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EFFECT OF CCC, SADH AND DIKEGULAC ON GROWTH MODIFICATION OF A SUNFLOWER CULTIVAR AND ITS IMPACT ON YIELD[1]

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ABSTRACT

Growth retardants like CCC (2-chloroethyl trimethyl ammonium chloride), SADH (succinic acid 2, 2-dimethyl hydrazide) and dikegulac (2, 3:4, 6-di-O-isopropylidene 2-keto-L-gulonate) significantly inhibited the plant height. Leaf number per plant, however remained unaltered except at 500 µg/ml dikegulac. Leaf area was reduced at all the higher concentrations, but the same was increased at all the lower concentrations. Dry weight of the treated leaves, however, did not change in any of the concentrations of the retardants. Consistent increase of stem circumference was the unique character regard less of treatments and their concentrations used. Though head diameter was significantly reduced only at 500 µg/ml dikegulac, total seed weight per plant and 1000 seed weight were remarkably reduced at the higher concentrations of all the retardants. But at lower concentrations total seed weight per plant was increased but increase in 1000 seed weight was evident in low concentrations of dikegulak and SADH. Fertility per cent of seeds was low only in case of higher concentrations of dikegulac. Seed size was diminished at 5000 µg/ml CCC, but it was increased at 100 µg/ml dikegulac and 5000 µg/ml SADH. Oil per cent, however, remained unchanged irrespective of treatments and concentrations.

INTRODUCTION

Effect of growth retardants on modification of growth, yield and some biochemical parameters have been extensively studied (Cathey, 1964; Hassan *et al.*, 1975; Lovett and Campbell, 1973; Orchard and Lovett, 1976). Though there are sample literature regarding the effects of conventional retardants like CCC and SADH, reports are rather scanty in case of dikegulac which is regarded to be promising and potent chemical pinching agent (Desilva *et al*, 1976). CCC and SADH have remarkable effect on the reduction of plant height (Guardia *et al*, 1974) whereas increased stem girth by CCC (Lovett and Campbell, 1973) and SADH (Dorrell, 1973) application and modifications of yield (Guardia *et al*, 1974; Lovett and Orchard, 1974) are also reported in sunflower. Though dikegulac effect on retardation of growth is documented in a wide range of plant species (Bocion *et al*, 1975) practically no work is done yet on the yield behaviour of crop plants. Hence, in the present investigation special attention was given on the analysis of yield beha-

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viour in addition to the study of growth modification. Growth retardants suppress the overall vegetative growth of plants by slowing down cell division and cell elongation without altering their gross morphology (Cathey, 1964). Sunflower is known to have strong apical dominance and show excessive vegetative growth though the stem is rather weak and often fail to support the weight of mature head. Hence, the main objective of the present experiment was to find whether these growth retardants could overcome such disadvantageous features and the impact of this on the yield attributes of the present sunflower cultivar.

MATERIAL AND METHODS

Sunflower plants were raised in a soilbased nethouse having 21 small plots each of which were adequately manured with organic and chemical fertilizers. Foliar spray of 3 growth retardants each at 2 concentrations (viz. CCC 5000 and 1000 μg/ml, SADH 10,000 and 5,000 μg/ml and dikegulac 500 and 100 μg/ml) were made till run off on whole plants 3 times at 2 day intervals just before the head initiation stage (30-d). Control plants were sprayed in the same manner with distilled water and all the treatments were replicated 3 times in a randomized block design. Growth data like plant height, leaf number, stem circumference, leaf area and dry weight were recorded when the plants reached their maximum grain-filling stage (80-d). Dry weight of leaves was analysed by oven drying method (70°C for 48 h); leaf area was simply calculated by multiplying the maximum length and breadth of leaves with a factor 0.808. After harvest the yield data taken include: head diameter, total seed yield per plant, fertility per cent, 1000 seed weight and oil per cent. Oil was extracted from seeds of each treatment by soxhlet apparatus using solvent ether as the extraction medium. To study the variation of seed size and shape by growth retardants, the healthy seeds from the treated and control heads were composited treatmentwise, then few seeds from each treatment were randomly selected and finally their photography was taken. All the above growth and yield data are the average of 30 uniformly growth individual plants of each treatment.

