

Yield of x'pelon bean *Vigna unguiculata* (L.) (Fabaceae) Walp. under inorganic fertilization

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ABSTRACT

Objective: The objective of this study was to evaluate the production of the X'pelón crop (*Vigna unguiculata* (L.) Walp) using two fertilization formulations.

Design/methodology/approach: In this research, two formulations based on nitrogen, phosphorus, and potassium were applied, along with a control, using a completely randomized block design. The data were analyzed using analysis of variance, Tukey's test for comparing means, and linear regression analysis.

Results: The results showed statistically significant differences in the number of pods (fruits) obtained per plant among the different fertilization treatments. However, no statistically significant differences were found between the fertilization formulas themselves, with the lowest production observed in the control group.

Limitations/implications of the study: No limitations were found in this research. It is worth noting that this type of research generates new knowledge and should therefore be conducted more frequently.

Findings/Conclusions: It is concluded that there are no statistically significant differences between the fertilization formulas, although both treatments resulted in higher pod production per plant than the control. Therefore, either fertilization formula can be recommended.

Keywords: Production, Fertilization, Fabaceae.

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INTRODUCTION

Legumes are characterized by their legume-shaped fruit. Legumes are seeds with a low-fat content. There are 150 species recorded as being used for human and animal consumption, the most important being beans (*Phaseolus* spp.); lentils (*Lens culinaris medicinalis* or *Lens esculenta* Moench.); peas (*Pisum sativum* L.); chickpeas (*Cicer arietinum* L.); broad beans (*Vicia faba* L.), and cowpeas (*Vigna unguiculata* (L.) Walp. or *Vigna sesquipedalis* Fruhw., *Vigna sinensis* (L.) Savi exd Hassk (Alonso *et al.*, 2010). In Mexico, legumes are economically important from a nutritional, cultural, social and primary sector perspective. Within this large group, there is the genus *Vigna savi*, which belongs to the Fabaceae family and among the species of this genus is *V. unguiculata* (Boukar *et*



et al., 2019, Monge *et al.*, 2019). This plant is known by different names; worldwide, it is recognized as cowpea (Badiane *et al.*, 2014). In the country, due to the characteristics of the plant, it has been given different common names, for example, in the south it is known as x'pelón, espelón, black-eyed bean, sin tiempo, or simply pelón bean. (Lecuona-Villanueva *et al.*, 2006).

The cowpea (*Vigna unguiculata* [L.] Walp.) is a legume native to Africa (Morales-Morales *et al.*, 2019; Amelio *et al.*, 2023). It offers agronomic, environmental, and economic advantages in semi-arid tropical regions (Araméndiz-Tatis *et al.*, 2011). Estimates indicate that around 11 million hectares have been established worldwide (Cardeiro *et al.*, 2019). All parts of this species can be used for human and animal consumption, including its leaves, pods, grains, and flour (Gonçalves *et al.*, 2016). For human consumption, the main product used is the grain, which contains a high nutritional value, rich in proteins and essential amino acids. This makes it an important alternative to meet global food needs (Araméndiz-Tatis *et al.*, 2016; Gonçalves *et al.*, 2016; Carneiro *et al.*, 2019).

The x'pelón bean has been reported to have properties rich in protein, carbohydrates, dietary fiber, iron, zinc, vitamin C, thiamine, riboflavin, niacin, total folate, and saturated fatty acids. It is also used for medicinal purposes (Pandey, 2019). This legume, like others, is cultivated to improve soil fertility (Ríos-Castillo *et al.*, 2018). X'pelon is adaptable, and has therefore been cultivated in a wide variety of soils. Previous studies have reported that it obtains better results in well-drained soils with medium fertility and that it is resistant to heat compared to other legumes (Arnon, 1972). Likewise, x'pelon plays an important role in the agricultural system, as it compensates for the loss of nitrogen absorbed by other crops, thus causing a beneficial impact in the soil because it has the ability to fix atmospheric nitrogen (Mendieta López, 1999; Aguila *et al.*, 2014; Soriano Soriano *et al.*, 2019). X'pelon is currently considered an important economic source for local producers, together with the contribution of essential nutritional elements to the local population who consume it in different typical dishes of the region (Márquez-Quiroz *et al.*, 2015). Therefore, this research aimed to know the production of the *V. unguiculata* crop fertilized with two chemical formulas.

