COMUNICACIONES

Effect of NAA and GA on sex expression and endogenous growth regulators in sponge gourd (*Luffa cylindrica* Poem)

Resumen. La aspersión de 100 mg/ml de ácido naftalen acético (ANA) a plantas de *Luffa cylindrica* con dos hojas verdaderas desarrolladas aumentó el número de flores con pestilo a expensas de las flores estaminadas, efecto que masculinidad, indicando que la concentración de giberalinas endógenas presentes en las plantas testigo ya se encontraba en un nivel óptimo. La aplicación conjunta de ANA y AG neutralizó el efecto del ANA. Los resultados sugieren que el balance de auxinas endógenas y giberalinas es el que regula la expresión sexual, más que sus cantidades absolutas.

The effect of applied growth regulators like auxins, gibberellins and norphactins on sex expression has been studied by several investigators. In general, it was observed that applied auxin induces femaleness in cucurbits (4, 5, 6, 7, 9, 13) while applied gibberellin favours maleness (2, 4, 10, 12, 14). Since these two growth regulators have opposing effects on sex expression it would be interesting to find their effects when both are simultaneously applied. Work on these lines seems to be meagre. Also, the present work is intended to find out whether the effect of applied auxin or gibberellin is through increasing their endogenous levels.

Materials and methods

In preliminary experiments on spraying the plants of *Luffa cylindrica* at 1, 2 and 3 – true leaf stages with aqueous solutions of naphthalene acetic acid (NAA) at 50, 100 and 150 μg/ml showed that spraying the plants at 2 – true leaf stage with NAA at 100 μg/ml till the point of run off was effective. However, spraying the plants with gibberellic acid (GA_3) at 10, 25 or 50 μg/ml had no stimulating effect on maleness.

For extraction of endogenous growth regulators, the plants (leaves and stem) one week after spraying (3-true leaf stage) with distilled water (control) or NAA at 100 μg/ml or GA at 10 μg/ml or with both of these together were used.

Extraction and bioassay of auxins and gibberellins:

The extraction of auxins from the plant material was carried out at 4°C in 70 percent ethanol containing 20 mg/100 ml sodium diethyldithiocarbamate as per the method os Mann and Jaworski (8). The concentrated extract was streaked onto Whatman no. 1 chromatography paper and developed with a solvent of isopropanol: ammonia: water (10:1:1). The chromatograms, after development, were dried and cut transversely into 10 equal strips and each strip was eluted in 3 ml 2 percent sucrose solution overnight at 0°C before the assay for growth activity using 'straight-growth' method with coleoptiles of rice (3). Length attained by the coleoptile segments both in control and the extracts at the end of 18 hours incubation at 24-25°C in darkness was measured.

Gibberellins: For extraction gibberellins, the plant material was macerated in ethanol with 5 g/100 ml solid sodium bicarbonate added as per the method employed by Radley (11). The concentrated acidic ethyl acetate extract was loaded onto Whatman no. 1 chromatography paper and developed with a solvent of isopropanol: ammonia: water (10:1:1). The chromatograms, after development were dried and cut transversely into 10 equal strips and each strip was kept in ethyl acetate overnight for elution. The eluates were evaporated to near dryness and the residues were dissolved in deionised water. The biological activity of the eluates was determined by the

cucumber hypocotyl bioassay (1) and the results are expressed as extension of hypocotyl.

Results and discussion

Spraying plants of sponge gourd with NAA resulted in (a) hastening the appearence of pistillate flowers (from node 21 to 14 bearing the first pistillate flower) while delaying that of staminate flowers and (b) increasing the number of pistillate flowers at the expense of staminate flowers thereby decreasing the sex ratio (Table 1). Similar effects of applied auxin on sex expression in cucurbits were observed previously (4, 5, 6, 7, 9, 13). GA, when applied alone, had no significant effect on sex expression in the sponge gourd although it was found to stimulate maleness in other cucurbits (2, 4, 10, 12, 14). However, when applied along with NAA it had apparently neutralised the effects of NAA on the production of pistillate and staminate flowers (Table 1).

Determination of endogenous levels of growth regulators revealed interesting points. In control plants (sprayed with distilled water) endogenous gibberellin content was high (and the auxin content was low) coinciding with maleness of the plants (i.e., appearence of staminate flowers first and a higher number of staminate flowers) (Figure 1.A). GA_3, rather than $GA_{4/7}$ is probably associated with sex expression in sponge gourd since its content was higher in the control plants.

In plants treated with NAA, endogenous auxin content increased remarkably (especially at Rf region 0.3–0.5, corresponding to IAA) while little change occurred in the content of gibberellins; this was associated with hastened appearence of pistillate flowers and their increased number (Figure 1.B). Applied GA had no significant stimulating effect on maleness, although endogenous gibberellin content increased (Figure 1.C). Apparently, the concentration of endogenous gibberellin already present (in control plants) was at the optimum level. Although endogenous levels of both auxins and gibberellins increased in plants treated with NAA and GA together (Figure 1.D), the behaviour of these plants with respect to sex expression was comparable to that of control plants (Table 1). In other words, higher auxin content (due to NAA treatment) which stimulated femaleness in the presence of low gibberellin content, failed to do so in the presence of high gibberellin content.