RESULTS AND DISCUSSION

All the growth retardants, used in the present investigation, caused a significant reduction in height, the effect being more pronounced in CCC & SADH treatment (Table I). Retardant effects regarding the reduction of plant height and internode length are well documented in several plant species including sunflower (Suranyi, 1976; Monselise and Luckwill, 1974; Lovett and Campbell, 1973; Hassan *et al.*, 1975). However, present analyses showed that regarding height reduction CCC and SADH were superior to the higher concentration of dikegulac used and in fact, the concentration over 5000 μg/ml of dikegulac showed deleterious effect on sunflower. Unlike plant height stem girth was increased which was shared by all the treatments. Though leaf number remained unaffected (except at 500 μg/ml dikegulac), differential responses were noted so far leaf area are concerned. While the lower concentrations of CCC, SADH and dikegulac increased leaf area, the higher concentrations of these retardants reduced the same (Table I). Such inhibitory action at higher concentrations of the retardants might be due to the adverse effect of the chemicals on overall growth and development of plants

TABLE I

EFFECT OF DIFFERENT CONCENTRATIONS OF GROWTH RETARDANTS ON CHANGES OF PLANT GROWTH OF SUNFLOWER

Treatments	Concentrations (μg/ml)	Parameters				
		Plant height (cm)	Leaf No	Stem Circumference (cm)	Leaf area (cm^2)	Dry wt. percent
Dikegulac	500	114.80	18.0	7.9	2783	14.75
	100	119.20	21.5	7.3	3679	16.80
CCC	5,000	99.60	20.9	6.9	3108	14.80
	1,000	104.20	22.0	7.4	3786	17.50
SADH	10,000	85.30	20.2	7.4	3260	15.90
	5,000	97.50	20.7	7.6	3895	17.39
Control	—	129.00	22.2	6.0	3398	17.37
LSD (P=0.05)		8.75	2.30	0.72	120	2.73

including very slow rate of cell division of leaves. However at low concentrations, the increase of leaf area is interesting to note and it might be attributed to the synergistic effect of the retardants at low concentrations with the endogenous hormones, especially with GA. Available reports showed that CCC increased leaf area in sunflower (Orchard and Lovett, 1976) though there are reports on initial retardation effect. However, at lower concentrations of these retardants no appreciable increase in dry weight was noted concomitant with increase in leaf area (Table I).

Concentration effect of retardants on yield attributes were also evident from the present investigation (Table II) High concentration of dikegulac reduced head diameter and, in fact, at this concentration distortion of head was noted. This suggests that mobilized dikegulac has effectively destroyed the growing apex (Arzee *et al.*, 1977), the lower concentration being ineffecive or less effective in this regard. Reduction in yield as well as other yield attributes at higher concentration of dikegulac is thus obvious. On the other hand, at low concentration of dikegulac increase of seed yield was noted and this was accompanied by the increase of leaf area, stem girth, 1000 seed weight as well as fertility per cent. Reduction of seed yield as well as 1000 seed weight at higher concentrations of CCC and SADH was, however, correlated with decrease of leaf area. Such reduction in leaf area might deprive these plants from their maximum photosynthetic ability to meet the sink demand though they have achieved desirable translocating system by increasing their stem girth. Stem girth increase by retardant application is reported (Lovett and Campbell, 1973; Osborne, 1975) and such increase has

TABLE II

EFFECT OF DIFFERENT CONCENTRATIONS OF THE GROWTH RETARDANTS ON YIELD ATTRIBUTES OF SUNFLOWER

Treatments	Concentrations (μg/ml)	Parameters				
		Head diameter (cm)	Total seed wt./plant (gm)	Fertility %	1000 seed wt. (gm)	Oil %
Dikegulac	500	10.2	20.5	52.5	45.7	36.0
	100	15.2	36.9	70.1	62.5	38.3
CCC	5,000	13.5	23.6	73.5	49.9	38.1
	1,000	14.6	34.3	77.6	58.5	39.4
SADH	10,000	14.8	25.7	76.4	56.4	37.5
	5,000	16.6	35.5	76.9	62.8	38.4
Control	—	15.5	30.6	62.0	53.2	38.31
LSD (P=0.05)		2.15	3.10	5.42	3.05	NS

been found to be accompanied by the increase of lumens of vascular system (Phelps *et al.*, 1980). In lower concentrations of CCC and SADH yield per plant as well as 1000 seed weight were increased and this was accompanied by increase of leaf area and stem girth but decrease of height. Oil per cent, however, remained unaffected irrespective of retardants and their concentrations used (Table II).

