Colegio de Postgraduados

Commercial amino acids for yield and its components of common bean Azufrado Reyna in Northern Sinaloa

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ABSTRACT

Objective: To investigate the effect of foliar commercial amino acids on yield and its components of common bean Azufrado Reyna under field conditions.

Design/methodology/approach: Randomized complete block design with four replicates and four treatments (three commercial amino acids and a control). Grain yield, aboveground biomass, number of pods and normal seeds per unit surface, number of grains per pod, number of normal seeds per pod, weight of 100 seeds, and individual weight of seed were evaluated.

Results: All biostimulants influenced the increase in grain yield, aboveground biomass, number of normal pods and seeds per unit surface as well as the number of seeds per pod with respect to the control.

Limitations on study/implications: The study only assessed the evaluation of agronomic variables; therefore, it is necessary the measurement of morpho-physiological traits that provide evidence about the benefits of foliar aminoacids on yield and the formation of each component under field conditions.

Findings/conclusions: Foliar biostimulant application had a positive effect on grain yield and some of its components as compared to the control. The number of normal seeds per normal pod was the variable that showed the highest correlation with grain yield.

Keywords: amino acids, yield, aboveground biomass.

INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is a significant crop for human consumption because it is a good source of minerals, proteins and fiber (Siwakoti *et al*., 2023). The state of Sinaloa ranked fourth in planting and harvesting surface (85,924.98 ha), with a production of 165,474.96 tons and an average yield of 1.93 t ha^{-1} by 2020 (SIAP, 2022). However, its production is limited by several abiotic factors, such as

drought, salinity, cold, freezing, and high temperatures that affect crop growth and development (El-Nasharty *et al.*, 2021). Thus, agronomic management practices based on biostimulant application represent an ecological tool to prevent or ameliorate stress (Kocira *et al.*, 2020). Amino acids (animal or plant source) have benefits on several physiological processes such as photosynthetic capacity, availability and translocation of nutrients, and quality parameters (Malécange *et al.*, 2023). Besides, physiological processes in plants are regulated by short-chain free amino acids (Rai, 2002). They are basic components of protein synthesis, promote active functions in plant development, participate in their response to environmental stress, and act as precursors of primary and secondary metabolites (Trovato *et al.*, 2021). Furthermore, amino acid application at the beginning of flowering enhances the yield of common bean and improves the nutrient use efficiency (Moreira and Moraes, 2017). Several studies show that amino acid application in crops has positive effects on growth parameters (Ismail and Fayed, 2020; Zaky *et al.*, 2021; El-Hay *et al.*, 2022) and yield (Zewail, 2014; Teixeira *et al.*, 2018; Baqir *et al.*, 2019). Based on this background, the objective of this study was to evaluate the effect of commercial amino acids on the yield and components of common bean Azufrado Reyna under field conditions.

MATERIALS AND METHODS

Location of the experiment

A field experiment (season 2023-2024) was conducted at the experimental site within Facultad de Agricultura del Valle del Fuerte, Universidad Autonoma de Sinaloa (25° 45' 20.88" N, 108° 50' 22.16" W and 14 m above sea level). Soil tillage techniques were those employed by growers of the region. A composite surface 30 cm soil sample was collected before fertilization for fertility evaluation. The soil was classified as clay loam (50% clay, 30% silt and 20% sand), low organic matter content (0.48%), bulk density of 1.15 g cm^{-3}, pH (6.3), E.C (1.38 dS m^{-1}), NO_3^{-1} (365 ppm), PO_4^{-1} (12 ppm), soluble K (28 ppm), exchangeable K (387 ppm), exchangeable Ca (1900 ppm), exchangeable Mg (540 ppm), Na (184 ppm), Fe (8.60 ppm), Mn (12.32 ppm), Cu (1.60 ppm) and Zn (1.23 ppm). The planting was done on moistened soil (November 3rd, 2023), and approximately 12 seeds m^{-1} of variety Azufrado Reyna were planted. These plants have determinate growth habit, can reach up to 40 cm in height, and are well adapted in northern and center Sinaloa and south Sonora. Their seed testa color is yellow, round-oval shape, and resistant to oxidation. The crop begins its flowering at approximately 52 days after planting and has good yield levels in irrigated areas, especially in northern Sinaloa (Iramfra, 2021). The fertilization rate was 500 kg ha^{-1} of Nitrofoska®Triple16. Irrigations were applied at the beginning of flowering (38 dap) and pod filling (67 dap). Besides, insecticide application (Imidacloprid®) was performed to control whitefly (*Bemisia tabaci*) and aphids at a rate of 2.5 L ha^{-1}, and weeds were manually controlled throughout the season.

