Influence of Nutrition and Bioregulators on Flower Retention, Pod Set and Yield on Pigeon Peas (*Cajanus Cajan* (L.) Huth)[1, 2]

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ABSTRACT

None of three growth regulators (TIBA, NAA and IAA) nor a soluble foliar fertilizer applied to two dwarf semi-determinate cultivars of pigeon peas, (GI 27/4a and CH 11/33/34) in Trinidad had any effect on pod set or final pod number; neither did they reduce or increase flower abscission, nor did they significantly alter pod fresh weight, seed number per pod or mean weight per seed. Effect on pod weight was generally small.

In both cultivars, application of TIBA (2,3,5-triiodobenzoic acid) caused epinasty of young leaves, loss of apical dominance, increased branching and delayed flowering and maturity. Plants changed from the reproductive to the vegetative stage. The intensity of these effects varied with the cultivar.

INTRODUCTION

The pigeon pea (*Cajanus cajan* (L.) Huth) is a traditional crop in parts of the Caribbean region, where it is normally grown as a subsistence crop. In its cultivation, seed production is of prime importance. The crop produces a great number of flowers a considerable number of which abort or absciss at an early stage of their development (1). Despite the fact that this overproduction of flowers may be a safeguard against unfavorable environmental conditions after flowering (1), this flower loss results in reduced pod set and eventually reduced yield (8).

Improvement of pigeon pea by breeding has been in progress for various years in many countries (11) but relatively little information has been published on its physiology and agronomy. Effect of planting date and spacing have been reported by Hammerton (5) and Riollano et al. (12). Hammerton (7) also briefly reviewed the literature on fertilizer response. From work carried out in Jamaica he also reported small increases in yield resulting from heavy dressings of NPK fertilizer, and observed that the crop is generally unresponsive to fertilizers. Work has also been reported on the growth and development of the crop in Guadeloupe (2).

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Pod set, as percentage of flowers produced, varies widely in pigeon pea. There is scant information on the influence of growth regulators on pigeon pea (1, 2, 8), but the effect of TIBA (2, 3, 5-triiodobenzoic acid) on soybeans has been studied by several workers, e.g. Wax and Pendleton, (13), and NAA (1-naphthalene acetic acid) has ben reported to increase yields of *P. mungo* Roxb. (10).

The work herein reported examines the possible roles of applications of exogenous growth regulators and soluble liquid fertilizer at flowering time on flower retention, pod set and yield.

MATERIALS AND METHODS

The experiments were carried out at the University Field Station, Champs Fleur, Trinidad, from October to December 1970. Details as to soil type, weed and pest control, were the same as those given by Del Valle and Hammerton (1). The pigeon pea lines used were dwarf semi-determinate cultivars developed by the breeding program of the Regional Centre of the University of the West Indies, namely GI 27/4a and CH 11/33/34, which have been described in an earlier paper (1). Both cultivars have condensed pseudo-umbel inflorescences with pods of limited maturity range. Several flushes of bearing can be obtained, plants ceasing vegetative growth during each flush, but with the production of new leaves between flushes. The cultivars are susceptible to *Uredo cajani* (leaf rust), which causes severe defoliation.

Two experiments, one with each cultivar, were carried out on plantings made in June 1970. Each consisted of a randomized block design with 13 treatments replicated 4 times. Each treatment consisted of two bushes occupying an area of 1.68 m^2 (18 ft^2). Treatments were as follows: TIBA (2, 3, 5-triiodobenzoic acid) at 74, 125 and 173 g/ha, respectively; IAA (1-indoleacetic acid) at 4.5, 11.2 and 22.4 g/ha, respectively; NAA (1-naphthaleneacetic acid) at 4.5, 11.2 and 22.4 g/ha, respectively; soluble foliar liquid fertilizer (22% N, 22% P_2O_5, 17% K_2O, Fe 370 p/m, 790 p/m Mg, 395 p/m Mn, 76 p/m Cu, 20 p/m Co, 33 p/m B, 68 p/m Zn and 50 p/m Mo) at 3, 7 and 10 kg/ha; and a control.

