

STUDIES ON HORMONE TREATMENT OF SUGARCANE

I. Pot Experiments with 2, 4-D

BY A. S. CHACRAVARTI, D. P. SRIVASTAVA, R. D. SAHI
AND K. L. KHANNA, F.A.Sc.

(Central Sugarcane Research Station, Pusa, Bihar)

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I. INTRODUCTION

Beneficial effect of 2, 4-D application on the sugar content of cane, as reported by Beauchamp,¹⁻³ was amply confirmed by Chacravarti, Srivastava and Khanna⁴⁻⁶ who adopted the technique of large-scale experimentation including milling tests at the factory so as to eliminate sampling errors which appeared to have led to erratic findings in a number of cases.⁷⁻¹¹ Average improvement in sugar content resulting from foliar spray of 2, 4-D (Sodium salt) obtained by Chacravarti, Srivastava and Khanna^{4,5} amounted to 0.55 unit. More recently these authors,¹² in course of preliminary experiments on soil application of 2, 4-D (amine salt), have obtained improvements of the order of 3 units. Side by side with these large-scale trials, pot culture studies have also been in progress over a period of two years, the results whereof are presented in this paper.

II. EXPERIMENTAL

Large concrete drums ($2\frac{1}{4} \times 2\frac{1}{4} \times 4$) were used in the experiments. In each year, variety used was B.O. 11 and number of replications three. Treatments in the two years were as follows:—

First year

- A : Control (no treatment).
- B : 3 lb./acre 2, 4-D (Sodium salt) at planting.
- C : 6 lb./acre 2, 4-D (Sodium salt) at planting.
- D : 9 lb./acre 2, 4-D (Sodium salt) at planting.
- E : 3 lb./acre 2, 4-D (amine salt) at planting.
- F : 6 lb./acre 2, 4-D (amine salt) at planting.
- G : 9 lb./acre 2, 4-D (amine salt) at planting.

Second year

- A: Control (no treatment).
 B: 6 lb./acre 2, 4-D (amine salt) applied 2 weeks after germination.
 C: 6 lb./acre 2, 4-D (amine salt) applied at earthing up.
 D: 6 lb./acre 2, 4-D (Sodium salt) applied 2 weeks after germination.
 E: 6 sprays of 2, 4-D (Sodium salt) as 50 p.p.m. solution at 60 gallons per acre applied during July-September.
 F: 1 spray of 2, 4-D (Sodium salt) as 50 p.p.m. solution at 60 gallons per acre applied 20 days before harvest.
 G: 6 sprays of 2, 4-D (amine salt) as 50 p.p.m. solution at 60 gallons per acre applied during July-September.

In both years, basal manuring was done at 60 lb. N + 75 lb. P₂O₅ per acre in the form of ammonium sulphate and single super. Soil application of 2, 4-D was made in the form of a dilute solution or suspension containing 0.15 per cent. of the acid. The entire crop was harvested (age 9 months in first year and 12 months in second year) and records taken of yield and chemical attributes. In the first year's experiment, the latter consisted of brix, pol. and purity of juice but in the second year, glucose and fibre determinations were added. Sugar per cent. cane was calculated with the approximate formula of Noel Deerr¹³:—

$$\text{Sugar \% cane} = \text{Pol. \% juice} \times \left(1 - \frac{4}{3} \times \frac{\text{fibre \% cane}}{100}\right)$$

The results have been presented below:

III. PRESENTATION OF DATA

First year.—The results will be seen in Table I. Treatment G records a significant increase in brix over control and treatments G, E and F in pol. per cent. juice. Purity rises under individual treatments, although large, fall short of the level of significance. Yields are significantly depressed under treatments C, E and F. As the above are not quite systematic, combined analyses have also been done so as to assess the average effects of 2, 4-D in the two forms. These indicate that brix under amine salt application is significantly higher than in case of both control and sodium salt treatment and the same holds good for pol. per cent. and purity of juice. With regard to yield, the contrary effect is observed, the amine salt causing a significant depression as compared to control and sodium salt treatment. The latter does not differ significantly from control in any respect. The magnitude

of improvement in juice quality resulting from application of amine salt of 2, 4-D is considerable, average increase over control being 1.56 in brix, 3.26 in pol. per cent. juice and 12.92 units in purity. Assuming a fibre content of 15 per cent. for both treated and untreated cane, the improvement in sugar per cent. cane would work out to a value of the order of 2.6 units. On the other hand, the yield is reduced by 40 per cent.