The experiment consisted of four treatments (three commercial amino acids and the control): T1 without amino acid; T2 Aminocel 500® (1 kg ha^{-1}), animal derived product that contains 50% free amino acids, 10% N, 8% P_2O_5, 10% K, 0.1% Fe, 0.003% Zn, 0.02 Mn, 0.01% Mg, 0.005% Mo and 0.01% B; T3 Amino 80® (1 kg ha^{-1}), plant derived product that contains 80% free amino acids, 12% N and <4% ammonium; T4) Fito-maat® (300 g ha^{-1}) plant derived product that contains 8% glycine betaine+1% proline, 9% N and 50% C.

All biostimulants were in powder form and were foliar applied at 35, 49 and 74 days after planting using a 20 L sprayer pump. The treatments were arranged in a randomized complete block design with four replicates. The experimental unit consisted of seven rows (0.8 m between rows and 5 m long) with a density of 12 plants m^{-1}. The useful plot consisted of two rows, and plants were taken from an area of 2.4 m^2.

Response variables

Seed yield (SY, kg ha^{-1}) was determined by taking the seed weight ratio to the harvested area (2.4 m^{-2}). Aboveground biomass at physiological maturity (DB, kg ha^{-1}) was determined by weighing the plants from each useful plot. Normal pods (NP m^2) were estimated by counting the total number of pods in each useful plot. A normal pod was considered to have at least one seed with the size and color of Azufrado Reyna Variety.

Seeds per pod (SP) was determined by counting the average number of seeds in 40 randomly selected pods from the sample used to determine seed yield.

Normal seeds (NS m^{-2}) were estimated by taking the ratio of total pods and the harvested area (2.4 m^{-2}). The number of normal seeds per normal pod (NSNP) was determined by taking the ratio of seeds per pod and total number of pods. Weight of 100 seeds (W100S, g) 100 seeds were randomly selected and weighted on a digital scale (Ohaus®). Individual seed weight (ISW, mg) was estimated by taking the ratio between the weight of 100 seeds and 100.

Statistical analysis

All data was subject to normality test (Shapiro and Wilk, 1965) and to an appropriate analysis of variance. Pearson correlation models were fitted and tested on significance levels ($p<0.0.05$) (Infostat®, 2020).

RESULTS AND DISCUSSION

Seed yield and its components were statistically ($p\leq0.05$) affected by the applied biostimulants, except for the weight of 100 seeds and individual seed weight that were similar. The application of Fito-maat® showed higher seed yield (19%). However, it was similar to treatments with Aminocel500® (15%) and Amino80® (3%), and with respect to the control (Table 1). The biostimulant Fito-maat® contains glycine-betaine, an amino acid that has been found to promote higher seed yield even in drought conditions, since it influences the increase of yield components, membrane stability, photosynthetic performance, and the antioxidant system (Ahmed *et al.*, 2019).

Aboveground biomass and number of normal pods were similar in all treatments but higher than the control. Accordingly, dry biomass was 21, 21 and 16% higher in

Table 1. Yield and its components of common bean Azufrado Reyna.

Treatment	SY kg ha^{-1}	DB kg ha^{-1}	NP m^2	SP	NS m^2	NSNP	W100S g	ISW mg
Fito-maat®	4342.3 a	6447.5 a	395 a	4.11 a	927 a	2188	46.7	47
Aminocel500®	4161.7 ab	6449.7 a	334 a	4.17 a	958 a	2264	44.7	45
Amino80®	3645.7 ab	6075.7 a	334 a	4.04 ab	834 ab	2001	48.0	48
Control	3535.0 b	5076.3 b	228 b	3.76 b	701 b	1954	45.3	45
Tukey ($p \leq 0.05$)	762	538	81	0.33	171	469	4.80	0.04

SY=Seed yield; DB=aboveground biomass; NP=normal pods; SP=Seeds per pod; NS=normal seeds; NSNP=number of normal seeds per normal pod; W100S=weight of 100 seeds; ISW=Individual seed weight.

treatments with Fito-maat®, Aminocel500® and Amino80® with respect to the control; while the number of normal pods was approximately 42, 32 and 32% higher for the same treatments respectively. Previous studies showed a similar trend when applying foliar amino acids as compared to the control. In that aspect, EL-Hay *et al.* (2022) observed higher seed yield, aboveground biomass and pods as increasing the amino acid concentration in common bean cv. Poulista. Ismail and Fayed (2020) also observed higher seed yield, dry biomass and normal pods (m^2) in the same crop. The number of seeds per pod and normal seeds was higher on treatments with Aminocel500® (10%) and Fito-maat® (9%), followed by Amino80®. In a similar manner, Espinoza-Galaviz *et al.* (2023) found an increase in the number of seeds per pod (11%) when applying amino acids to common bean Azufrado Higuera. The number of normal seeds per pod, as well as the seed weight, were not statistically different for all treatments. These results coincide with those found by Gonçalves *et al.* (2012) who evaluated different treatments based on amino acids and nutrients on common bean cultivars. Finally, Bianchi *et al.* (2020) stated that an increase in the number of seeds per pod in soybean plants (*Glycine max*) enhanced seed yield regardless of the number of pods and plant density.

