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EFFECT OF GROWTH REGULATORS ON GROWTH YIELD AND METABOLISM IN SOYBEAN GENOTYPES

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ABSTRACT

Field experiment was conducted with determinate and semideterminate soybean genotypes to study the effect of growth regulators on NR activity, chlorophyll content, rate of photosynthesis, growth and yield. The growth regulator treatments improved all the parameters and the effect was seen more in determinate genotype. The seed yield was significantly higher with TIBA (50 ppm) application followed by MC (100 ppm) and CCC (250 ppm) which was associated with higher number of pods and seeds per plant.

INTRODUCTION

In soybean, two growth habits are common, the determinate and indeterminate, but recently some cultivars have been identified with relatively less indeterminate habit. The response of varieties to growth regulators depends on the growth habit of the plant (Gu-Wei-Hong and Gu-WH, 1998) and hence there is an urgent need to screen the genotypes for their response to different growth regulators. Growth retardants are known to reduce internodal distance (Grossman, 1990), thereby reducing plant height (Deotale *et al.*, 1995) and enhancing source sink relationship and stimulate the translocation of photosynthates towards sink (Chandrababu *et al.*, 1995 and Reena-Tagade *et al.*, 1998). The growth promoter like cytokinin enhance hormone modified translocation of photosynthates which helps in better seed filing at latter stages of crop growth (Sharma and Walia, 1996).

In the present study the effect of cycocel (CCC), mepiquat chloride (MC), tri-iodobenzoic acid (TIBA) and kinetin were studied on physiological and biochemical changes in leaves and their relationship with growth and yield of soybean genotypes differing in growth habit.

MATERIAL AND METHODS

Seeds of soybean genotypes (JS-335 determinate and MACS-124 semi-indeterminate) were sown in the field at a spacing of 30 x 10 cm. The growth regulator treatments, CCC (250 and 500 ppm), MC (500 and 1000 ppm), TIBA (50 and 100 ppm) and kinetin (25 and 50 ppm) were given as foliar spray at 40 DAS. Plants sprayed with distilled water served as control. The experiment was laid out in a factorial block design with three replications.

Chlorophyll content and nitrate reductase activity were measured following the method of Arnon (1949) and Saradhambal *et al.* (1978), respectively. Photosynthesis, transpiration and stomatal conductance were measured on the adaxial surface of the fully expanded leaf at 55 DAS, using CO_2 gas analyser (Model, CID-CI-301, USA).

The plant height and biomass (dry weight) were recorded in 70 days old plants. The yield attributes *viz.*, number of pods, number of seed, total yield per plant and 100-seed weight were recorded at harvest.

RESULTS AND DISCUSSION

The NR activity and chlorophyll content differed significantly due to genotype and growth regulator treatments and the higher values were observed in genotype JS-335 as compared to MACS-124 (Table 1). Koti (1997) also observed significant variation in NR activity and chlorophyll content in determinate and indeterminate soybean genotypes. All the

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Table 1. Influence of growth regulators on chlorophyll content and nitrate reductase activity in soybean genotypes

Treatments	Nitrate reductase activity (μ moles NO_2g fr. Wt^{-1} h^{-1})		Chlorophyll (mg g fr. Wt^{-1})	
	JS-335	MACS-124	JS-335	MACS-124
CCC (250 ppm)	138.00	120.00	3.84	2.95
CCC (500 ppm)	149.00	128.00	4.46	3.00
MC (500 ppm)	130.00	99.00	3.76	3.09
MC (1000 ppm)	126.00	118.00	4.28	3.29
TIBA (50 ppm)	122.00	110.00	4.03	3.05
TIBA (100 ppm)	140.00	125.00	4.31	3.26
Kinetin (25 ppm)	120.00	102.00	4.16	3.25
Kinetin (50 ppm)	138.00	118.00	4.47	3.91
Control (water spray)	83.68	96.00	3.52	2.83
Mean	127.40	112.89	4.09	3.12
	SEm±	CD at 5%	SEm±	CD at 5%
Genotypes	4.390	12.618	0.046	0.132
Growth regulators	9.313	26.767	0.097	0.280
Interaction	13.171	NS	0.138	NS

growth regulator treatments except kinetin (25 ppm) recorded significantly higher NR activity over control. Increased NR activity was also noticed with growth regulator treatments by Goswami and Srivastava (1988) and Mansour *et al.* (1994). Similarly, chlorophyll content also increased with growth regulator treatments except CCC (250 ppm) and MC (500 ppm). It has been suggested that the application of growth regulators resulted in enhanced nitrate uptake by plants (Kuchenberch and Jung, 1988) which might have helped in increased chlorophyll content (El-Kheir *et al.*, 1994 and Reena-Tagade *et al.*, 1998).