MATERIALS AND METHODS

Description of the study site

The study was carried out at the Technological Institute of Chiná, Campeche, Mexico (19° 46' 14.66" N and 90° 30' 6.95" O, with an elevation of 27 meters above sea level). The climate of the region is warm or hot climate with little precipitation, in the study period the minimum annual temperature was 19.6 °C and maximum 37.8 °C, and an annual precipitation of 1 132.5 mm, for the year 2025 (CONAGUA, 2023).

Experimental design

A 3×3 randomized block design was used in an area of 20 m². Treatments consisted of applying 100 g per strain (consisting of four plants) of two granulated chemical fertilizers composed of nitrogen (N), phosphorus (P), and potassium (K), for which two formulas N18-P46-K00, N17-P17-K17, and a control were applied. This is equivalent to 1.8 g of N, 4.6 g

of P, and 0.0 g of K in the case of the first formula, while in the case of the second formula, 1.7 g of N, P, and K of each of the elements would be applied to each plant strain. If this were applied to one hectare, 120 kg of N and 307 kg ha⁻¹ of P of the 18-46-00 formula would have to be applied. For the 17-17-17 formula, 113 kg ha⁻¹ of each element, N, P, and K, would have to be applied. Each treatment had 10 vines. Fertilizer application was carried out on each vine, burying the fertilizer 5 to 10 cm into the soil (10 cm from the stem of the vine) on two different dates. The first application was made 15 days after planting (50 g), once all the seedlings had emerged, and the second was applied 20 days after the first with the same amount of fertilizer (50 g).

V. anguiculata seeds were obtained from a cooperating farmer in the community of Pich, Campeche, Mexico, and showed 97% viability. Sowing was done by hand, using the club method, burying the seeds at a depth of 3 to 5 cm. Planting spacing was 30 cm between vines and 50 cm between rows, yielding approximately 66,667 vines ha⁻¹ in a ferric luvisol soil (Kankab in the Mayan classification). Planting took place on October and three harvests were performed at different times to evaluate pod yield. The first harvest was on December (60 days after planting), the second on February (112 days after planting), and the last on February (123 days after planting). The variables evaluated were pod number and pod weight. The data obtained were analyzed using ANOVA, means were compared using Tukey's Multiple Range test ($p < 0.05$), and a regression was performed between pod weight and grain weight to generate an equation for estimating grain quantity based on whole pod weight. These data were processed using INFOSTAT 2020 statistical software.

RESULTS AND DISCUSSION

Number of pods produced

First of all, it is important to mention that this research was not free from the presence of pests, the main one being the aphid (*Aphis fabae*), which was successfully controlled using garlic (*A. sativum*) and onion (*A. cepa*) extract as mentioned in the methodology. Regarding crop production, at the end of the evaluation period, the production in number of harvested pods did show statistically significant differences ($P < 0.0001$) between treatments. However, the opposite was true between treatments. Figure 1 shows that formula 17-17-17 is slightly higher (17.05 ± 11.13 pods/strain) than formula 18-46-00 (16.43 ± 10.16 pods/strain), while the lowest production was seen in the control (11.75 ± 7.08 pods/strain) (Figure 1).

Regarding the number of pods produced in the different harvest periods between treatments, a differentiated behavior was observed. In the first harvest (60 days after planting), the results show statistical differences ($p = 0.0026$), although the treatment with the 18-46-00 formula did not differ from the other treatments, of which the best was the 17-17-17 formula and the worst the control. In the second harvest (112 days after planting), statistical differences were also shown ($p = 0.0003$), where, as in the first harvest, there were no statistical differences between the fertilization treatments, and the control was again the one with the lowest pod production. In the last harvest (123 days after planting), no statistical differences were observed ($p = 0.2747$) between treatments,

