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EFFECT OF GA_3, KNap, C_3 AND NUTRIENTS ON CHLOROPHYLL CONTENT OF JUTE LEAVES

A. H. M. AHMED[1], M. MOHSIN, A. AICH[2] AND R. MANDAL

Department of Soil Science, University of Dacca, Bangladesh.

Abstract

Impact of growth regulators, nutrients and their combinations on chlorophyll 'a' and 'b' content of jute leaves have been studied by foliar application. In all cases, chlorophyll 'a' was higher than 'b'. Gibberellic acid caused the chlorophyll 'a' content to decrease per unit area and to increase per unit weight with concentration. Potassium naphthenate, chloromequate chloride and nutrients each enhanced chlorophyll (a & b) content up to certain levels depending upon the conditions. Combinations of gibberellic acid and nutrients increased chlorophyll content, but potassium naphthenate and nutrients, and chloromequate chloride and nutrients reduced the same. Chloromequate chloride in presence of potassium naphthenate inhibited the influence of the latter, and even nutrients added together could not improve the situation. Among the treatments, potassium naphthenate at 30 ppm appeared best with respect to increase in chlorophyll content.

Introduction

Growth regulators are complex organic compounds having the capacity to modify growth and yield of plants if applied in small amounts. The important chemicals of this class that are now-a-days being commonly used are gibberellic acid (GA_3), potassium naphthenate (KNap), chloromequate chloride (C_3) ; of which the former two are generally classed as growth promoter and the latter as growth retarder. The role of growth regulators on the growth, yield and nutrient uptake of various species of plants have been amply demonstrated, but as regards the chlorophyll content of leaves reports are few and are in apparent contradiction. Stowe and Yamaki (1957) proved that the application of GA_3 caused a decrease in chloroplasts and chlorophyll content resulting chlorosis. Wolf

Present address : 1. Dept of Chemistry, D. U. ; 2. Mohipur Experimental Farm (BWDB), Rangpur, Bangladesh.

and Haber (1960) also made the same observation and attributed this to the inability of the plants to keep pace with the enhanced leaf expansion even in presence of nutrients specially nitrogen where dilution of the pigment as well as partial delayed effects of malnutrition occur. However, Wheeler and Humpheris (1963) explained that the rate at which chlorophyll synthesis increased was lower than that of leaf area leading to a net decrease in the chlorophyll content.

Naphthenic acid and its salts (*e. g.* KNap) were also noted to cause significant increase in chlorophyll content as well as assimilative surface area per plant (Yureva 1965, Ladygina 1965, Pasha 1972, Roy 1972). Similarly, Primost *et al.* (1967) reported that C_3, a growth retardant, also caused the leaves to be greener and thicker in potato plants and this was supported by Mohsin and Smith (1972) who found that C_3 increased chlorophyll content of bush bean plants. Contrary to this, Halevy and Shilo (1970) working with C_3 on cotton and gladiolus plants observed decreased chlorophyll content.

Since different workers have examined the individual effects of growth regulators on the chlorophyll content of plants, effects of promoter-retarder combination was considered interesting to study together with added nutrients. Promoter-retarder combination on the growth and yield on the jute plant has proved to be of value (Mohsin *et al.* 1977). An endeavour, therefore, has been made to examine the effects of regulators, promoter-retarder combination, in presence and absence of added nutrients on the chlorophyll content of *Corchorus capsularis*.

Experimental

The soil, experimental set up and the doses of GA_3, KNap, C_3 and nutrients used were the same as Mohsin *et al*, (1977) and Aich *et al.* (1978).

Four discs, two from each side of the midrib, from the 11th leaf, counted downwards from the last fully expanded leaf at the top of each plant, was taken with the help of a cork borer after two and three weeks from the date of the first foliar application of growth regulators. The leaf discs were selected at random from the same treatment and fresh weight and chlorophyll content were recorded.

Chlorophyll was extracted by treating the leaf samples for one hour in 80% hot ethanol (containing traces of $CaCO_3$) at $78^0C \pm 1^0C$ and estimated colorimetrically after cooling in dark in a Coleman Spectrophotometer (Junior II) at 665 and 645 mμ for chlorophyll 'a' and 'b' respectively). Each value represents the average of three separate determinations.