The genotype JS-335 recorded significantly higher rate of photosynthesis and transpiration as compared to MACS-124 (Fig. 1a, b). The rate of photosynthesis and transpiration increased due to growth regulator treatments and such increase was associated with increase in stomatal conductance. The higher availability of CO_2 due to increase in stomatal conductance (Fig. 1c) is related with higher photosynthetic rate, which is resulted from growth regulator treatments (Kumari and Bharti, 1992). The higher uptake of nitrate increased the NR activity which has been closely associated with higher chlorophyll content in the leaf tissues. The superiority in nitrate reduction and chlorophyll content resulted in higher rate of photosynthesis and transpiration. Saha and Gupta (1998) also suggested that rate of photosynthesis is regulated by amount of nitrate reduction and chlorophyll content in mungbean.

The genotype MACS-124 recorded significantly higher plant height and total biomass (Table 2). Among the growth regulator treatments, significantly lower plant height was recorded with higher used concentration of TIBA (100 ppm) and that was followed by its lower (50 ppm) used concentration and also with CCC (500 ppm) whereas kinetin application resulted in higher plant height as compared to control. However, total biomass increased with growth regulator treatments. The increase, recorded in NR activity, chlorophyll content and biophysical parameters showed their impact on biomass production. It may be possible that the growth regulator applications increased biomass production by enhanced metabolic activities (Mansour *et al.*,

Table 2. Influence of growth regulators on plant height, biomass and yield attributes in soybean genotypes

Treatment	Plant height (cm)		Biomass (g plant^{-1})		No. of pods plant^{-1}		No. of seeds plant^{-1}		Seed yield (g plant^{-1})	
	JS-335	MACS-124	JS-335	MACS-124	JS-335	MACS-124	JS-335	MACS-124	JS-335	MACS-124
CCC (250 ppm)	26.25	61.17	19.99	20.93	37.13	55.60	76.43	72.45	12.06	11.22
CCC (500 ppm)	25.27	58.97	19.62	20.42	37.93	57.20	77.09	72.98	12.27	11.42
MC (500 ppm)	28.56	60.37	18.32	19.31	36.33	55.10	81.28	73.37	12.42	10.91
MC (1000 ppm)	27.92	59.33	18.55	20.39	38.40	56.30	80.73	82.14	12.68	11.05
TIBA (50 ppm)	25.16	58.89	20.08	19.22	43.69	64.56	93.49	83.93	13.37	12.27
TIBA (100 ppm)	23.78	56.72	19.16	18.95	38.80	58.00	86.92	79.00	12.25	11.31
Kinetin (25 ppm)	29.66	64.46	17.83	18.37	34.10	52.40	73.96	68.32	11.43	10.44
Kinetin (50 ppm)	30.27	64.89	18.48	19.30	34.53	54.60	74.21	68.47	11.57	10.60
Control (water spray)	30.86	64.44	16.67	17.20	33.80	49.00	68.03	61.46	10.21	9.12
Mean	27.52	61.03	18.52	19.34	37.19	55.86	79.13	73.58	12.03	10.93
	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
Genotypes	0.704	2.022	0.364	0.900	0.509	1.460	1.131	3.251	0.134	0.384
Growth regulators	1.493	4.200	0.664	1.910	1.071	3.080	2.400	6.897	0.283	0.814
Interaction	0.612	NS	0.939	NS	1.520	NS	3.394	NS	0.401	NS

