EFFECT OF AUXIN, ANTI-AUXIN AND METABOLIC INHIBITOR ON THE FLOWERING OF EARLY AND LATE FLOWERING VARIETIES OF SUGAR CANE

S. Singh, K. Mohan Naidu and D. N. Tyagi
Sugar Cane Breeding Institute, Coimbatore-641 007, India

ABSTRACT

At Coimbatore (latitude 11°N)(, in both the early (Co 1158) and late (Co 740) flowering varieties in Gibberellic acid sprayed plants, a marked delay in flowering in pot and reduction under field conditions was noted. Unlike pot, under field conditions, spray of Napthalene acetic acid and 6-azauracil reduced the flowering. 2,3, 5-Tri-iodobenzoic acid tended to delay the flowering specially in late flowering variety Co 740. 2,4-d-Dinitrophenol accelerated the inflorescence emergence. In both the early and late flowering varieties, inhibitory effects of these compounds on flowering were observed when leaf spindle was sprayed after inflorescence initiation had occured. This was more marked in late than in early flowering varieties.

INTRODUCTION

In sugar cane hybrid varieties, which are quantitative short day plant, the chemicals, namely, Maleic hydrazide, L-Napththalene acetic acid, [4, 11] Gibberellic acid [3] and 6-azauracil [1] have been reported to inhibit flowering. Similarly, in other short day plants, 2,4-Dinitrophenol, [19] Indole-acetic acid and 2,4-Dichlorophenoxy acetic acid, [12, 13, 14] are known to affect the flowering adversely. However, in sugar cane, it is not known that which phase of flowering process do they influence. Further, unlike higher latitude, at lower ones specially at Coimbatore (latitude 11°N) where sugar cane flowers heavily because of favourable temperature and wider inductive day length range, [15] in late flowering of varieties, a single cutting of leaf spindle during floral inhibition period checked the flowering almost completely, while in early flowering varieties flowering could be checked only when leaf spindle was cut repeatedly at 4-5 days intervals. [16] This indicates that flowering mechanism is more stronger in early than in late flowering types. Thus, there is a possibility that they may behave differently in their flowering response to the spray of these above chemicals. Experiments were therefore conducted simultaneously both in pots as well as in field to study the flowering response of early and late flowering varieties of sugar cane to the spray of auxin, anti-auxin and metabolic inhibitor.

MATERIALS AND METHODS

The experiment was planted on February 7, 1978, in earthern pot (40 cm length and 50 cm 0) containing well mixed garden soil. N, P_2O_5 and K_2O were uniformly added to each pot to ensure good supply of the nutrients to the plants. There were four normal plants of Co 1158 (early flowering) per pot. The pots were watered daily to keep the soil moist. The mother shoots were only allowed to grow and the tillers were cut off when formed.

There were eight chemicals (see Table 1) which were used only at the optimum concentration reported to inhibit flowering at higher latitude. There were nine pots for each chemical. These were divided into three sets, each with three pots. In each chemical, the period of spraying treatment was three, namely (i) pre-inflorescence initiation (July 1 to July 15), (ii) initiation (July 20 to August 3) and (iii) post-initiation (August 10 to August 24). For each period, of spray there were three pots having altogether twelve plants. One lot of three pots was used for control (distilled water spray). The chemicals were initially disolved in a small quantity of suitable solvent and then made up to desired level in distilled water. In each chemical, the total solution used for each stage was 500 mL. This was found to be sufficient to completely wet the leaf spindle with hand Barber spray.

The above experiment was simultaneously planted in field with and additional treatment, namely, repeated spraying during the photo inductive range (July 11 to August 23). A similar field experiment was also planted for late flowering variety Co 740. In both the varieties, there were four periods of spray for each chemical. There were four cane rows of 2 m length, for each chemical, each row with 15-20 canes for every period of spray. In both the varieties, for each period of spray, 1 500 mL of chemical solution was needed to completely wet the top foliage of 2 m length cane row. During each period of spray, the top foliage was sprayed three times at weekly intervals. The top foliage of Co 740 was sprayed during pre-initiation (July 26 to August 9), initiation (August 14 to August 28), post-initiation (September 10 to September 24) and repeated spray (July 26 to September 24). In both pot and field conditions, spraying was done early in the morning.