The results of the present investigation suggest that it is not the absolute quantity of auxin or gibberellin that decides the sex expression in *Luffa cylindrica*, but the balance between the two. Higher endogenous gibberellin content than that of auxin favours maleness while higher auxin content than gibberellin favours femaleness.

Summary

Naphthalene acetic acid at 100μg/ml sprayed on plants of *Luffa cylindrica* at 2 true leaf stage increased the number of pistillate flowers at the expense of staminate ones, which was correlated with increased endogenous auxin content. Applied gibberellic acid had no stimulating effect on maleness, indicating that the concentration of endogenous gibberellin already present in the control plants was at the optimum level. When applied along with NAA, GA neutralised the effects of NAA. Results suggest that the balance of endogenous auxin and gibberellin

Table 1. Effect of NAA and GA on Sex expression in *Luffa cylindrica*.

Observation	Control	Treatment		
		NAA 100 μg/ml	GA 10 μg/ml	NAA/GA
Position of node bearing first staminate flower	13	18	13	13
Position of node bearing first pistillate flower	21	14	21	19
Total number of staminate flowers (with buds) per 10 plants	824	496	830	820
Total number of pistillate flowers per 10 plants	68	95	67	68
Sex ratio (staminate: pistillate)	12.1:1	5.2:1	12.2:1	12:1

