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EFFECTS OF FIVE GROWH REGULATORS ON THE GROWH AND DEVELOPMENT OF THE BEAN (*Phaseolus vulgaris* L.) PLANT

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Yield increases have been reported after spraying beans with many diverse growth regulators (1,2,4,5,8,9,10,11). The positive effects of these chemicals have usually been inconsistant, and dependant on the absence of environmental stresses (1,9,11). In several cases yield increases were shown to result from greater pod set (1,4,5,9). Under high light and temperature conditions napthenates stimulated growth resulting in larger plants and more pods (11). Ethephon sprays resulted in a stimulation of flowering (7,8) and a reduction of flower abscission (8), but in no significant seed yield increases. Our field research with 5 growth regulators demonstrated more profuse flowering but no yield increase with ethephon, and a significant yield increase with phosphon-D in the rainy but not in the dry season (7). To better evaluate the potential of these 5 growth regulators for increasing yields of edible beans under Brazilian conditions, a detailed greenhouse study was under taken to examine their effects on the growth and development of the bean plant.

Pots containing 8 kg of a soil and sand (1:1) mixture supplemented with 1.5 g of $(NH_4)_2SO_4$ 3.6 g of simple superphosphate, 0.4 g of KCL and 12 g of dolomitic limestone were seeded with 'Rico 23', an indeterminate black bean cultivar widely grown commercially in Brazil. After 10 days the plants were thinned out, and only the most vigorous disease-free were left per pot. Greenhouse temperature averaged 27°C during the day and 20° at night.

Succinic acid-2,2-dimethyldydrazide (SADH), α -cyclopropyl-α-(4-methoxipropyl)-5 pirimidine methanol (ancymidol), 2-chloroethyl-trimethyl ammonium chloride (chlormequat), (2-chloroethyl) phosphonic acid (ethephon), and 2,4-dichlorobenzyl-tributhylphosphonium choride (phosphon-D) were each applied at 4 concentrations either once 18 days after germination when the first trifoliate leaves were well developed, or twice at 18 days and again at 38 days when plants began to flower. Concentrations applied were 1,000, 2,000, 4,000 and 8,000mg/liter

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of SADH, 100, 200, 400 and 800 mg/liter of ancymidol, 500, 1,000, 2,000 and 4,000 mg/liter of chlormequat, 125, 250, 500 and 1,000 mg/liter of ethephon and 50, 100, 200 and 400 mg/liter of phosphon-D. Solutions were applied to runoff, and included 200 mg/liter of the wetting agent Extravon. Data collected included leaf area, plant height (beginning on day 19), numbers of nodes, branches, flowers and pods, and seed weight per plant. The experimental design was a randomized block with 4 replications. Square root transformation ($\sqrt{x+.5}$) was done on count data before analysis of variance.

All growth regulator treatments reduced plant height (Figure 1). Only ancymidol, phosphon-D and the highest concentration of ethephon reduced leaf area when applied once, but with 2 applications only the lowest concentration of chlormequat and ethephon failed to reduce leaf area (Figure 2). Ancymidol, ethephon and phosphon-D decreased node number (Table 1). Only ethephon increased the number of lateral branches, probably because the highest concentration broke plant apical dominance by killing the terminal growing point (Table 1). Only the highest concentrations of ancymidol decreased flowering (Figure 2). In fact most treated plants had more flowers, suggesting a general stress effect on flowering. Even Phosphon-D applications, which decreased height by 75% even at lowest concentration, resulted in no less flowers than controls. There were no significant increases in pod number or seed yield in this greenhouse experiment.