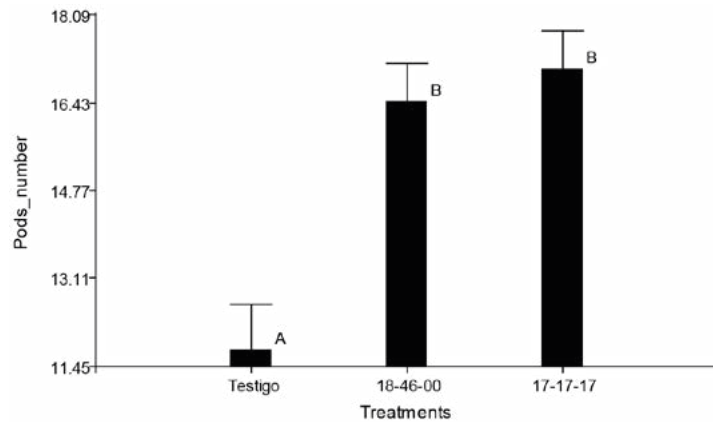


Figure 1. Production of x'pelón (*Vigna anguiculata* [L.] walp) pods with different inorganic fertilizers. Formula 17-17-17 (113 kg ha⁻¹ of N, P, and K) and 18-46-00 (120 kg of N, and 307 kg of P ha⁻¹) after 123 days of cultivation.

although, as observed on the different dates, the highest number of pods was obtained in treatments with chemical fertilizers (Figure 2).

Weight of pods with seeds

The weight of pods with seeds between treatments did not show statistically significant differences ($p=0.05$) at the end of the evaluated period (Figure 3). However, when comparing treatments between dates, only the first harvest (60 days after planting) showed statistically significant differences between treatments ($p<0.0001$), where the control (5.7 ± 1.57) and formula 18-46-00 (5.66 ± 1.61) were the ones that obtained the highest weights, while formula 17-17-17 obtained the lowest average value (3.06 ± 0.75) in pod weight with seeds. In the two subsequent harvests, there were no statistically significant differences between treatments (Figure 4).

This may possibly need to be reinforced with manure or other organic material mixed with inorganic fertilizers. Iwanthika and Thayamini (2023) report in their research work that they applied a mixture of 10 t/ha of poultry waste mixed with 75% triple

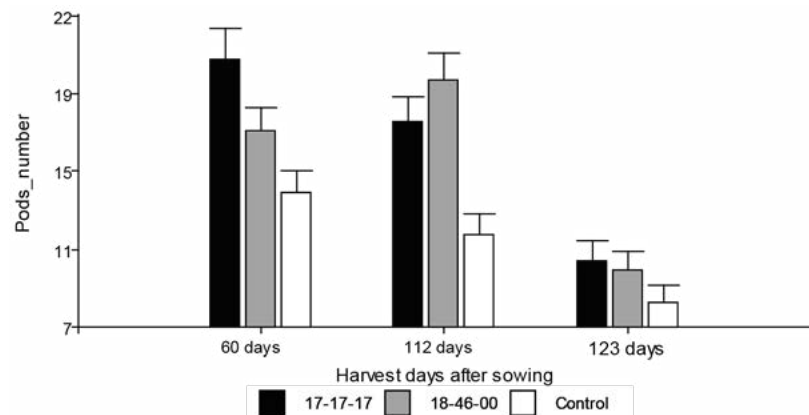


Figure 2. Number of x'pelón (*Vigna anguiculata* [L.] walp) pods produced under different inorganic fertilization treatments on different harvest dates. 60 days, 112 days, 123 days.

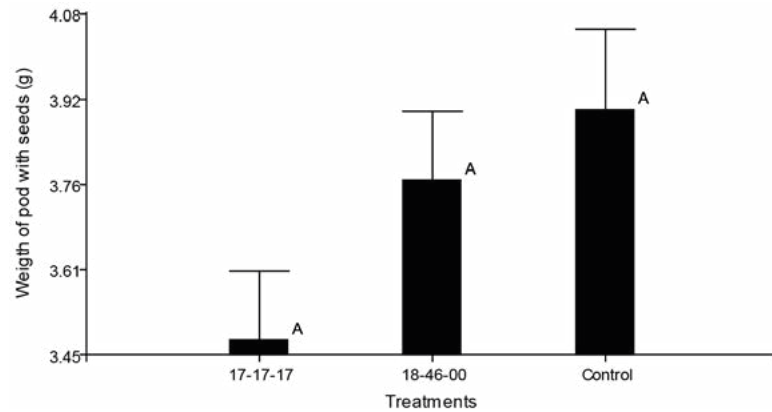


Figure 3. Weight of pods with x'pelón seeds (*Vigna anguiculata* [L.] walp) produced under different chemical fertilization treatments harvested after 123 days after sowing.

