embrapa, 2018). Chemical attributes and particle-size analysis of the soil were carried out before the installation of the experiment, according to the methodology proposed by Ribeiro et al. (1999), presenting the following values of chemical attributes in the 0-20 cm soil layer: P (Melich-1): 9.3 mg dm^{-3}; O.M.: 17.1 g dm^{-3}; pH; 6.20 pH ($CaCl_2$); K: 0.26 $cmol_c$ dm^{-3}; Ca: 2.40 $cmol_c$ dm^{-3}; Mg: 0.90 $cmol_c$ dm^{-3}, H+Al: 1.70 $cmol_c$ dm^{-3}, and base saturation: 67.7%.

Statistical design and plant materials

The experimental design used was a randomized block in a 5 x 5 factorial scheme, with five sowing times with 40-day intervals after the first sowing and five nitrogen doses (0, 50, 100, 150, and 200 kg ha^{-1}), with four replicates. Urea was used as a nitrogen source with 45% N.

Each experimental plot consisted of five rows with 5.0 m long and row spacing of 0.50 m, with a total area of 15 m^2. The average plant population was 66,000 plants per hectare. The three central rows were considered a useful area, excluding one meter on each end, making a total area of 9.0 m^2.

The sowing of the corn crop was performed mechanically, through direct sowing, over sorghum straw (*Sorghum bicolor* L.), using the hybrid LG 6030. The sowing of the five times was carried out with the aid of a seed-drill seven rows. The five sowing times were: [1^{st} (10/19/2018); 2^{nd} (11/29/2018); 3^{rd} (01/08/2019); 4^{th} (02/18/2019) and 5^{th} (03/28/2019)].

Fertilizing was carried out together with sowing, using 300 kg ha^{-1} of the NPK formulation 08-22-15 (N-P_2O5-K_2O), for all sowing times. The top-dressing fertilization (doses application) was performed manually when the plants had six fully expanded leaves (growth stage V6) and applied along the entire length of the sowing row with the aid of a measuring cup, made with disposable plastic. The other necessary crop managements during the conduct of the experiment in the five sowing times were carried out according to the technical recommendations for the crop.

During the entire experiment duration, data of maximum and minimum temperature in Celsius degrees (°C) and rainfall in millimeters (mm) were collected daily at the meteorological station of the University Unit of Ipameri.

Evaluated characteristics

The harvests were carried out manually as the ears reached the point of milk grain, growth stage R3, when the grains had 70 to 80% water content, considering the ideal point for fresh commercialization, approximately 90 days after sowing, for each sowing time.

After the establishment and development of the culture, the evaluations of the relative chlorophyll index were indirectly measured in the fully expanded new leaves, always one week after fertilization, in five plants of the useful area of each plot. A portable chlorophyll meter (ChlorofiLOG model CFL 1030 Falker®) was used, and the results were expressed in Chlorophyll Falker Index (CFI).

Leaf dry mass (g): obtained when the plants were in stage R1 (silking). Ten leaves were collected per experimental unit, this being the first physiologically mature leaf, opposite and below the ear. The material was placed to dry in an oven with forced air circulation, at a temperature of 65 ºC, until reaching constant mass, after the samples were weighed on a precision digital scale.

Leaf nitrogen content (g kg^{-1}): After determining the leaf dry mass, the material was grounded in a Wiley mill equipped with 1 mm mesh sieve and packed in polyethylene bags for analysis, following the methods reported by Malavolta et al. (1997).

To determine the yield and its components, ten plants of the useful area of each plot were sampled during harvest and taken to the laboratory to determine variables such as plant height (m): the distance between the base of the plant and the end of the tassel; it was measured up individually and randomly, with the aid of a measuring tape, resulting in the average plant height per parcel; the first ear insertion height (m): the distance between the base of the plant and the insertion of the first ear in the plant was determined with the aid of a measuring tape; ear diameter (mm): obtained with the aid of a digital caliper, measuring the ear circumference; ears length (cm): obtained with the aid of a measuring tape measuring the distance between the base and the tip of the corn ear.

The total yield of ears with husks (kg ha^{-1}) was also determined: the mass of all ears harvested was gathered and then transformed in values for hectare; the yield of commercial ears without husks (kg ha^{-1}): obtained with the mass of commercial ears, without husks, and then transformed in values for hectare, and grain yield (kg ha^{-1}): obtained by cutting the grains close to the surface of the cob, then weighted and transformed in values for hectare.

Statistical analysis

Collected data were submitted to the analysis of variance and the F-test ($p<0.05$), and when significant, data were adjusted by the regression analysis with $p>0.01$ and $p<0.05$ for the sowing periods and nitrogen doses. Statistical analyzes were processed using the Sisvar statistical analysis software (Ferreira, 2014).

Conclusions

The sowing times and nitrogen doses in topdressing influenced the leaf nitrogen content, relative chlorophyll index, leaf dry mass, yield, and most of its components. Thus, it can be indicated that the best time for sowing corn for fresh consumption is in October (1st sowing time), and the estimated nitrogen dose in topdressing to obtain the maximum yield is 160 kg ha^{-1} of nitrogen.

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