Analysis of retardant effect on seed size and shape revealed that the size was diminished at 5000 μg/ml CCC treatment and somewhat bold seeds were noted at 5000 μg/ml SADH as well as at 100 μg/ml dikegulac. Seed shape was also changed a bit at SADH and dikegulac treatment. Bold seeds were produced in heads presumably having strong and steady sink demand, permitting the growing seeds to accumulate sufficient assimilates. On the contrary, small sized seed production might be the cause of subdued sink demand as well as limited source of assimilates (Fig. 1).

Available reports (Orchard and Lovett, 1976; Lovett and Orchard, !974 showed that in sunflower decrease of plant height and increase leaf area as a result of retardant application increased yield and the effect was concentiation dependent. Deferral of senescence (Cathey, 1964; Guardia *et al*, 1974) as well as higher retention capacity of chlorophyll (Jain and Yadava, 1981) were obtained with retardant application. Orchard and Lovett (1976), suggested that increased seed yield and 1000 seed weight by CCC application was the result of greater supply of assimilates to the seeds because of greater leaf area. Whil: studying the processes of monocarpic senescence Noodén *et al.*, (1979) concluded that prevention of senescence

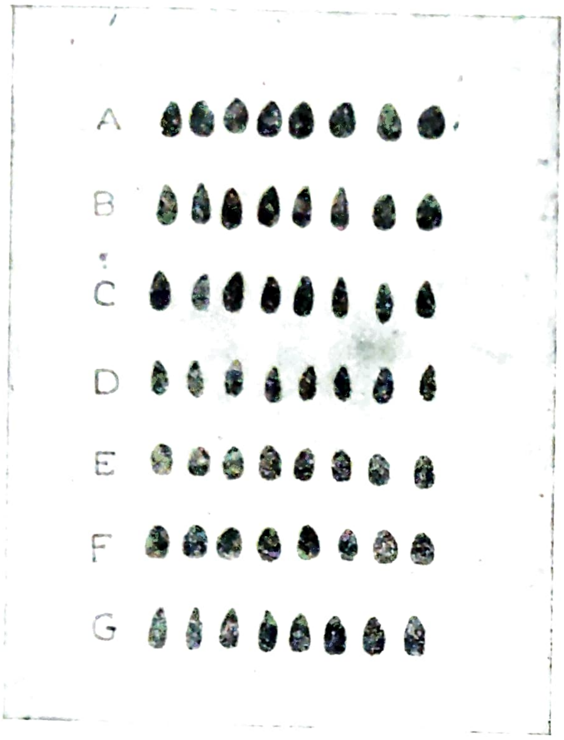

Fig. 1 Effect of different concentrations of the growth retardants on the variation of size and shape of sunflower seeds (A-SADH 5000; B-SADH 10,000; C- CCC 1000; D-CCC 5000; E-dikegulac 5000; F-dikegulac 100 and G-control).

processes might open a way to yield improvement. Our own unpublished data showed that chlorophyll retention capacity as well as protein content of the contributory leaves (Johnson, 1972) were higher and these were accompanied by lower activities of senescence promoting enzymes like RNase and protease. This proves that leaf longevity was increased and senescence was delayed. Possibly the desired growth modifications and such condition of plants, treated with low concentrations of the retardants, cumulatively caused augmentation of yield. However, at higher concentrations the low yield could be justified by decreased leaf area, as observed in the present investigation, and/or by hindrance of acropetal mobilization of assimilates by retardants (Monselise and Luckwill, 1974; Hoad and Monselise, 1976).

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