All chemical treatments, except TIBA, were prepared from a stock solution consisting of 0.1 g of the specific growth regulator dissolved in 100 ml of 85% ethyl alcohol and then diluted with distilled water to the desired concentrations. IMC 3889[4] (2.5% solution of 2, 3, 5-triiodobenzoic acid as the dimethylamine salt in water) was used to prepare the TIBA

[4] Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

solutions. All solutions were made the day prior to application and kept in brown bottles in a cool room.

Sprays were applied with a low pressure hand sprayer to wet all leaves thoroughly at approximately 335 l/ha. containing 0.5% wetting agent (Tween 20). Spraying was carried out between 6:00 and 8:00 a.m.; screens were used to prevent spray drift. The controls were sprayed with distilled water and surfactant.

The fertilizer was applied in three sprays at fortnightly intervals when the plants flowering with small buds (light green and ranging in length from 5 to 10 mm) were dominant. The growth regulators were applied in six sprays at weekly intervals, starting when plants had a preponderance of large flower buds.[5] Tagging studies (1) were used to examine the effect of treatments on pod set, at least 20 flowers being tagged per treatment after each spraying. Flower buds of 16 mm in length were selected for these studies. Daily counts were made between every two sprays. Mature green pods were harvested five times (with cultivar CH 11/33/34) or six times (with cultivar GI 27/4a) and the pod number per plant, seed number per pod, seed size (dry weight of 50 seeds in grams), number of aborted[6] and undeveloped ovules[6], plant height (from the soil to the terminal bud of the main stem), and counts of primary and secondary order branches were determined for all treatments. Yields for each treatment were estimated from the two treated plants.

RESULTS AND DISCUSSION

The data are summarized in tables 1 and 2. All TIBA-treated plants showed epinasty of the younger leaves and loss of apical dominance within 1 week after the first treatment. However, this effect was more marked in experiment 1 with cultivar GI 27/4a. Flower production, vegetative growth, increased branching, and new leaf production were delayed. The highest rate of TIBA significantly increased the number of secondary branches (at the 5% level of probability) in experiment 2 with cultivar CH 11/33/34 but not with cultivar GI 27/4a.

Neither IAA nor NAA treatments affected branching or apical dominance, and none of the growth regulator treatments significantly affected plant height.

Tagging of flower buds after each spray treatment showed no significant effects of any growth regulator or soluble fertilizer treatments on pod-setting. In experiment 1, with cultivar GI 27/4a, there were significant differences between treatments as to pod number per plant and mean

[5] At this stage the corolla appears with the standard showing its characteristic color; it is tightly folded around the wings and keel, ranging in length from 16 to 25 mm.

[6] Aborted ovules—ovules which appeared to have increased in size but failed to reach full size at pod maturity.

number of aborted ovules (table 1), but no differences were measured in the other parameters studied. The highest yield was obtained with IAA (4.5 g/ha), and the lowest with TIBA at 74 g/ha. Increased rates of TIBA and soluble foliar fertilizer (only at 3 and 7 kg/ha) increased the total number of pods per plant. However, increased rates of TIBA increased the number of aborted ovules. In contrast, increased rates of IAA and NAA decreased the total number of pods per plant as observed with soluble foliar fertilizer at 10 kg/ha.

TABLE 1.—*Effect of nutritional treatments and plant growth regulators on the yield and yield components of June-sown cultivar GI 27/4a*