Chlormequat at 500 mg/liter and ethephon at 125 mg/liter, when applied

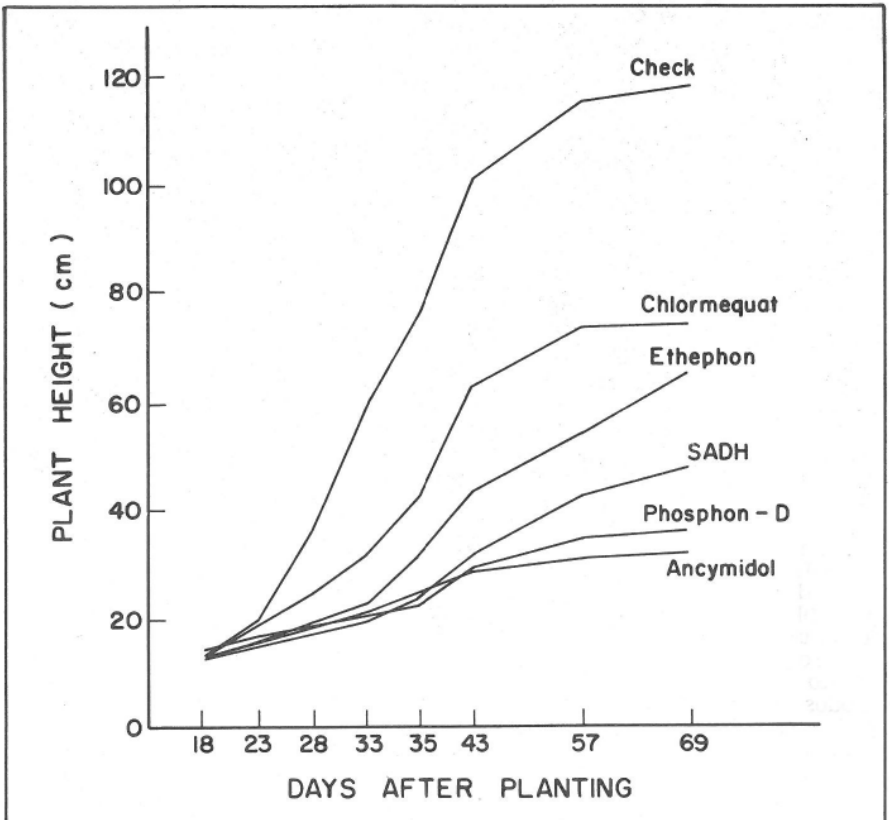

FIGURE 1 - Effect of 5 growth regulators on plant elongation beginning on day 19, the day following the first application. Data are means of 4 concentrations and 2 application times for each chemical.

TABLE 1 - The effect of 3 growth regulators on node and shoot number per plant. Chlormequat and SADH effects were not significant.

Chemical	Number of nodes per plant				Number of shoots per plant	
	Concentration				Applications	
	1	2	3	4	1	2
control	13.6a*	-	-	-	1.4a	-
ancymidol	11.1b	11.4b	5.2c	4.0c	2.4a	1.9a
phosphon-D	11.0b	11.6ab	10.4b	9.4b	1.2a	1.7a
ethephon	13.3a	8.4b	5.2c	6.1c	2.7a	4.1b

*Mean separation by Tukey's test at the 5% level.

twice, resulted in more leaf area, flower and pod numbers and seed weight, and may warrant further field testing especially under low-stress growing conditions. CASTRO and TOLEDO (2) demonstrated a significant yield increase in the field with 2,000 mg/liter of chlormequat. In our experiments chlormequat caused the least reduction in leaf area, and did not decrease node number and flowering.

Phosphon-D was not as effective as chlormequat, but delayed maturation for almost 2 weeks in both the greenhouse and field and did give a significant yield increase in the field during the rainy season (7). Ethefon treatments at the lower concentrations reduced leaf size and resulted in plants with a desirable open structure. The highest concentration killed the growing point and stunted young plants, resulting in almost a one month delay in maturation.

