# BIOSTIMULANT AS A STRATEGY TO WATER DEFICIT IN COMMON BEANS

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**ABSTRACT:** The common beans have socioeconomic importance because it is the basis of human nutrition. As all agricultural crops, they have suffered from water scarcity due to irregular rainfall. This study verified the growth, and yield components of common bean cultivar IPR Campos Gerais under water depths and biostimulant Stimulate® adoption in two consecutive years. The experiment was designed in randomized blocks, in a factorial scheme (2x2x5), with four replications. The treatments consisted of two crop years (2019 and 2020), presence and absence of biostimulant (Stimulate®) and five water depths (63.3, 73.8, 84, 108.8 and 133.9% of evapotranspiration). The shoot dry mass, leaf area, final plant population, final height and yield components (number of pods per plant, number of grains per plant, number of grains per pod) were evaluated. Data were submitted to analysis of variance and, when significant, Tukey's test for qualitative variables and regression analysis for quantitative variables. There was no difference regarding the biostimulant use to minimize the effects of water deficit in common bean. The water regimes did not interfere in common bean yield. Climatic conditions with lower temperature variations and higher evapotranspiration provide 24% increase in vegetative development with the biostimulant application.
**KEYWORDS:** phytohormones, *Phaseolus vulgaris* L., water depth.

# BIOESTIMULANTE COMO ESTRATÉGIA AO DÉFICIT HÍDRICO EM FEIJOEIRO COMUM

**RESUMO:** O feijoeiro comum possui importância socioeconômica por compor a base da alimentação humana. E como todo cultivo agrícola, têm sofrido com a escassez hídrica devido a irregularidade no regime pluviométrico. Verificou-se neste estudo o crescimento e os componentes de produção do feijão comum IPR Campos Gerais sob regimes hídricos e

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presença e ausência do bioestimulante Stimulate® em dois anos consecutivos. O experimento foi delineado em blocos ao acaso, em esquema fatorial (2x2x5), com quatro repetições. Os tratamentos consistiram em dois anos agrícolas (2019 e 2020), presença e ausência de bioestimulante (Stimulate®) e cinco regimes hídricos (63,3, 73,8, 84, 108,8 e 133,9% da evapotranspiração). Foram avaliados a massa seca da parte aérea, área foliar, população final de plantas, altura final e os componentes de produção (número de vagens por planta, número de grãos por planta, número de grãos por vagem, massa de cem grãos e produtividade). Os dados foram submetidos à análise de variância e quando significativos ao teste de Tukey para variáveis qualitativas e análise de regressão para variáveis quantitativas. Não houve efeito quanto a utilização do bioestimulante para minimizar os efeitos do déficit hídrico no feijão comum. Os regimes hídricos não interferiram na produtividade do feijão comum. Condições climáticas com menores variações de temperaturas e maior evapotranspiração proporciona incremento de 24% no desenvolvimento vegetativo com a utilização do bioestimulante.
**PALAVRAS-CHAVE:** fitormônios, *Phaseolus vulgaris* L., regime hídrico.

## INTRODUTION

The common bean (*Phaseolus vulgaris* L.) crop has a socioeconomic importance worldwide, as it is the vegetable protein main source in human food (MONDO & NASCENTE, 2018; SOUZA et al., 2016), in addition to providing fiber, vitamins and minerals (BITOCCHI et al., 2017). Water deficit has become increasingly frequent and its effects on plants vary according to duration, intensity, frequency, cultivar characteristics and plant adaptability to this adversity (EMAM et al., 2010; ROSALES et al., 2012). Water is a limiting factor for the best yield performance. The frequent occurrence of droughts has effects on the legumes production (NEMESKÉRI et al., 2018), causing effects on the reduction of shoot and pod biomass (WAKRIM et al., 2005) and leaf area index (TANGOLAR et al., 2015). It is estimated that water scarcity affects about 60% of common bean production areas in the world (BEEBE et al., 2013). In this sense, it is necessary to study techniques that mitigate the effects of water deficiency in common bean. The main strategy for mitigating the effects of water deficit is the development of tolerant cultivars. However, the use of biostimulants has become promising (GALVÃO et al., 2019). Biostimulants act in the regulation and/or modification of the plants physiological processes, aiming at stimulating growth, minimizing the limitations of stress effects and increasing crop yield (YAKHIN et al., 2017). The beneficial effects of crops such as corn (OLIVEIRA et., 2016) and soybeans (MARTYNENKO et al., 2016) with the use of biostimulants, which act by modulating the plant's physiological responses to abiotic stresses, are established. Based on the hypothesis that plant biostimulants can attenuate the effects of water deficiency in plants, the present study verified the growth and yield components common bean under water regimes and presence and absence of the biostimulant Stimulate® in two consecutive years.