TABLE I
Showing Effects of Soil Application of 2, 4-D (Sodium and Amine Salts) at Planting

Characters Treatments	Yield (lb./drum)	Juice analysis		
		Brix	Pol.	Purity
A	.. 10.4	16.0	9.18	57.3
B	.. 10.0	15.1	9.19	59.1
C	.. 6.4	16.6	9.79	58.9
D	.. 9.6	16.1	10.24	63.6
E	.. 6.4	17.3	11.83	68.2
F	.. 4.6	17.1	11.74	68.8
G	.. 7.6	18.3	13.77	73.6
Mean for sodium salt	.. 8.66	15.91	9.74	60.52
Mean for amine salt	.. 6.18	17.56	12.44	70.22
C.D. at 5% (treatment mean)	.. 1.94	1.34	1.43	12.50
C.D. at 5% (means of sodium salt vs. amine salt)	1.12	0.77	0.81	7.22

Second year.—The results incorporated in Table II would indicate that considering the treatments individually, effects are not significant for any of the criteria, notwithstanding the fact that the actual improvements in juice quality attributes resulting from most of the treatments are quite large. An examination of the average effects of (i) the sodium and amine salts as also those of (ii) soil and foliar application, however, leads to a different

TABLE II
*Showing Effects of Soil and Foliar Application of 2, 4-D
 (Sodium and Amine Salts) at Different Stages*

Characters Treatments	Yield (lb./drum)	Juice analysis				Fibre % cane	Sugar % cane
		Brix	Pol.	Purity	Glucose		
A	11.7	20.6	17.01	82.4	0.80	15.16	13.27
B	8.6	21.6	19.28	88.0	0.31	15.05	15.14
C	6.1	21.7	19.63	90.3	0.44	14.51	14.80
D	8.3	22.0	19.83	90.3	0.48	17.38	15.24
E	7.1	21.8	18.58	87.2	0.27	16.80	14.41
F	8.1	21.5	19.00	88.5	0.66	13.91	15.48
G	5.6	22.3	18.64	83.5	0.53	17.29	14.55
Mean for sodium salt	7.84	21.8	19.14	88.7	0.47	16.03	15.04
Mean for amine salt	6.77	21.8	19.18	87.3	0.43	15.62	14.83
Mean for soil application	7.69	21.8	19.58	89.5	0.41	15.65	15.06
Mean for foliar applica- tion	6.93	21.8	18.74	86.4	0.49	16.00	14.81
C.D. at 5% (sodium or amine salt means vs. control and soil or foliar applica- tion vs. control)	Non-signi- ficant	0.71	1.46	8.16	Non-signi- ficant	Non-signi- ficant	1.42

picture. Thus, considered from the former standpoint, the average increases over control produced by both sodium and amine salts of 2, 4-D are significant in respect of brix, sucrose per cent. juice, purity and sugar per cent. cane. Responses in cane yield, glucose per cent. juice and fibre content of cane are, however, non-significant. As between the average effects of sodium and amine salts, no significant differences are observed in respect of any attribute. The degree of improvement in quality brought about by both sodium and amine salts is considerable, being 6.3 and 4.8 units respectively in purity and 1.77 and 1.56 units in sugar content of cane.