Treatments and rates	Total pod number/ plant	Mean pod and fresh seed weight	Mean number seeds/ pod	Mean seed size	Mean number of aborted ovules	Mean number of undeveloped ovules
		g		*g*		
TIBA 74 g/ha	55.6 d[1]	1.97	5.8[2]	4.24[2]	4.5 d[3]	14.5[2]
TIBA 125 g/ha	86.4 cd	1.96	5.5	3.72	17.5 ab	12.3
TIBA 173 g/ha	153.9 abc	1.93	5.2	4.00	14.0 ab	24.8
IAA 4.5 g/ha	190.8 a[1]	2.01	5.3	4.47	11.8 ab	27.0
IAA 11.2 g/ha	174.5 ab	2.08	5.2	4.09	14.0 ab	23.5
IAA 22.4 g/ha	119.8 abcd	1.99	5.2	4.29	11.5 ab	20.3
NAA 4.5 g/ha	114.8 abc	2.09	5.3	4.25	14.0 ab	29.0
NAA 11.2 g/ha	132.0 abc	2.11	5.4	4.46	5.0 d	9.0
NAA 22.4 g/ha	119.6 abcd	2.09	5.2	4.26	7.5 abcd	19.3
Liquid fertilizer 3 kg/ha	131.6 abc	2.01	5.6	4.45	9.8 abc	24.5
Liquid fertilizer 7 kg/ha	171.8 ab	1.92	5.3	4.06	20.8 a	34.5
Liquid fertilizer 10 kg/ha	97.9 bcd	2.00	5.1	4.36	15.0 ab	14.0
Control	150.3 abc	2.09	5.5	4.35	8.3 abc	23.3
Treatments	*	N.S.	N.S.	N.S.	**	N.S.
S. E. ±	23.46	0.07	0.02	0.24	2.6	5.6
C. V. %	35.3	6.5	6.6	11.4	44.1	56.1

[1] Means followed by one or more letters in common do not differ significantly at the 5% probability level using Duncan's multiple range test.

[2] Differences nonsignificant.

[3] Significance at the 1% probability level.

In experiment 2, with cultivar CH 11/33/34, there were significant differences between treatments (table 2) only in mean fresh weight per pod; the highest rate of TIBA (173 g/ha, treatment 3) differed significantly from the untreated control (means were 1.45 and 1.71 g per pod).

TIBA, IAA, NAA and the soluble foliar fertilizer exerted some influence on the different parameters studied in the two experiments. For the same parameter there were differences in the cultivars in some of these responses. The incidence of rust and the influence of the existing climatic conditions probably prevented the detection of a statistically significant response to some of the factors under study (1).

None of the growth regulators or soluble fertilizer treatments significantly influenced flower abscission, nor did they significantly alter pod fresh weight, seed number per pod, or mean weight per seed relative to the untreated control.

TABLE 2.—*Effect of nutritional treatments and plant growth regulators on the yield and yield components of June-sown cultivar CH 11/33/34*

Treatments and rates	Total pod number/ plant	Mean pod and fresh seed weight	Mean number seeds pod	Mean seed size	Mean number of aborted ovules	Mean number of undeveloped ovules
		g		g		
TIBA 74 g/ha	124.0[1]	1.53 bc[2]	5.1[1]	3.57[1]	10.3[1]	14.3[1]
TIBA 125 g/ha	170.9	1.74 a	5.1	3.27	19.0	17.0
TIBA 173 g/ha	221.6	1.45 c	5.1	3.70	22.3	23.0
IAA 4.5 g/ha	213.9	1.66 ab	5.1	3.93	13.3	16.0
IAA 11.2 g/ha	152.0	1.68 ab	5.0	3.86	12.8	13.8
IAA 22.4 g/ha	147.4	1.62 abc	5.0	3.66	18.0	12.5
NAA 4.5 g/ha	221.5	1.61 abc	5.0	3.45	15.8	16.8
NAA 11.2 g/ha	187.8	1.78 a[1]	5.0	3.86	13.5	14.5
NAA 22.4 g/ha	234.4	1.67 ab	5.0	3.50	14.3	14.3
Liquid Fertilizer 3 kg/ha	187.4	1.71 ab	5.0	3.45	8.5	13.5
Liquid Fertilizer 7 kg/ha	134.8	1.63 abc	5.0	3.76	9.0	12.8
Liquid Fertilizer	101.5	1.67 ab	5.0	3.63	13.3	14.8
10 kg/ha	101.5	1.67 ab	5.0	3.63	13.3	14.8
10 kg/ha						
Control	182.8	1.71 ab	5.1	3.83	11.5	18.8
Treatments	N.S.	*	N.S.	N.S.	N.S.	N.S.
S. E. ±	37.03	0.06	0.21	0.16	3.43	3.04
C. V. %	42.2	7.1	2.7	9.0	49.2	39.1

[1] Differences nonsignificant.