RESULTS AND DISCUSSION

It was found that both the early (Co 1158) and late (Co 740) flowering varieties in pots as well as in field (Table 1) conditions, 2,4-DNP hastended the flower emergence, whereas Tri-iodobenzoic acid (TIBA) tended to delay it at the concentration which also caused inhibition in stalk growth. In both the varieties, Gibberellic acid (GA_3) caused dramatic promotion of stem elongation and as a result of that inflorescence emergence delayed considerably. In pot, it did not affect the flowering, whereas in field conditions, unlike pot, in both the varieties, GA_3 caused significant reduction in inflorescence emergence which was more marked when sprayed three times at weekly intervals during each initiation, and post-initiation. In early flowering variety Co 1158, 2-4-Dichlorophenoxy acetic acid (2,4-D) retarded stalk height without affecting flowering in pot studies but regardless of its time of spray, it caused early tip emergence by 2-3 days in field conditions. Whereas in late flowering variety Co 740, it was found to inhibit both the flowering and mother shoot height when applied either during initiation, post-initiation or at both stages. In Co 1158 in pot culture studies, Indole acetic acid (IAA), Naphthalene acetic acid (NAA), Maleic hydrazide (MH) and 6-azauracil did not affect either growth or flowering, while in field conditions in both early and late flowering varieties, IAA and NAA inhibited flowering without causing any visible effects on plant growth when applied either during initiation, post-initiation or at both stages. In both varieties, 6-azauracil caused inhibition in flowering as well as stalk height, while, 2,4-DNP though retarded the shoot height,

Table 1. Flowering Response of Sugar Cane Varieties to the Spray of Auxin, Anti-Auxin and Metabolic Inhibitors (Field Studies). Variety Co 1158 (Early Flowering). Stages of Spray

Chemicals	Concentrations	Pre-initiation First and Last Date Tip Emergence (A)	Flowering (%) (B)	Initiation (A)	Initiation (B)	Post-initiation (A)	Post-initiation (B)	Continuous spray (A)	Continuous spray (B)
Gibberellic acid (GA_3)	7×10^{-4} M	Oct 8-24	80,0	Oct 10-24	50,0	Oct 10-24	70,5	Oct 18-24	46,1
Indole acetic acid (IAA)	$11{,}5 \times 10^{-4}$ M	Oct 9-12	91,7	Oct 8-13	86,7	Oct 8-14	88,9	Oct 10-14	85,0
Naphtalene acetic acid (NAA)	3×10^{-3} M	Oct 7-14	90,5	Oct 7-14	85,7	Oct 5-14	90,0	Oct 5-14	85,7
2,4-Dichlorophenoxi-acid (2,4-D)	3×10^{-3} M	Oct 5-12	95,0	Oct 5-12	100,0	Oct 6-12	91,7	Oct 5-12	100,0
Maleic hydrazide (M. H.)	5×10^{-3} M	Oct 9-14	90,9	Oct 6-14	100,0	Oct 9-14	100,0	Oct 6-14	100,0
2,3,5-Tri-iodobenzoic acid (TIBA)	4×10^{-4} M	Oct 8-14	92,0	Oct 10-14	87,5	Oct 11-14	91,6	Oct 8-14	94,1
2,4-Dinitrophenol (2,4-DNP)	1×10^{-3} M	Oct 6-11	95,0	Oct 8-11	100,0	Oct 6-11	100,0	Oct 8-11	100,0
6-azauracil	5×10^{-4} M	Oct 5-14	90,7	Oct 6-14	92,9	Oct 5-14	100,0	Oct 5-14	86,2
Control (Water spray)		Oct 9-14	96,0	Oct 9-14	100,0	Oct 9-14	100,0	Oct 5-14	100,0

Table 1 (Cont.). Variety Co 740 (late flowering)

Chemicals	Pre-initiation (A)	Pre-initiation (B)	Initiation (A)	Initiation (B)	Post-initiation (A)	Post-initiation (B)	Continuous spray (A)	Continuous spray (B)
Gibberellic acid (GA_3)	Nov 11-Dec 6	76,9	Nov 23-Dec 6	57,1	Nov 20-Dec 6	58,3	Dec 1-7	57,1
Indole acetic acid (IAA)	Nov 9-23	64,9	Nov. 9-23	45,4	Nov 9-23	53,3	Nov 12-23	50,0
Naphtalene acetic acid (NAA)	Nov 9-20	75,0	Nov 9-23	66,7	Nov 9-23	62,5	Nov 12-23	68,0
2,4-Dichlorophenoxi-acid (2,4-D)	Nov 9-23	72,7	Nov 9-23	55,0	Nov 9-23	63,6	Nov 9-23	50,0
Maleic hydrazide (M. H.)	Nov 9-23	80,0	Nov 7-23	70,0	Nov 4-23	85,7	Nov 5-23	70,0
2,3,5-Tri-iodobenzoic acid (TIBA)	Nov 9-23	80,0	Nov 9-23	62,5	Nov 9-23	61,5	Nov 6-23	60,0
2,4-Dinitrophenol (2,4-DNP)	Nov 9-20	76,0	Nov 9-20	70,0	Nov 9-20	70,6	Nov 10-20	75,0
6-azauracil	Nov 5-23	92,3	Nov 5-23	69,2	Nov 5-23	91,7	Nov 9-23	60,0
Control (Water spray)	Nov 9-23	75,0	Nov 9-23	80,0	Nov 9-23	80,0	Nov 9-23	75,0

it did not affect the flowering when applied after inflorescence initiation had occured. Both the early and late flowering varieties did not respond to MH spray. Further, it was of interest to note that both in early and late flowering varieties, strong inhibitory effects of these compounds on flowering were observed when applied after inflorescence initiation had ocurred, which was more marked in late than in early flowering varieties. None of the chemical was found to affect the flowering when applied during pre-initiation period. In pot, there was cent per cent flowering in Co 1158 in all the treatments applied at different stages of floral primordia development.