RESUMO

Em estudo realizado em casa de vegetação, o succinato 2,2-dimetilhidrazina (SADH), α -ciclopropil-α-(4-metoxipropil)-5-metanol pirimidina (ancymidol), cloreto de 2-cloroetil-trimetil amônio (chlormequat), ácido 2-cloroetil fosfônico (ethephon) e cloreto de 2,4-diclorobenzil tributil fosfônico (phosphon-D) foram, cada um deles, pulverizados em plantas de *Phaseolus vulgaris* cv. 'Rico 23', em quatro concentrações, uma vez aos 18 dias após a germinação ou em duas vezes, sendo a primeira aos 18 dias e a segunda aos 38 dias (início do florescimento). Todos os reguladores de crescimento reduziram a altura das plantas. Com duas aplicações, todos os tratamentos reduziram a área foliar, exceto a mais baixa concentração de chlormequat e ethephon. Somente o ancymidol, o phosphon-D e a mais alta concentração de ethephon reduziram a área foliar, quando aplicados uma vez. O ancymidol, o ethephon e o phosphon-D também diminuíram o número de nós, enquanto que apenas o ethephon aumentou a ramificação lateral. Apesar dos efeitos de reduzir a altura das plantas, somente a mais alta concentração de ancymidol reduziu o florescimento. Não houve aumento significativo do número de vagens ou da produção de sementes. O chlormequat, na dose de 500 mg/litro, e o ethephon, na dose de 125 mg/litro, quando aplicados duas vezes, foram os tratamentos mais positivos, merecendo outros estudos.

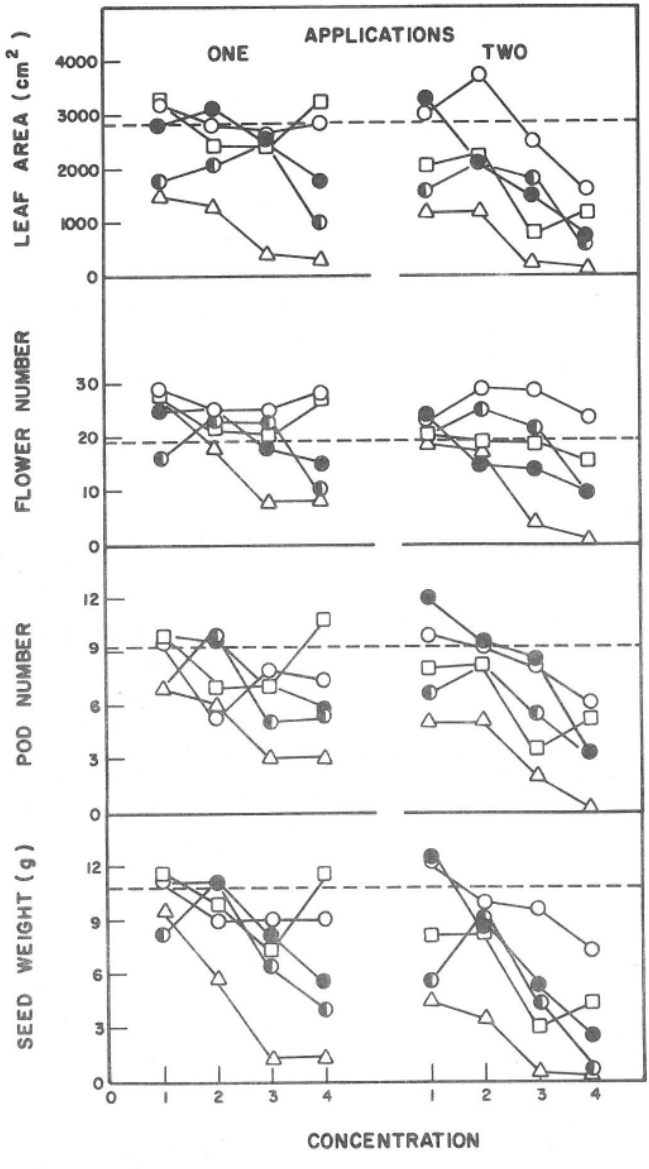

FIGURE 2 - Effect of SADH (□), chlormequat (○), ancymidol (△), ethephon (●) and phosphon-D (◐) on leaf area, seed weight and total numbers of flowers and pods per plant. The horizontal dashed lines indicate values of checks. No positive effects were judged significantly different at the 5% level (Tukey's test).

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