## MATERIAL E METHODS

The experiments were carried out during two agricultural years in the bean winter crop, 2019/2020 and 2020/2021 in the experimental irrigation area, located at the Experimental Farm of the Faculty of Agrarian and Veterinary Sciences, Unesp, Jaboticabal, SP. According to the Köppen classification (1923), the climate of the study region is defined as Aw. The soil in the experimental area is classified as Eutrophic Red Latosol (EMBRAPA, 2013). The experimental design adopted was in randomized blocks, in a factorial scheme (2x2x5), with four replications, two agricultural years (2019 and 2020), presence and absence of biostimulant (Stimulate®) and five water depths (63,3, 73 .8, 84.0, 108.8 and 133.9% of crop evapotranspiration). The common bean cultivar adopted in the experiment was IPR Campos Gerais, which has a normal cycle, with approximately 88 days from emergence to maturation, indeterminate growth habit type II and drought tolerant. The biostimulant used was Stimulate®, applied in stages V4 and R6. Irrigation of the experiment was carried out by conventional sprinkler, with sprinklers spaced at 6 m. The lines were located in the center of the area, so that the experimental units were arranged perpendicularly to the irrigation line in four blocks (HANKS et al., 1976). The irrigation water was evenly distributed parallel to the sprinkler and the water volume gradually decreased with distance from the sprinkler line. Irrigation management was carried out based on climatological data provided by the Unesp/FCAV Agroclimatological Station. Crop evapotranspiration (ETc) was calculated according to the FAO 56 method. Reference evapotranspiration (ETo) was estimated daily using the Penman-Monteith method (ALLEN et al., 1998). The interpolated kc values used were 0.40 (0 to 10% soil cover), 0.40 to 1.15 (between 10 and 80% soil cover), 1.15 (80 to 100% soil ground cover) and between 1.15 and 0.35 (maturation). Irrigation was performed when the accumulated deficit was equal to 18 mm. The shoot dry mass, leaf area, final plant population, final height and yield components (number of pods per plant, number of grains per plant, number of grains per pod, one hundred grains mass and yield) were evaluated. Normality was verified using the asymmetry and kurtosis coefficients. After verifying the normality of the data, analysis of variance (ANOVA) was performed and, when significant, the means were compared by Tukey's test at 5% probability for qualitative factors and regression analysis for quantitative factors.

## RESULTS AND DISCUSSION

There was no significant interaction between biostimulant and water depth, as well as for the year and water depth (Table 1). This fact can be justified because the cultivar IPR Campos Gerais is drought tolerant. The use of common bean cultivars tolerant to water stress is a strategy to reduce the effects on the crop (DARKWA et al., 2016; HEINEMAN et al., 2016).

**Table 1.** Variance analysis of the common bean growth variables for the agricultural year, biostimulant application (Bioest) and water depths (WD) factors.