In both early and late flowering varieties observed dramatic promotion of stem elongation in GA_3 treated plants resulting in a marked delay in inflorescence emergence in pot and a significant reduction in field conditions are in close agreement with Kasembey and Sushu[8] who observed no depressing or promotive response to GA_3 spray in sugar cane and also with Alexander *et al* [3] who reported nearly 100% inhibition in GA_3 treated crop. Accordint to Humber *et al*, [7] Maleic hydrazide combined with GA_3 gave total inflorescence inhibition in Australia. Neither compound was inhibitory when applied alone. This variable results may be, possibly because of differences in inductive temperature during inductive photoperiod range and also varieties. Similarly, unlike pot studies, indole acetic acid, Naphthalene acetic acid and 6-azauracil inhibited flowering under field conditions both in early and late flowering varieties. Higher inhibitory effects of these substances in field compared to pot are probably because of more unfavourable factors such as temperature, soil moisture, etc., for flowering under field than under pot conditions. In the absence of any one of these factors, which do not dictate but control flowering, application of the chemicals for inhibition of flowering becomes more effective. Heavy flowering in pots compared to field has been reported by Stevenson and Daniels [17] and Pollock. [10] In sugar cane, inhibitory effects, of 6-azauracil by delaying flower development [1] an also of NA [4, 11] and IAA in other plants [12, 13] have been reported. In both early and late flowering varieties, 2,4-Dinitrophenol which is know to induce protein synthesis [2] accelerated the inflorescence emergence, whereas 2,3,5-Tri-iodobenzoic acid an anti-auxin usually considered to increase the flowering response of short day plant was found to have tendency to delay it at the concentrations which also caused inhibition in stalk growth especially in late flowering variety Co 740. The effect of T1 BA as growth retardant has been reported by Galston [6] and Vlitos. [18] In sugar cane, Coleman [5] also did not find significant flowering response of TIBA Spray. Both early and late flowering varieties did not respond to Maleic hydrazide spreay which is similar to results reported by Humber *et al.* [7] Since M. H. is generally active as a growth retardant and is know to reduce the flowering through inhibiting flower development, [9] non-depressing effect of this compound at the concentration used on flowering is likely to occur in the conditions favourable for flowering especially in heavy flowering varieties. Further, in both early and late flowering varieties, inhibitory effects of these compounds on flowering were observed when applied after inflorescence initiation had occurred. This was more marked in the late flowering variety Co 740, than in early flowering variety Co 1158. Thus, they evidently inhibited inflorescence primordia development and their effects have no specific relation to photo induction.

ACKNOWLEDGEMENT

Thanks are due to Dr. J. Thuljaram Rao, former Director of this Institute for provindig facilities.

