EFFECTS OF GROWTH REGULATORS ON SUNFLOWERS IN THE GREENHOUSE AND IN FIELD PLOTS

M. DIAZ DE LA GUARDIA, L. GARCIA TORRES, and J. BERENGENA
(Spain)

The sunflower varieties currently being grown on a large scale in Spain (Peredovik and Smena) are excessively tall, particularly under irrigation, presenting problems of lodging and harvesting. Genetic and plant breeding studies with these and other varieties in the greenhouse in the winter, with relatively low light intensity, are made difficult because the plants grow too tall and are weak stemmed. These problems in the field and greenhouse can best be overcome by producing shorter varieties with equal or greater productivity. Until this objective is reached, it may be possible to reduce plant height and maintain or increase seed yield by the use of growth regulators.

Various chemical growth regulators introduced in the last few years have proved effective in reducing the height of plants and influencing their development. Most studies with these substances have been made on horticultural plants, ornamantals, and fruit trees. Some positive results have also been reported with field crops. Cycocel or CCC (2 either the plant height or yield (W a t s o n e t all 1970). While the presnt work was in progress, it was reported that Alar (N-dimethylaminosuccinamic acid), reduced the height of sunflovers grown in the greenhouse (D o r r e l l, 1973).

Few experiments have been made with growth regulators on sunflower. CCC applied to sunflower plants growing in sand with nutrient solutions reduced plant height and increased the thickness of stems (T a w a g e n, 1970). Tiba applied to sunflower in the field did not affect either the plant height or yield (W a t s o n et all 1970). While the present work was in progress, it was reported that Alar (N-dimethylaminosuccinamic acid), reduced the height of sunflowers grown in the greenhouse (D o r r e l l, 1973).

This paper presents the results of experiments with various growth regulators on varieties and inbred lines of sunflowers in the greenhouse and field in 1972 and 1973.

GREENHOUSE EXPERIMENTS

Plants of the sunflower line HA 232 were grown directly in the soil in a plastic greenhouse between March and June. Groups of four plants were treated with Alar, CCC, Ethrel (2 chloroethyl-phosphonium), and Tiba in various concentrations singly and in combination, applied to run-off. Plant height and leaf area were measured weekly.

All treatments reduced plant height. The shortest plants (75% of untreated controls) resulted from three applications of Alar at 8,500 p.p.m. at intervals of ten days.

Alar begins to affect shortly after treatment, and the effect continues. Treatment with Ethrel affects growth very strongly, but this effect does not become apparent until about 20 days after application (figure 1). This suggests that the tissues affected and the point of action are different for the two products.

Two applications of Alar (8,500 p.p.m.) significantly increased the area of lower leaves. The area of leaves formed later was equal to or less than that of the controls, so that the total leaf area of treated plants was not significantly different from the controls (figure 2). Treatments with Tiba or Ethrel singly or in combination reduced leaf area to 60 or 70% of that of untreated control plants.

As Alar appeared to be the most promising of the products tested, it was employed in another experiment at 5,000 p.p.m., with various dates of treatment and numbers of applications. The height of plants and the height of insertion of leaves number 5, 10, 15, 20, and 25, were measured weekly. Plants were of the hybrid CMS-HA 232 × RHA 265, grown in pots, between December and April. There were seven plants in each treatment.

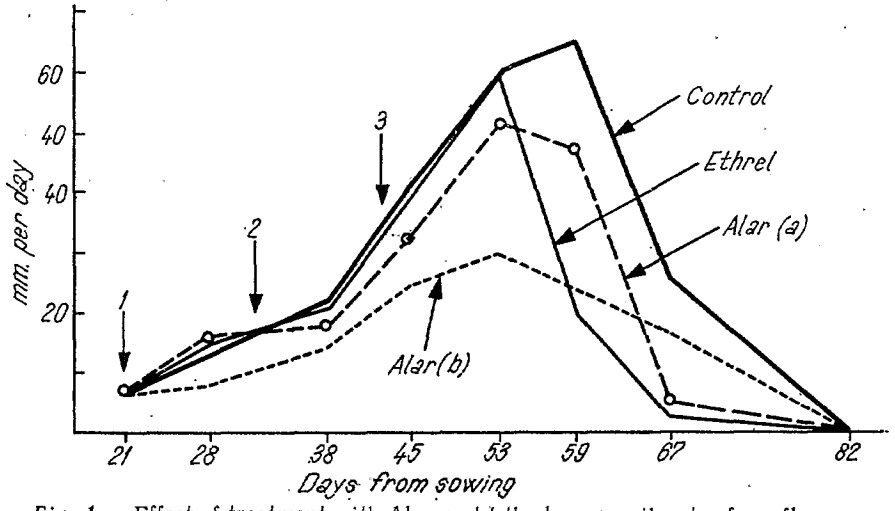

Fig. 1 — Effect of treatment with Alar and Ethrel on growth rate of sunflowers in the greenhouse.