| Cause of variation | | MSPA V4 | MSPA R6 | MSPA R8 | MSPA F | AF R6 | AF R8 | PF ($x10^3$) | ALT |
|---|---|---|---|---|---|---|---|---|---|
| Year | 2019 | 2,26 | 8,65 | 15,93 | 45,00 a | 1722,37 | 2003,76 | 209,07 b | 0,69 b |
| | 2020 | 2,47 | 15,53 | 29,87 | 35,81 b | 2362,44 | 2201,18 | 238,89 a | 0,87 a |
| F Test | | $2,54^{NS}$ | 79,43* | 169,36* | 23,18* | 27,43* | $1,65^{NS}$ | 31,41* | 100,27* |
| Bioest | Presence | 2,53 a | 13,45 | 24,32 | 40,42 | 2219,11 | 2041,29 | 223,10 | 0,80 |
| | Absence | 2,20 b | 10,74 | 21,49 | 40,39 | 1865,71 | 2163,64 | 224,86 | 0,76 |
| F Test | | 6,63* | 12,28* | 6,96* | $0,00^{NS}$ | 8,36* | $0,63^{NS}$ | $0,11^{NS}$ | $3,24^{NS}$ |
| WD | 63,3 | 2,31 | 11,77 | 21,81 | 39,57 | 1959,19 | 1947,00 | 232,87 | 0,74 |
| | 73,8 | 2,64 | 12,09 | 22,33 | 38,45 | 1978,27 | 1928,97 | 227,89 | 0,75 |
| | 84,0 | 2,37 | 11,99 | 23,68 | 39,80 | 2149,52 | 1960,33 | 213,19 | 0,78 |
| | 108,8 | 2,24 | 12,35 | 22,70 | 40,62 | 2042,69 | 2297,20 | 224,31 | 0,82 |
| | 133,9 | 2,26 | 12,26 | 23,99 | 43,59 | 2082,37 | 2378,85 | 221,64 | 0,81 |
| F Test | | $1,25^{NS}$ | $0,07^{NS}$ | $0,59^{NS}$ | $0,83^{NS}$ | $0,32^{NS}$ | $1,60^{NS}$ | $1,53^{NS}$ | 2,88* |
| F Test | Y*B | $2,19^{NS}$ | 7,87* | 8,05* | $0,71^{NS}$ | 7,91* | 4,04* | $1,05^{NS}$ | $3,20^{NS}$ |
| | Y*WD | $1,55^{NS}$ | $0,57^{NS}$ | $1,66^{NS}$ | $1,74^{NS}$ | $0,36^{NS}$ | $1,06^{NS}$ | $0,52^{NS}$ | $2,11^{NS}$ |
| | B*WD | $1,02^{NS}$ | $0,24^{NS}$ | $0,60^{NS}$ | $0,26^{NS}$ | $0,29^{NS}$ | $0,59^{NS}$ | $0,43^{NS}$ | $0,26^{NS}$ |
| | Y*B*WD | $1,25^{NS}$ | $0,06^{NS}$ | $1,45^{NS}$ | $0,86^{NS}$ | $0,31^{NS}$ | $0,41^{NS}$ | $0,90^{NS}$ | $0,86^{NS}$ |

Means followed by the same letter do not differ by Tukey's Test ($p<0.05$); *: significant at the 5% probability level ($p<0.05$); $^{NS}$: not significant at the 5% probability level; MSPA V4: shoot dry mass in V4 (g); MSPA R6: shoot dry mass in R6 (g); MSPA R8: shoot dry mass in R8 (g); MSPA F: final shoot dry mass (g); AF R6: leaf area at R6 ($cm^2$); AF R8: leaf area at R8 ($cm^2$); PF: final plant population (pl $ha^{-1}$); ALT: height (m).

The interaction between the agricultural year and biostimulant application differed for the shoot dry mass and leaf area variables at R6 and R8 stages (Table 3). In 2020, an average increase of 40% was observed for the afore mentioned variables, indicating that that year may have provided better conditions for bean growth. Also, the occurrence of frost in 2019 caused

12% of burned leaves, causing a decrease in the afore mentioned variables. Large thermal amplitudes can cause high temperature variations in plants, causing cold and heat stress during the vegetative phase (ZHOU et al., 2018). In 2020, with the biostimulant application, there was an average increase of 24% for the variables MSPA R6, MSPA R8 and AF R6 (Table 3). This may indicate that in more favorable climatic conditions for the common bean gorwth, the effect of the biostimulant can be verified, causing an increase in the vegetative growth. The effects of plant growth regulators vary with crop, climatic conditions, rate and method of application (RADEMACHER, 2015; FANG et al., 2019).

**Table 2.** Analysis of variance of the common bean yield components for the agricultural year, biostimulant application (Bioest) and water regimes (WD) factors.

