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Production indicator models for fodder maize (*Zea mays L.*) in the Comarca Lagunera II

Modelos de indicadores de producción para maíz forrajero (*Zea mays L.*) en la Comarca Lagunera II

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Abstract

Forage corn is a crop in greatest demand in the Comarca Lagunera. The objective is to obtain the models for the production indicators of forage maize hybrids, which could improve the production systems. The variables evaluated were: leaf area index (IAF), number of leaves and dry matter (DM). The DM model as a function of the IAF was 17.13 grams plant per unit of IAF. For the days after sowing (DDS) a production of 5 grams plant / elapsed day was found. For IAF based on DDS, 0.36 units of IAF were obtained per day and the IAF increased by 0.65 units as a function of the number of leaves. It is concluded that the behavior of the evaluated variables provides results of linear and polynomial regression models, with different levels of reliability, which allow future estimates to be made to choose the hybrids that best adapt to the region.

Forage corn, Leaf area index, Models

Resumen

El maíz forrajero es un cultivo de mayor demanda en la Comarca Lagunera. El objetivo es obtener los modelos de indicadores de producción de híbridos de maíz forrajero, los cuales podrían mejorar los sistemas de producción. Las variables evaluadas fueron: índice de área foliar (IAF), número de hojas y materia seca (MS). El modelo de MS en función del IAF fue de 17.13 gramos planta por unidad de IAF. Para los días después de siembra (DDS) se encontró una producción 5 gramos planta/día transcurrido. Para IAF en función DDS se obtuvieron 0.36 unidades de IAF por día y el IAF se incrementó de 0.65 unidades en función del número de hojas. Se concluye que el comportamiento de las variables evaluadas proporciona resultados de modelos de regresión lineales y polinomiales, con diferentes niveles de confiabilidad, que permiten hacer futuras estimaciones para elegir los híbridos que mejor se adapten a la región.

Maíz forrajero, Indice de área foliar, Modelos

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Introduction

Corn is of great economic importance worldwide either as human food, as feed for livestock or as a source of a large number of industrial products (Paliwal, 2001). In Mexico in 2020 a total of 28 million tons was produced, ranking 8th worldwide. The Lagunera region ranks second nationally with 50,993 ha of forage corn (SADER 2020). This is due to the use of hybrids considered as foragers, due to their great capacity to produce forage (Núñez et al., 2003). Currently there is a great variety of hybrids that are sown in the Lagunera region, which makes it necessary to obtain short-term production indicators for forage corn hybrids that meet production and adaptation expectations.

The use of models allows an advance representation of the role of the components and resources, the advantages that modeling offers to obtain coefficients from data and later make future estimations from an equation. The above represents a great importance in agriculture, for the management and planning of future productive systems (Candelaria et al., 2011). The leaves are responsible for intercepting the radiation to carry out the photosynthesis process, a relationship has been found between the relative intensity of light and the accumulated leaf area index, having that the light is extinguished exponentially as a function of the increase in the leaf area (Van Heemst, 1988); the biomass production by the crop will depend fundamentally on the duration of its cycle and the efficiency with which it captures the light resource.

This framework of interpretation assumes that the accumulation of dry matter by the crop is the consequence of the interception of incident light by the leaves and by their architecture to assimilate sunlight, followed by its conversion into chemical energy. Therefore, the impact of the studied factor of the leaf area index is of great relevance to interpret and later model the accumulation and biomass yield. Photosynthetic tissue is extremely important in photosynthesis, it is a fundamental element of growth and productivity. Its dynamics can be monitored by means of the leaf area index, which represents the amount of leaf surface supported (m2) by a given surface area (m2) (Yang et al., 2006).

As fully described (Kross et al., 2014), the leaf area index is an excellent indicator of crop development, it is used as an input variable for crop growth models and its yield forecast allows estimating the capacity photosynthesis of plants helping to understand the relationship between biomass accumulation and yield under different environmental conditions (Acosta et al., 2008).

The objective of this work was to obtain models and values of production indicators of the leaf area index, number of leaves and dry matter, for the hybrids: Sorento, Lucino, Abt 1280, 6008w and 6018w.

Methodology

The work was carried out in the agricultural cycle spring - summer of 2017 in the facilities of the Technological Institute of Torreón, located on the Torreón-San Pedro highway, km 7.5 Torreón, Coahuila, Mexico. The land was prepared with a fallow land, subsequently a tracing was carried out and the clods were eliminated with the scrap to facilitate the preparation of the melgas. Melgas with a length of 133 m long by 12 m wide were established.