[2] Means followed by one or more letters in common do not differ significantly at the 5% probability level using Duncan's multiple range test.

In agreement with the results obtained by Galston (3) in soybeans, the application of TIBA caused epinasty of young leaves, loss of apical dominance, increased branching, delayed flowering and maturity in both cultivars. The changing of plants from the reproductive to the vegetative stage which was more marked in GI 27/4a (experiment 1) is in contrast to the findings of Greer and Anderson (4) in soybeans; they reported that plants changed from vegetative to reproductive development when they were sprayed with TIBA at the beginning of flowering. Cultivar CH 11/

33/34 (experiment 2) is much smaller with shorter branches forming a more compact bush than GI 27/4a, which has longer branches and apparently a more open habit of growth. This probably accounts for the different responses exhibited in the cultivars. Increased rates of TIBA increased the total number of pods per plant (at the 5% level) in GI 27/4a (table 1). These results differed from those reported by Hammerton in Jamaica, who stated that TIBA applications at 56, 448 and 897 g/ha considerably depressed dry seed yields (6). No mention was made as to the cultivars used. In the experiments herein reported none of the rates used were as high as 1 kg/ha. It is possible that the extremely high rates which Hammerton (6) applied in one spray at flowering could have been toxic to the plants, thereby resulting in decreased yields.

In general, the responses of the two cultivars to IAA and NAA applications were in agreement with the results reported by Hammerton (6), even though the rates of these growth regulators in the present study were about half those sprayed by him. IAA produced greater yields than the control, whereas NAA led to lower yields than those of the control.

In these studies, increased yields (total number of pods per plant) were obtained by the application of the soluble foliar fertilizer at 3 and 7 kg/ha (table 1) with cultivar GI 27/4a but not with CH 11/33/34 even though these yields were not significantly better than the control. If it is assumed that the applied mineral nutrients were absorbed by the leaves and that plants at this stage (flowering) were probably deficient in nutrients the lack of which could limit yields, then an increase because of this factor might be expected. However, no such clear-cut results were obtained. This may have been due to the rate of spray application used, the time of application or interaction with other endogenous growth regulators as suggested by Hammerton (9), because of a poor uptake of minerals by the pigeon pea plant when applied in foliar sprays.

RESUMEN

Dos experimentos se realizaron en la finca experimental de la Universidad de las Indias Occidentales en Trinidad, de octubre a diciembre de 1970 para examinar el rol de aplicaciones foliares de reguladores exógenos de crecimiento y fertilizante soluble al momento de la floreción en dos variedades semi-determinadas de gandul enano (GI 27/4a y CH 11/33/34) y su efecto en la persistencia de las flores, producción de vainas y rendimiento de semillas. En cada experimento se utilizó un diseño de bloques al azar con 13 tratamientos repetidos 4 veces. Cada tratamiento consistió de dos arbustos que ocupaban un área de 1.68 m^2 (18 $pies^2$).

Los resultados revelaron que ninguno de los reguladores exógenos de crecimiento (TIBA, NAA y IAA) ni el fertilizante soluble aplicado al follaje

de las dos cultivares tuvieron un efecto significativo en la producción de vainas, en el número de vainas comerciales en la disminución o aumento en la caída de las flores ni alteraron el peso verde de las vainas, el número de semillas por vainas o el peso medio de la semilla recolectada en oposición al tratamiento control. El efecto en el peso de la vaina fue generalmente pequeño.

En ambas cultivares la aplicación de TIBA (2, 3, 5 ácido triiodobenzoico) causó epinastia en las hojas jóvenes, la pérdida de deminancia apical, produjo un aumento en el número de ramas laterales y retardó la floreción y madurez de las vainas. La intensidad de estos efectos varió en ambas cultivares.

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