| Cause of variation | | NV/PL | NG/PL | NG/V | 100G | Yield |
|---|---|---|---|---|---|---|
| Year | 2019 | 24,71 | 101,99 a | 4,19 a | 27,01 a | 3725,39a |
| | 2020 | 23,84 | 86,13 b | 3,61 b | 22,32 b | 3059,37b |
| | F Test | 0,57 $^{NS}$ | 14,44* | 31,15* | 274,95* | 27,20* |
| Bioest | Presence | 24,15 | 95,88 | 4,00 a | 24,56 | 3478,64 |
| | Absence | 24,40 | 92,24 | 3,80 b | 24,78 | 3306,12 |
| | F Test | 0,04 $^{NS}$ | 0,76 $^{NS}$ | 4,58* | 0,60 $^{NS}$ | 1,83 $^{NS}$ |
| WD | 63,3 | 24,56 | 93,90 | 3,84 | 24,44 | 3287,60 |
| | 73,8 | 22,70 | 86,87 | 3,90 | 24,29 | 3452,60 |
| | 84,0 | 23,86 | 91,68 | 3,86 | 24,32 | 3272,82 |
| | 108,8 | 23,74 | 96,24 | 4,07 | 24,89 | 3536,42 |
| | 133,9 | 26,50 | 101,62 | 3,83 | 25,38 | 341247 |
| | F Test | 1,19 $^{NS}$ | 1,37 $^{NS}$ | 0,90 $^{NS}$ | 2,20 $^{NS}$ | 0,61 $^{NS}$ |
| F Test | Y*B | 0,86 $^{NS}$ | 0,16 $^{NS}$ | 0,52 $^{NS}$ | 0,22 $^{NS}$ | 0,11 $^{NS}$ |
| | Y*WD | 0,91 $^{NS}$ | 1,83 $^{NS}$ | 0,59 $^{NS}$ | 1,49 $^{NS}$ | 2,04 $^{NS}$ |
| | B*WD | 0,38 $^{NS}$ | 0,45 $^{NS}$ | 0,41 $^{NS}$ | 0,67 $^{NS}$ | 0,89 $^{NS}$ |
| | Y*B*WD | 1,02 $^{NS}$ | 1,19 $^{NS}$ | 0,56 $^{NS}$ | 0,88 $^{NS}$ | 2,37 $^{NS}$ |

Means followed by the same letter do not differ by Tukey's Test ($p<0.05$); *: significant at the 5% probability level ($p<0.05$); $^{NS}$: not significant at the 5% probability level; NV/PL: number of pods per plant; NG/PL: number of grains per plant; NG/V: number of grains per pod; 100G: one hundred grains mass (g); Yield (kg $ha^{-1}$).

There was an increase of 13% in MS V4 and 5% in NG/V with the biostimulant application (Table 8). This fact occurred due to the presence of phytohormones in the product, which promote plant growth, thus increasing the shoot dry mass. The number of grains per pod is an intrinsic characteristic of the cultivar, but it can be affected by large environmental variations (GALVÃO et al., 2019). Also, authors claim that the use of hormones as a biostimulant in common bean can increase the number of grains per pod (DOURADO NETO et al., 2014).

**Table 3.** Common bean shoot growth under the effect of biostimulant (presence or absence) in two consecutive years (2019 and 2020).

| | MSPA R6 (g) | | MSPA R8 (g) | | AF R6 (cm²) | | AF R8 (cm²) | |
|---|---|---|---|---|---|---|---|---|
| | Bioestimulante | | | | | | | |
| Ano | Com | Sem | Com | Sem | Com | Sem | Com | Sem |
| 2019 | 8,92 bA | 8,38 bA | 15,83 bA | 16,04 bA | 1727,19 bA | 1717,55 aA | 1788,01 bA | 2219,50 aA |
| 2020 | 17,98 aA | 13,10 aB | 32,81 aA | 26,94 aB | 2711,02 aA | 2013,87 aB | 2294,58 aA | 2107,78 aA |

Means followed by equal lowercase letters in the columns and uppercase in the rows do not differ from each other according to Tukey's test ($p<0.05$); MSPA R6: shoot dry mass at stage R6; MSPA R8: shoot dry mass at stage R8; AF R6: leaf area at the R6 stage; AF R8: leaf area at the R8 stage.

Final plant population and height performed better in 2020 (Table 8). The highest average height observed in 2020 can be justified due to the higher crop evapotranspiration rates and higher temperatures ranging from 13.2 to 35.1°C. Common bean supports temperatures between 20 and 35°C (ASFAW et al., 2017). As well as the lowest final plant population in 2019, it can also be explained by climatic factors. The occurrence of frost in 2019 may have caused the death of plants.

## CONCLUSIONS

The biostimulant does not attenuate the effects of water deficit in common bean IPR Campos Gerais. The biostimulant provides a 24% increase in common bean vegetative growth under climatic conditions with lower temperature variation and higher evapotranspiration rates.

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