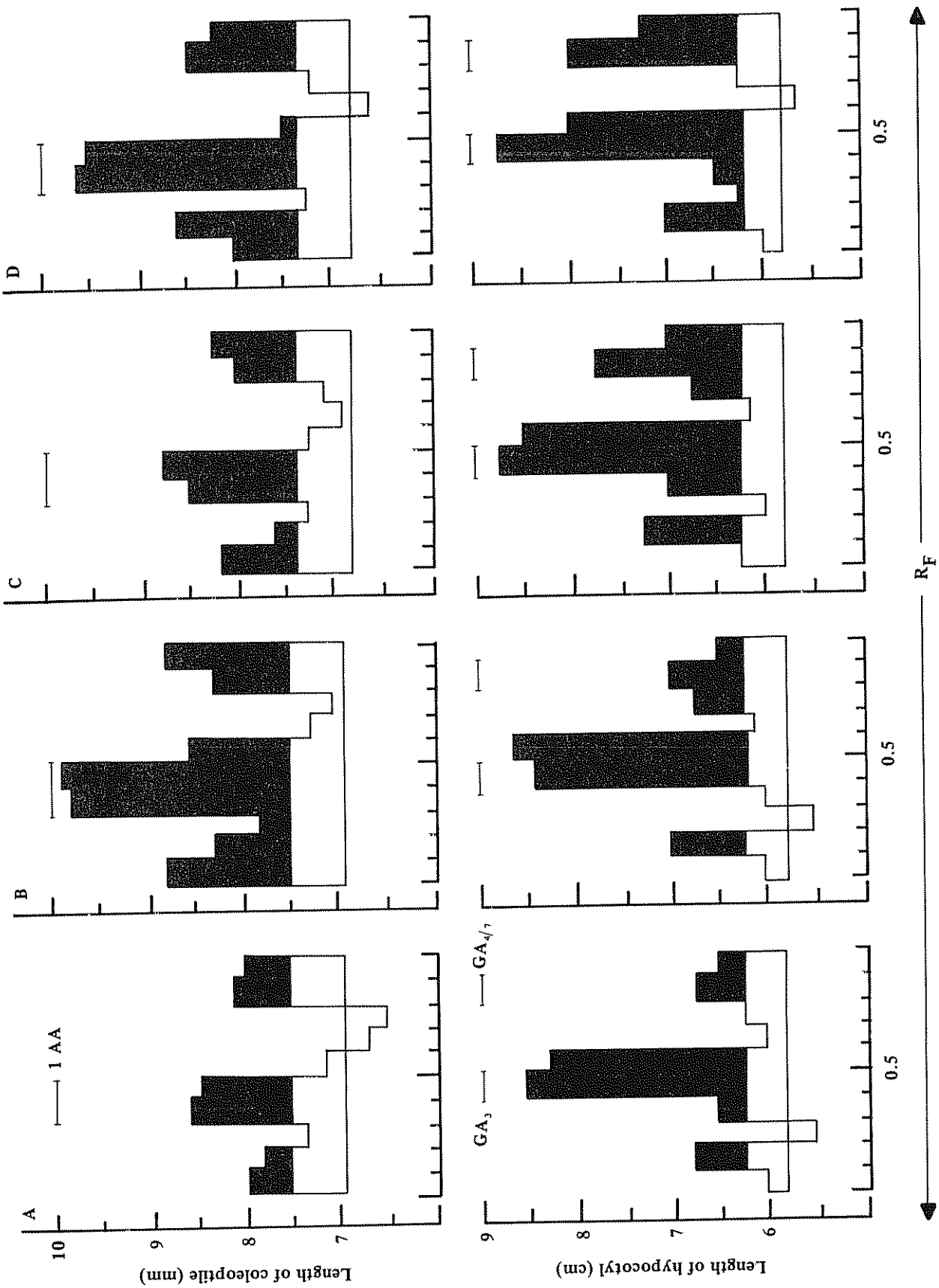

Fig. 1. Endogenous contents of auxin (as indicated by rice coleoptile bioassay) or gibberellin (as indicated by cucumber hypocotyl bioassay) in plants of *Luffa cylindrica* one week after spraying with distilled water (A), or NAA at 100μg/ml (B), or GA at 10μg/ml (C) or GA and NAA together (D). Blackened areas represent regions significantly different from controls at 5 percent probability level. Weight of plant material used for chromatography Auxins = A and C, 10g; B and D, 5g. Gibberellins = A and B, 10g; C and D, 5g.

regulates sex expression rather than their absolute quantities.

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Literature cited

1. BRIAN, P. W., HEMMING, H. G. and LOWE, D. Comparative potency of nine gibberellins. Annals of Botany 28:369-389. 1964.

2. BUKOVAC, M. J. and WITTWER, S. H. Gibberellin modification of sex expression in *Cucumis sativus* L. Advances in Chemical Series 28:80-88. 1961.

3. DAS, V. S. R., RAJU, P. V. and RAO, M. P. The rice coleoptile straight growth test for auxin bioassay. Current Science 35:56. 1966.

4. GALUN, E. Effects of gibberellic acid and naphthalene acetic acid on sex expression and some morphological characters in the cucumber plant. Phyton 13:1-8. 1959.

5. GALUN, E., JUNG, Y. and LANG, A. Morphogenesis of floral buds of cucumber cultured *in vitro*. Development Biology 6:370-387 1963

6 ITO, H. and SAITO, T. Factors responsible for the sex expression of Japanese cucumber. III. The role of auxin on the plant growth and sex expression. Journal of Horticultural Association of Japan 25:101-110. 1956.

7. LAIBACH, F. F. and KRIBBEN, J. Der Einfluss von Wuchstoff auf die Bluterbildung der Gurke. Naturwissenschaften 37:114-115. 1950

8 MANN, J. D. and JAWORSKI, E. G. Minimising loss of indoleacetic acid during purification of plant extracts. Planta 92:285-291. 1971.

9 PANDEY, R. P., SINGH, K. and TIWARI, J. P. Effect of growth regulators on sex expression, fruit set and yield of sponge gourd (Luffa cylindrica Poem). JNKVV Research Journal 10:1-4. 1976.

10. PETERSON, C. E. and ANHDER, L. D. Induction of staminate flowers in gynoecious cucumber with GA_3. Science 131:1673-1674. 1960.

11. RADLEY, M. The development of wheat grain in relation to endogenous growth substances. Journal of Experimental Botany 27:1009-1021. 1976.

12. SAITO, T. and ITO, H. Factors responsible for the sex expression of Japanese cucumber. XIII. Physiological factors associated with the sex expression of flowers (2) Role of gibberellins. Journal of Japanese Society of Horticultural Science 32:278-290. 1963.

13. WITTWER, S. H. and HILLYER, I. G. Chemical induction of male sterility in cucurbits. Science 120:893-894. 1954.

14. WITTWER, S. H. and BUKOVAC, M. J. Staminate flower formation on gynoecious cucumbers as influenced by the various gibberellins. Naturwissenschaften 49:305-306. 1962.

Response of soybeans to varying planting patterns[1]

Resumen. Se investigó la respuesta de la soya sembrada bajo un sistema lineal, rectangular y triangular. El rendimiento de semilla (kg/ha) fue de 1839, 1959 y 1762 para los patrones lineal, rectangular y triangular, respectivamente.

Las relaciones entre el rendimiento de semilla en el tallo y en las ramas fueron 1.04, 1.13 y 1.17 para los tres patrones de siembra, indicando que los tallos fueron más importantes en la determinación del rendimiento para las ramas. Sin embargo, la relación número de vainas/m^2 en los tallos y en las ramas fue inferior a la unidad y osciló entre 0.97 y 0.98. El tamaño de las semillas para la relación tallo/rama varió entre 1.0 y 1.1, indicando que las semillas provenientes del tallo eran mayores que las producidas en las ramas. La relación entre el índice de área foliar (LAI) y el peso específico de la hoja (SLW) en el tallo/rama fue mayor que la unidad, ocurriendo el inverso para la relación área foliar (LAR) y el área específica de la hoja (SLA).

1 Contribution from Crop Production Department, Bunda College of Agriculture