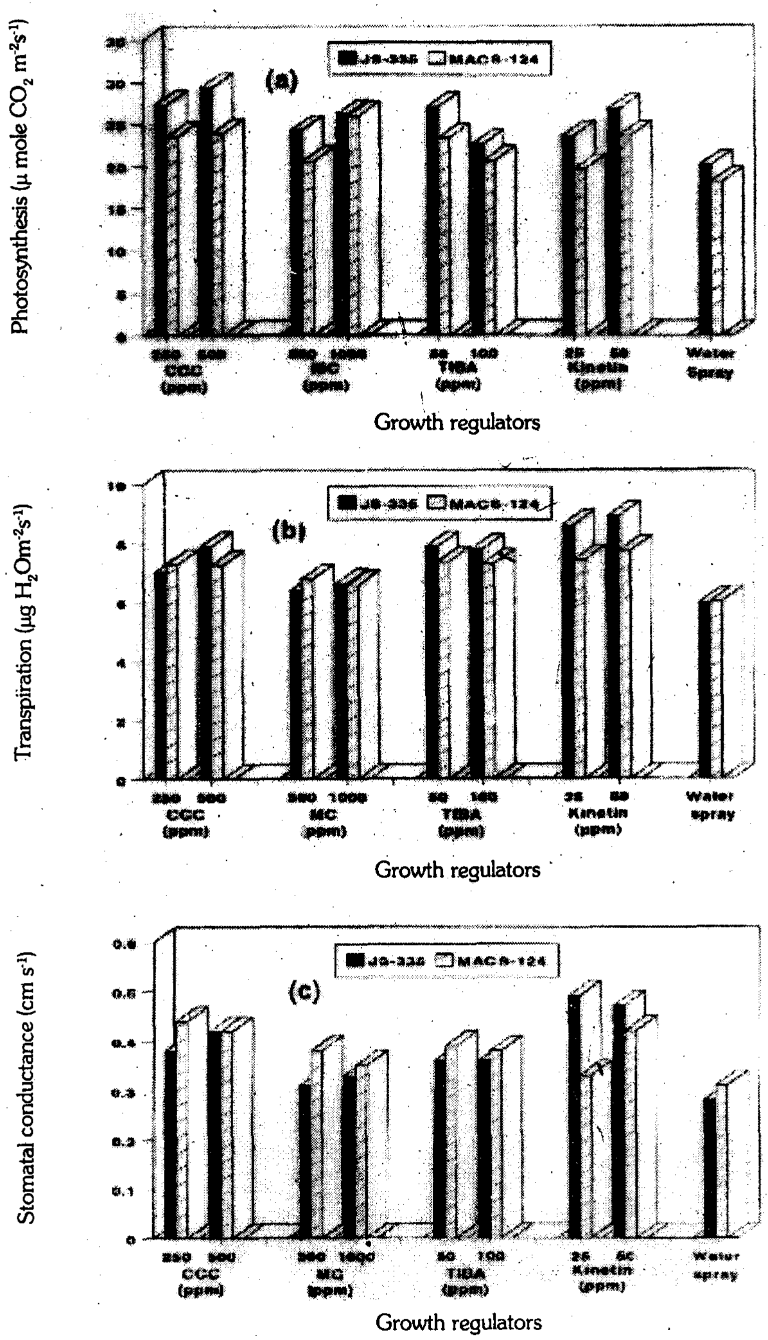

Fig. 1. Influence of growth regulators on (a) photosynthesis rate, (b) transpirations and (c) stomatal conductance in soybean genotypes

1994 and Chandrababu *et al.*, (1995).

The genotype JS-335 recorded significantly higher seed yield and number of seeds per plant. Whereas, MACS-124 possessed significantly higher number of pods per plant (Table 2). Though the genotype MACS-124 recorded significantly higher number of pods per plant, the seed yield per plant was significantly higher in JS-335 which was due to higher number of seeds per pod. The application of growth regulators significantly increased seed yield, the treatment TIBA (50 ppm) recorded maximum seed yield followed by MC (1000 ppm) and CCC (500 ppm). The increased seed yield was associated with increased number of pods per plant and number of seeds per plant. Among the growth regulators the response of growth retardants was more prominent as compared to promotor application, which might be due to suppressed vegetative growth and higher assimilate partitioning towards sink. As also suggested by Mansour *et al.* (1994), Deotale *et al.* (1996) and Gu-Wei Hong and Gu-WH (1998).

It is emphasized from the results obtained that determinate genotype responded better to growth regulator applications. So, the determinate growth habit should be given due importance while breeding for high productivity in soybean.

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