The sowing was carried out on April 30, 2017 with a density of 100 thousand plants per hectare, the five forage corn hybrids were used: Lucino, Sorento, 6008w, 6018w and Abt 1280 with distance between rows of 70 cm. The fertilization formula 296-104-00 of NPK was applied, distributed as follows: at the moment of sowing 100 kg of urea plus 200 kg of MAP, at 40 days after sowing 450 kg of urea were applied and at the 82 days after sowing, 100 kg UAN-32 were applied.

Five gravity irrigations were applied throughout the crop cycle, to add a total sheet of 80 cm. For the fall armyworm control, two doses of product were applied, the first with the DENIM product and the second with granulated chlorpyrifos product at 33 and 55 days after sowing.

The variables evaluated were: leaf area index, number of leaves and dry matter. Leaf area index readings were taken with the Plant Canopy Analyzer, Licor Inc. LAI-2200, these were recorded weekly for each hybrid throughout the phenological cycle.

For the number of leaves, the average number of four plants sampled weekly for each hybrid during its entire growing cycle was taken and for the variable of weight of dry matter per plant (gr plant-1) it was measured weekly; The registered weight was four plants, which were previously placed inside perforated paper bags, this in order to have a control of each sample and better aeration and quick drying. Later they were placed in a forced air oven at a temperature of 60-65 ºC until reaching a constant weight. The production indicator models were obtained through equation linear regression analysis. Yij = β1Xi β0 eij. Where Yij = is the dependent variable, Xi = independent variable, β1 = slope of the line, β0 = intercept at the origin and eij = model errors with zero mean and one variance. The statistical analysis of the evaluated variables was carried out using the Microsoft Excel 2013 computer package and the FAUANL experimental design package. Version 2.5 (Olivares, 2012).

Results

Dry matter production model as a function of the leaf area index

The dry matter production as a function of the leaf area index for the hybrids studied was represented by a linear type model (Figure 1.). The increase in dry matter during the crop cycle is due in 73% to the growth of the leaf area index. Since a coefficient of determination (R2) of 0.73 was obtained. In the model obtained, it is observed that for each unit of leaf area index 17.13 grams of dry matter are produced per plant. Montemayor (2018) obtained two models in which he found values of 86.2 and 65.76 grams of dry matter for each unit of leaf area index, when evaluating the plastic mulch in forage corn.

The dispersion of the values observed in (Figure 1). They are attributed to the phenotypic variability of the hybrids evaluated; as were the number of leaves, plant height and dry matter per plant. The highest productions were in those hybrids with a leaf area index of eight to nine. Tinoco et al., (2008) obtained a leaf area index of 5 to 6 with yields of 7.5 tons of dry matter per hectare.

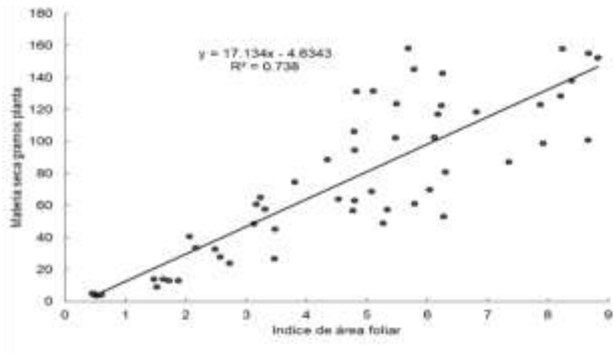

Figure 1 Dry matter production model as a function of leaf area index
Source: Own Elaboration

Dry matter production model as a function of days after sowing

Dry matter production as a function of days after sowing was represented by a second-order polynomial type model (Figure 2.). This dry matter production is explained by 78% according to the model obtained. Rivera (2013) reports a first degree polynomial model that estimates an increase of 246.2 kg ha of dry matter for each centimeter increase in the applied water surface. In the model, it is also observed that the linear effect provides us with a daily growth of dry matter per plant of five grams per day, and that this growth occurs mainly during the vegetative stage of the crop, between twenty and seventy-one days later. of sowing.

The maximum dry matter production per plant was 158 grams and this production is obtained 71 days after sowing. The quadratic effect of the model represents the period of flowering, pollination and grain filling of the crop, until reaching physiological maturity.