Relationship between seed yield and its components

The correlation analysis showed a positive relationship but not statistically different between yield and aboveground biomass (Figure 1A), yield and number of seeds per pod (Figure 1B), as well as yield and number of normal seeds (Figure 1C). There was only a positive and significant relationship between yield and normal seeds/normal pod (NSNP) [$SY = 2.44\,(NSNP) - 1198.8$, r=0.92, p=0.02] (Figure 1 D).

Previous studies have shown a positive and significant relationship between yield and the number of seeds per pod in peas (*Pisum sativum*) cultivars (Naeem *et al.*, 2020; Kaur *et al.*, 2023). Other works by Bianchi *et al.* (2020) mention that the number of seeds per pod is a relatively stable component of yield, while the number of pods is strongly influenced by environmental and management factors.

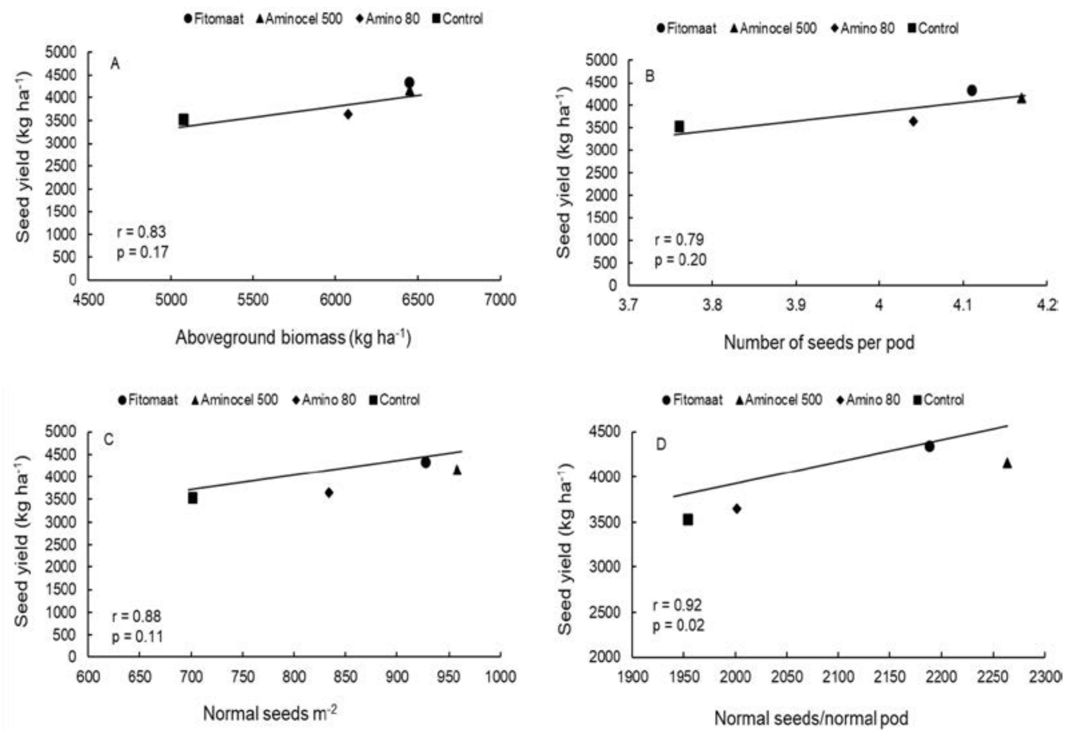

Figure 1. Correlation analysis A) SY-DM); B) SY-SP; C) SY-NS; D) SY-NSNP.

CONCLUSIONS

Foliar amino acid application showed a positive effect on yield, biomass, number of normal pods, and number of seeds per pod on the common bean variety Azufrado Reyna.

The number of seeds per normal pod was the component with the highest relationship with yield.

It is suggested the application of amino acids in specific stages (pre-bloom, flowering and beginning of pod filling) to enhance the overall growth and yield potential of common bean.

The biostimulant Fito-maat® performed better in crop characteristics in the rates recommended by the manufacturer.

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