On considering the results from the standpoint of average effects of 2, 4-D as soil and foliar application, irrespective of the form of salt, a similar behaviour is indicated. Thus both soil and foliar applications produce significant increases in brix, sucrose per cent. juice, purity and sugar per cent. cane as compared to control but they do not differ significantly between themselves. Yield, glucose and fibre values are not significantly affected. Improvements in quality attributes are quite large for both soil and foliar applications, being 7.1 units in purity and 1.79 units in sugar per cent. cane for soil application and 4.0 and 1.54 units respectively for foliar application.

IV. DISCUSSION

In the first year's trials, involving soil application of sodium and amine salts of 2, 4-D at the time of planting (before germination), the former produced no significant effects on yield or quality attributes. The latter, on the other hand, occasioned a significant increase of the order of 2.6 units in sugar per cent. cane which was accompanied by a significant depression in yield amounting to 40% over control. During the second year, when treatments consisted of both salts of 2, 4-D applied in soil or as foliar spray, average effects of both forms of the hormone as also of both methods of application, were significant with regard to quality attributes and non-significant for yield. The actual mean improvements resulting from sodium and amine salts were of the order of 1.8 and 1.6 units respectively in sugar per cent. cane while the corresponding mean increases due to soil and foliar application were about 1.8 and 1.5 unit. The above results would appear to leave little doubt on the efficacy of 2, 4-D in increasing sugar in cane notwithstanding the fact that, considered treatment-wise, many of the effects did not attain the level of significance which was presumably due to the degrees of freedom being too low in such a case. So far as yield is concerned, the first year's results would point to the inadvisability of soil applications of the amine salt at the planting stage as also the lack of response to sodium salt applied in the soil at planting, both in the matter of yield and quality. With soil applications two weeks after germination or at the time of earthing up considerable improvement in quality results, with no adverse effect on yield of the crop and this holds good for both forms of 2, 4-D. Similarly, foliar application of either form increases sugar without affecting the yield. All these results fall in line with the findings of large-scale trials in collaboration with the industry.^{4-6, 12} Particular mention may be made of the trials on soil application of amine salt¹² wherein two applications at inter-culture and earthing up produced an improvement in sugar content of the order of 3 units, with no adverse effect on yield or growth criteria at harvest,

viz., (i) number of millable canes per clump, (ii) number of green leaves per cane, (iii) number of internodes per cane, (iv) height of cane and (v) weight per cane. In this connection, it may not be out of place to refer to the findings of Overbeek¹⁴ and Audus¹⁵ to the effect that sugarcane growth is not adversely affected by fairly high concentrations of 2, 4-D even at the early stages of the plant. Similarly, it is of interest to note the observations of Rege (private communication), who conducted an extensive series of large-scale trials on pre-harvest spraying of 2, 4-D in South India and came to the conclusion that the treatment, on an average, produces increase in sugar content of the order of 0.2 to 0.4 unit. The above effect under South Indian conditions, where the crop has a longer period of growth and, at the time of pre-harvest spraying, is much nearer the stage of maturity than is the case in North India, might be regarded as particularly encouraging. In a recent review by H. M. L.¹⁶ on sugarcane research in the Bombay-Deccan, Kulkarni and Nadgauda are reported to have observed favourable responses to 2, 4-D, indole acetic acid and *o*-Et-N-Ph-carbamate. It would thus appear that phyto-hormones offer immense potentialities for the sugar industry in all parts of the country.

V. SUMMARY

(1) Pot culture studies on the effect of 2, 4-D on sugarcane have been reported in the paper.

(2) Soil application of 2, 4-D (amine salt) at planting increases sugar content by about 2.6 units while depressing yield by 40%. Sodium salt of the hormone applied at this stage has no significant effect on yield or quality.

(3) Soil application of both salts, either two weeks after germination or at the time of earthing up, significantly improves sugar content (by 1.8 units) with no significant effect on yield.

(4) The same holds good for foliar application, mean improvement in sugar being 1.5 units.

(5) When applied to soil two weeks after germination, at earthing up or as foliar spray, the two forms of the hormone afford the same order of improvement in sugar (1.6-1.8 units).

(6) The above results conform to the findings of large-scale trials in collaboration with the sugar industry, reported earlier.

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