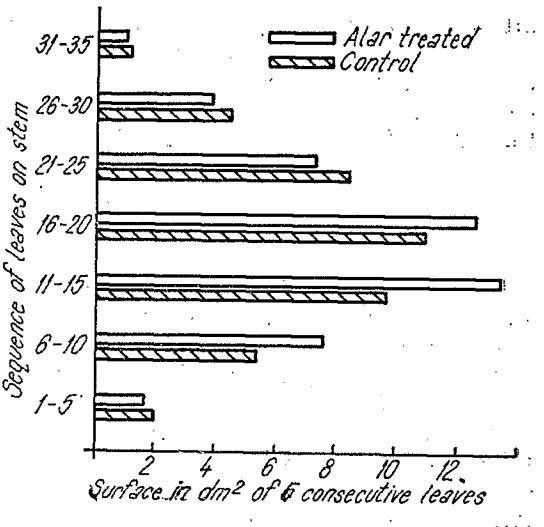

Fig. 2 — Effect of treatment with Alar on leaf area of sunflowers in the greenhouse.

All treatments in this experiment reduced plant height significantly below the untreated control plants. The length of the internodes was reduced, but not the number of leaves. The effect of treatments on final height and on height of various leaves is shown in figure 3.

Each treatment affects the growth of the internodes which are in the elongation phase at the time of the application, and the ten successively higher internodes. If a second treatment is applied while a given

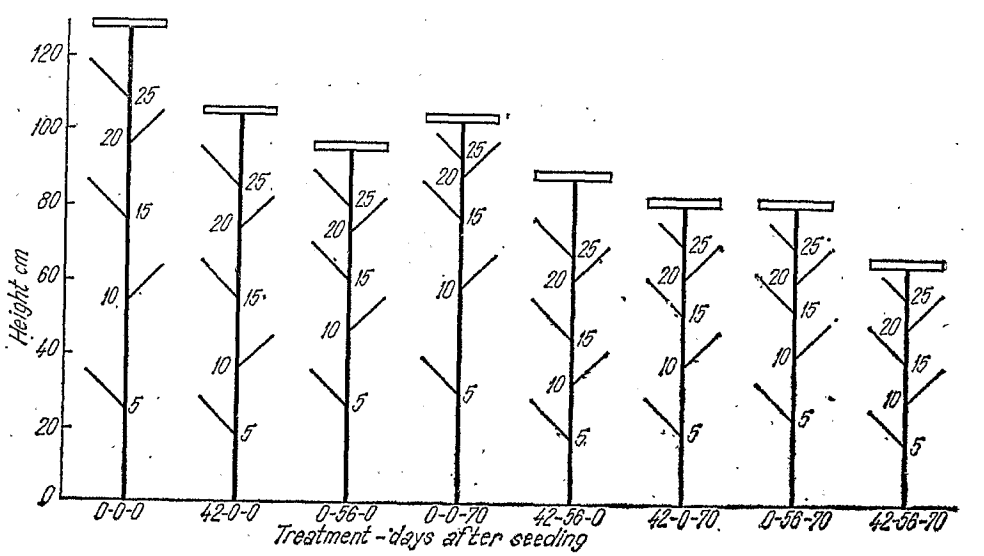

Fig. 3 — Effect of treatment with Alar on height and internode length of sunflowers in the greenhouse.

internode would still normally be elongating, the inhibiting effect is cumulative. This is obvious in the effect on internodes between leaves five and ten in figure 3. The greatest reduction was induced by three treatments, and the effect of intermediate or late treatments was greater than that of early treatments.

FIELD EXPERIMENTS

Experiments in field plots in 1972 and 1973 were made in sandy loam soil. The variety was Peredovik, at 55,000 plants per hectare, in irrigated plots. The products and concentrations were : Alar 8500 p.p.m. ; CCC 1000 p.p.m ; Ethrel 500 p.p.m. ; Tiba 250 p.p.m. ; and the combinations Tiba 250 p.p.m. plus CCC 2500 p.p.m. and Ethrel 250 p.p.m. plus CCC 5000 p.p.m. Plants in some plots were treated only once, when they were 30 cm tall and had from 10 to 12 true leaves ; others received a second treatment when they were 95 cm tall and had 20 true leaves. All treatments were applied to run-off.