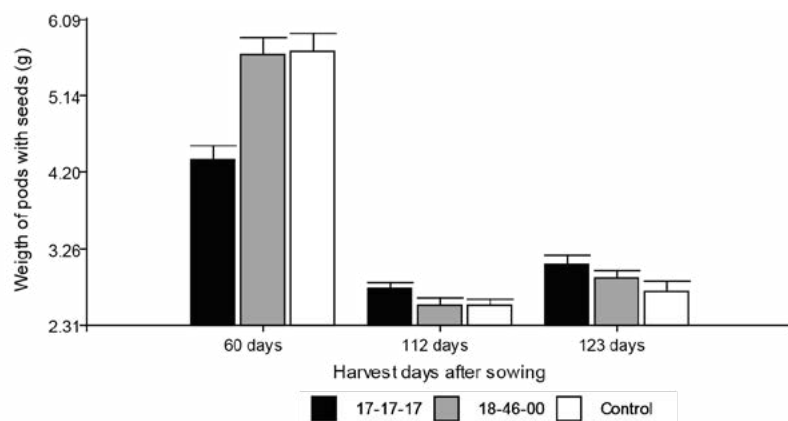


Figure 4. Weight of pods with seeds of x'pelón (*Vigna anguiculata* [L.] walp) produced under different chemical fertilization treatments harvested on different dates. 60 days, 112 days, 123 days.

superphosphate and 75% MOP (00-00-60), which showed a higher yield compared to other fertilization treatments in the cultivation of x'pelón in a sandy regosol soil. This was observed through a literature review, where different investigations report the positive relationship that exists between a combined fertilization of organic fertilizer + NPK + biofertilizers (Kaur and Rawat, 2020). Therefore, the use of inorganic fertilizers provides nutrients quickly, but they can affect, and affect the characteristics of the soil, which was observed in this research, being better in the number of pods, but not in their weight. For their part, da-Conceição *et al.* (2023), points out that the yield and productivity of x'pelón in the Yucatan Peninsula is better under irrigated conditions, since the humidity factor is decisive in the length of the fruits and the large size of the seed.

Linear regression analysis generated an equation to estimate the seed weight that can be obtained from whole pods. This will allow us to estimate the kilograms of *V. anguiculata* seeds that can be obtained by removing the hulls from the pods, with the advantage of not having to shell all the pods (Figure 5).

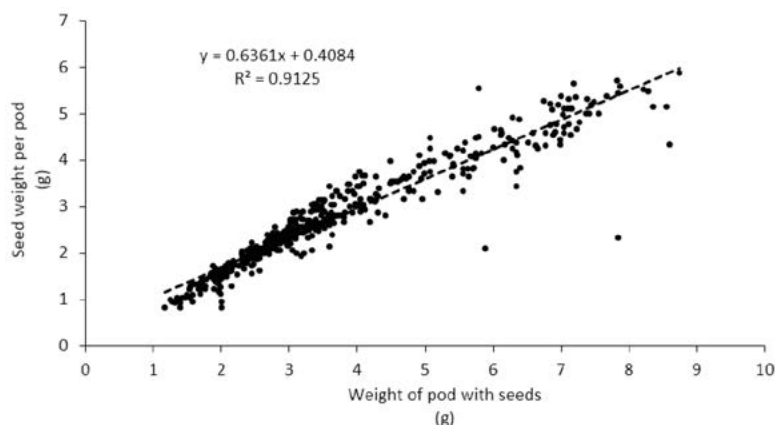


Figure 5. Linear regression analysis of the relationship between seed weight and whole pod weight of x'pelón (*Vigna unguiculata* [L.] walp) produced under different chemical fertilization treatments.

CONCLUSIONS

The objective of this research was to determine the yield of *V. unguiculata* crops fertilized with two chemical formulations. The results suggest that the use of chemical fertilizers does influence the yield of x'pelón crops, improving production in both fertilization formulas compared to the control (without fertilization), making it feasible to use either of the two fertilizers.

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