REFERENCES

1. Alexander, A. G. (1973): Flowering Chapter 14. Sugar Cane Physiology. Amsterdam, Elsevier, p. 567.
2. Alexander, A. G. (1973): Sucrose Biosynthesis. Chapter 6. Sugar Cane Physiology. Amsterdam, Elselvier, 259 p.
3. Alexander, A. G.; Montalvozapata, R.; Spain, G. L.; and Kumar, A. (1972): Sugar Cane Flower Control Studies With Paraquat, Cibberellic Acid and Sodium Metasilicates. J. Agric. Univ., **56**(3):201-218.
4. Burr *et al* (1957): The Sugar Cane Plant. Plant Physiol., **8**:275-308.
5. Coleman, R. E. (1959): Factory Involved in the Flowering of Sugar Cane *(Saccharum* sp.) Proc. of the X Congress of the ISSCT. Hawaii, pp. 805-814.
6. Galston, A. W. (1947): The Effect of 2, 3, 5-Tri-iodobenzoic Acid on Growth and Flowering of Soybeans. Amer. J. Bot., **34**:356-360.
7. Humbert, R. P.; Lima, M. and Govea, J. (1968): Tassel Control Progress With Reglone in Mexican Sugar Industry. Proc. of the XIII Congress of the ISSCT. Taiwan, pp. 462-467.
8. Kasembe, J. N. R. and Shushu, D. D. (1978): The Effect of Gibberellic Acid and Indoleacetic Acid on Sugar Cane Devlopment With Particular Reference to Pollen Vaibility. ISSCT Sugar Cane Breed. Newsl., **41**:20-28.
9. Lang, A. (1965): Physiology of Floral Initiation. Encyclopedia of Plant Physiol., **15:**1380-1536.
10. Pollock, J. (1973): Heavy Flowering in Meringa Pot Trials. ISSCT. Sugar Cane Breed. Newsl., **33**:26.
11. Raja Rao, T. and Srivastava, K. K. (1968): Studies on the Prevention of flowering in Sugar Cane. ii. The Effects of Some Chemical Sprays. Proc. of the XIII Congress of the ISSCT. Taiwan, pp. 476-483.
12. Salisbury, F. B. (1955): The Dual Role of Auxin in Flowering. Plant Physiol., **30**:327-334.
13. Salisbury, F. B. (1957): Growth regulator and flowering. 1. Survey methods Plant Physiol., **32:**600-608.
14. Salisbury, G. B. (1961): Photopeniadism and the Flowering Processes. Plant Physiol., **12**:293-326.
15. Singh, Sudama (1977): Natural Photoinductive Range for Flowering of Sugar Cane at Coimbatore. Phyton., **352**:163-167 (XI).
16. Singh, Sudama (1977): Flowering of Sugar Cane at Coimbatore. Proc, of the XVI Congress of the ISSCT. Brazil, pp. 1671-1692.
17. Stevenson, N. D. and Daniels, J. (1967): Heavy Flowering Observed in Pot Trials. ISSCT. Sugar Cane Breed. Newsl., **20**:71-73.
18. Vlitos, A. J. (1975): Review of Plant Growth Regulatory Chemicals in Sugar Cane Cultivation. Int. Sug. J., **77**:107-109.
19. Zeevaart, J. A. D. (1962): Physiology of Flowering Science, **137**:723-731.

EFFETS DES AUXINES, ANTI-AUXINES ET DES INHIBITEURS MÉTABOLIQUESSUR LA FLORAISON DES VARIÉTÉS DE CANNE À SUCRE À FLORAISON PRÉCOCEET TARDIVE

S. Singh, K. Mohan Naidu et D. N. Tyagi
Institut d'amélioration génétique de la canne à sucre, Coimbatore-641007, Inde

RÉSUMÉ

A Coimbatore (latitude 11°N), les auteurs ont observé un retard marqué dans la floraison de cannes cultivées en pots et une réduction de celle-ci sur le terrain, aussi bien pour les variétés à floraison précoce (Co 1158) que tardive (Co 740) arrosées avec de l'acide gibbérellique.

Contrairement à ce qui se passe pour les pots; l'arrosage sur le terrain d'acide acétique naphtaléne et de 6-azauracil a réduit la floraison. L'acide 2, 3 5-tri-iodobenzoîque a montré une tendance à retarder la floraison, notamment pour la variété Co 740 à floraison tardive. Pour sa part, le 2,4-d- Dinitrophénol a accéléré la floraison.

Les effets inhibiteurs de ces produits ont été observés dans les variétés à floraison précoce et à floraison tardive lorsque le fouet foliaire a étéarrosé après le debut de la floraison. Cet effet a été plus notoire sur les variétés à floraison tardive que sur celles à floraison précoce.

EFECTOS PRODUCIDOS POR EL AUXIN, ANTI-AUXIN Y EL INHIBIDOR METABÓLICO SOBRE LA FLORACIÓN DE VARIEDADES DE CAÑA DE AZÚCAR DE FLORACIÓN PRECOZ Y TARDÍA

S. Singh, K. Mohan Naidu y D. N. Tyagi
Instituto de Mejoramiento Genético de la Caña de Azúcar, Coimbatore-641 007, India

RESUMEN

En Coimbatore (latitud 11°N), tanto en las variedades de floración precoz (Co 1158) como en las de floración tardía (Co 740), en plantas rociadas con ácido giberélico se observó una marcada demora en la floración en macetas y una reducción bajo condiciones de campo. A diferencia de como sucede en las macetas, bajo condiciones de campo, la rociadura de ácido acético naftaleno y 6-azauracil redujeron la floración. El ácido 2, 3, 5-tri-iodobenzoico tendió a demorar la floración, especialmente en la variedad Co 740 de floración tardía. El 2,4-dinitrofenol aceleró la aparición de

la inflorescencia. Tanto en las variedades de floración precoz, como en las tardías, los efectos inhibidores de estas sustancias sobre la floración pudieron observarse cuando la espiga de la hoja fue rociada después que había ocurrido el inicio de la inflorescencia. Esto resultó más señalado en las variedades de floración tardía que en las de floración precoz.