Various treatments reduced height significantly in the first stages of plant development, but one month later only the plants treated with a combination of Ethrel and CCC were significantly shorter (81%) than the controls. Plants treated with Tiba were slightly taller than the control plants at the end of the experiment. The effects of the respective treatments on height, yield, and other characteristics of the plants are given in table 1. Highest yields were obtained from plants treated with the mixture of Tiba and CCC. Ethrel alone or combined with CCC was most effective in reducing plant height, but also reduced the yield and seed weight.

Plants treated with CCC became chlorotic a few days after the application, but this effect later disappeared. Treatment with Alar induced a darker green color in the leaves.

Table I

Effects of various treatments under field conditions on Peredovik sunflowers, 1972

Treatment	Final height (1)	Yield (1)
Alar	90	107
CCC	94	95
Ethrel	88	88
Tiba	107	112
Tiba + CCC	105	121
Ethrel + CCC	81*	78
Control	100	100

(1) Per cent of untreated control plants
* Difference significant at 5% level.

As results were variable using the heterogeneous variety Peredovik, in 1973 experiments were made with the pure line HA89 as well as with Peredovik. Plant density was 70,000 plants per hectare. The chemicals used were Alar, as a single early treatment, a single late treatment, and three treatments ; and Tiba as a single late treatment. The results of this experiment are given in table 2. The effects on plant height were easier to determine in line HA89 than in Peredovik, because of its greater uniformity. Some of the differences were significant in HA99 ; none were significant in Peredovik.

Table 2

Effect of various treatments of Peredovik and HA 89 sunflower under field conditions 1973

Treatment	HA 89		Peredovik	
	Height	Yield	Height	Yield
Alar (1,2,3)[1]	85**	91	97	93
Alar (1)	94	98	106	97
Alar (3)	96	100	94	100
Tiba (3)	93*	106	100	101
Control	100	100	100	100

** Difference significant at 1% level
* Difference significant at 5% level
[1]) Numbers 1, 2, 3 refer to stage of plants at time of treatment, as follows: 1 : 6 true leaves; 2 : 10—12 leaves; 3 : 15—20 leaves.

Another parallel experiment was sown with line HA99, genetically very similar to line HA89. Plants were hervested at intervals from the treated plots, to determine height, leaf area, and dry matter in leaves and in stems and petioles.

As in preliminary experiments, an early treatment with Alar reduced plant height, but the effect did not last. One late treatment, and repeated treatments, had a greater and more persistent effect.

Treatment with Tiba reduced leaf area to 75 to 85% of the control, by reducing the number of leaves significantly. Plants treated with Alar had sligthly less dry matter in stems and petioles than did control plants, and slightly more dry matter in the leaves than did the control.

EVAPOTRANSPIROMETER EXPERIMENTS

The fact that treatment with Alar reduced plant height without any significant effect on leaf area, indicated that it might reduce evapotranspiration by reducing the volume of air in contact with the transpiring leaf surface.

Two Thornthwaite evapotranspirometer were sown with the sunflower variety Peredovik. Plants in one tank were treated, those in the other served as controls. Each tank contained 25 test plants, surrounded by a border of sunflower plants. Alar at a concentration of 8,500 p.p.m. was applied to run-off three times at intervals of ten days. Evapotrans-

piration was recorded daily, and plant height and leaf area were recorded at intervals.

Conditions in this experiment differed from those in field plots and greenhouse, as plant roots grew down to the water table and the plants therefore had all the water they needed.

Although the height of treated plants was reduced initially, the difference gradually disappeared. Leaf area was greater in treated than in control plants. Evapotranspiration was equal in both tanks except in the final period as plants became senescent, when the treated plants used more water. Alar treatment delays senescence, and treated plants stay green longer than untreated controls.

CONCLUSIONS

These results indicate that the effect of treatment with growth regulators is influenced greatly by environamental conditions. Plant height is reduced much more under poor light conditions in the greenhouse in winter than in the field. The results of treatment in the field are not consistent from one year to the next.

Alar applied once or twice at concentrations of 5,000 and 8,500 p.p.m. was the most effective of the products tested in reducing height without other adverse effects. Another beneficial effect of treatment with Alar is that treated plants have thicker and stronger stems, and are easier to handle in greenhouse or laboratory, without having to be staked. These results confirm those of Dorrell (1973).

Plant height can be reduced more by three treatments with a lower concentration (5,000 p.p.m.) than by one treatment with a higher concentration of Alar. Although the shorter plants produced by three treatments yield somewhat less seed and the seeds have somewhat lower oil content than control plants, these effects are not important in plants being grown for crossing in the greenhouse in winter.

Tiba, applied alone or in combination with CCC, increased yield but produced plants as tall or taller than the controls. Additional work is required to determine if this increase can be repeated with other varieties and in different years.

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