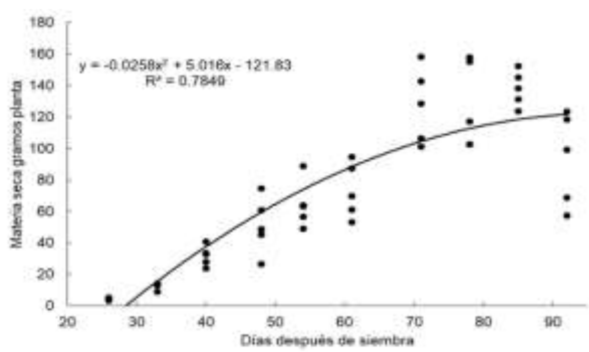

Figure 2 Dry matter model as a function of days after sowing
Source: Own Elaboration

Leaf area index production model as a function of days after sowing

The behavior of the leaf area index as a function of the days after sowing was represented by a second-order polynomial type model for the five hybrids (Figure 3). In the model, a linear effect is observed that represents a growth of the leaf area index was 0.36 units day-1. Montemayor et al., (2012) reported a linear effect of daily leaf area index of 0.251, 0.155 and 0.106, when evaluating the effect of three irrigation systems on the growth of this variable. Montemayor (2018) reported a model with a linear effect of daily leaf area index of 0.29 and 0.25 when evaluating different colors of plastic mulch.

The maximum values of leaf area index were presented after 71 days after sowing (Figure 3), while (Guevara, 2005) obtained maximum values of leaf area index from 6 to 79 days after sowing at different densities of sowing. The trend of stabilization of the growth of the leaf area index and its subsequent fall from 88 DDS, is mainly due to the fall of the lower leaves of the crop; the senescence process affects the capture of light; senescence can be accelerated by disease, water stress, low fertility, and genetic factors (Lafitte, 2001).

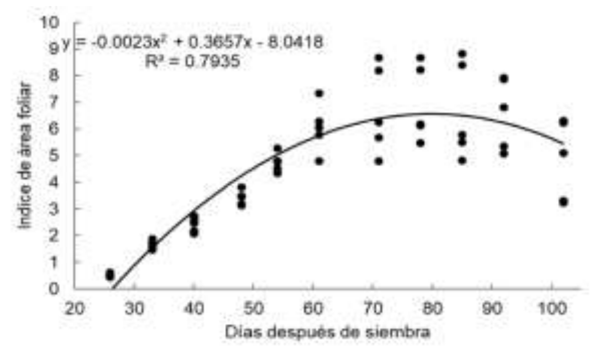

Figure 3 Leaf area index model as a function of the day after sowing
Source: Own Elaboration

General model of the leaf area index as a function of the number of leaves

(Figure 4) presents the model of the leaf area index as a function of the number of leaves during the period from 26 to 102 days after sowing. The correlation between both variables was 0.88, which explains that the leaf area index is linearly correlated with the number of leaves per plant.

The slope of the model presents 0.65 units of leaf area index per unit of leaves. Sánchez et al., (2011) obtained a trend between leaf area index and planting densities, in which, at higher planting densities, a higher leaf area index corresponds. Despite the phenotypic difference of the materials; The results allow admitting that the model can be used as a reliable tool to estimate or predict the yield in commercial plots, with an acceptable level of reliability (Báez et al., 2002).

There is a linear trend that the greater the number of leaves, the greater the leaf area index (Figure 4.). The number of leaves increases the infrared radiation emitted by the plant towards the sensor of the equipment and therefore, a higher leaf area index is recorded. The angle of inclination of the leaves impacts the architecture of the crop. Therefore, the interception and use of radiation have received considerable attention. The erect upper leaves combined with the lower horizontal leaves result in a more efficient use of radiation by the crop (Lafitte, 2001).

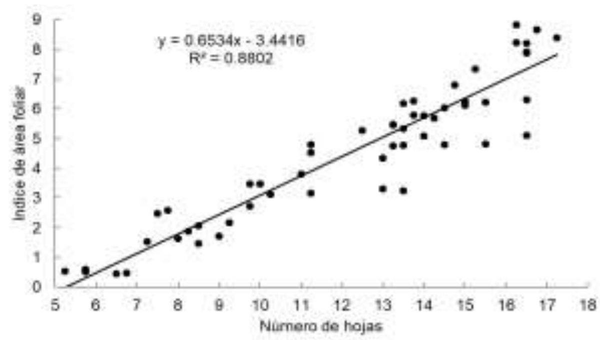

Figure 4 Leaf area index model as a function of the number of leaves
Source: Own Elaboration

Conclusions

There was variability in the growth and development of the hybrids evaluated; expressed in the difference of the production indicators, as a consequence of the phenotypic and genotypic characteristics that distinguish them. The behavior of the evaluated variables produces second order linear and polynomial regression models, with different levels of reliability. The models allow future estimates to be made to choose the hybrids that best suit the region.

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