Results and Discussion

It is obvious from the tables (1–2) that in all the cases including the control, chlorophyll 'a' is generally higher than 'b'. After two weeks (first stage of sampling) and three weeks (second stage of sampling) of first aerial spray of the growth regulator, GA_3 generally caused the chlorophyll 'a' content to decrease per unit leaf area and to increase per unit weight with concentration (Tables 1 and 2). Chlorophyll 'b' also followed the same trend as chlorophyll 'a', but at the second stage of sampling showed an upward trend with concentration in general. However, concentrations of both the fractions of chlorophyll of a sample with respect to per unit leaf surface area has inverse relationship with the corresponding values expressed as per unit weight of fresh leaf. The decrease in chlorophyll content due to GA_3 application was reported by some investigators (Wheeler and Humpheris 1963, Halima 1973). Monselise and Halevey (1962) observed that GA_3 resulted in small leaf area and caused a reduction in chlorophyll content. Mallik (1973) also stated that GA_3 made chlorophyll 'a' content higher and that of 'b' lower 39 day after application in jute leaves. This apparent contradiction of the present findings with that of those investigators is due to the fact that they presumably did not covert the chlorophyll content to prerogative growth factor i. e. chlorophyll content per unit weight of leaf *vis-a-vis* per leaf or plant.

KNap and C_3 individually caused a significant increase in the chlorophyll content with concentration up to a certain level at both the stages of sampling (Tables 1–2). Among the doses of KNap, 30 ppm appeared to be the best to induce the chlorophyll* content of leaves at the first stage of sampling. These results are in good agreement with that of Pasha (1972) and Roy (1972) who reported positive effect of KNap on the chlorophyll content of rice and jute plants respectively.

* Chlorophyll content stands for both the fractions (a & b) expressed as per unit area as well as per unit weight of fresh leaf if not stated otherwise,

Interestingly, nutrients in both the sets of experiments produced a considerable increase in chlorophyll 'a' and resonable increase in 'b' with concentration in most of the treatments at both of the stages of sampling (Tables 1–2). The nutrients possibly created the condition congenial for the synthesis of more chlorophyll. High Mg content in nutrient solution (1%) might have played a significant role in the increased formation of chlorophyll.

In the preceding paragraphs, GA_3 and nutrients have been ranked as chlorophyll promoter when applied separately. Application of GA_3 followed by nutrients failed to cause any signaficant change in chlorophyll content per unit weight of fresh leaves at the first stage of sampling (Tables 1–2). However, at the second stage of sampling, the significant increase in chlorophyll content was obtained when GA_3 was applied together with nutrients. The content of chlorophyll increased with concentrations of the both.

Thus, it is clear from the above that GA_3 in presence of nutrient solution (high in Mg) has helped to increase the content of chlorophyll. Nutrients alone played a significant role only at the first stage of sampling of jute leaves musking the influence of GA_3, but the impact of GA_3 in association with nutrients became apparent after a lapse of time, *i.e.* at the second stage of sampling.

Nevertheless, chlorophyll content per unit area increased significantly with nutrients concentration with respect to the values obtained by GA_3 treatments, *i. e.*, nutrient solution increased the same. Alternately, it could be said that the dialation of leaf thickness caused by GA_3 was arrested by the nutrients. However, combination of higher doses of GA_3 with higher doses of nutrients produced comparatively more favourable impact on chlorophyll content of leaves.

Aerial application of KNap in presence of nutrients failed to increase the chlorophyll content of jute leaves where nutrients possibly created hindrance at the first stage of sampling (Tables 1–2). KNap in combination with nutrients showed a decrease in chlorophyll content with concentration, However, both the treatments inereased the same when applied separately, but their combinations produced effects contrary to the expectation and with the passage of time, *i. e.*, at the second stage of sampling, a decrease in the concentration of the same was pronounced.

Table 1. Effect of GA_3 and nutrients on chlorophyll content of jute leaves expressed as O. D./unit area (outside parentheses) and and O. D./unit weight (within parentheses).

Nurrients (%)	GA_3 (ppm)	After two weeks Chlorophyll a	After two weeks Chlorophyll b	After three weeks Chlorophyll a	After three weeks Chlorophyll b
0	0	0.200(9.93)	0.191(8.01)	0.175(7.38)	0.120(5.45)
	0.50	0.197(10.39)	0.150(7.90)	0.177(8.77)	0.115(5.20)
	0.75	0.195(11.06)	0.157(8.93)	0.170(7.23)	0.117(5.20)
	1.00	0.195(11.12)	0.145(8.27)	0.160(7.67)	0.136(6.09)
	1.25	0.190(10.85)	0.142(8.14)	0.162(7.87)	0.147(6.63)
	1.50	0.181(10.66)	0.135(7.97)	0.165(8.40)	0.147(6.71)
	3.00	0.177(10.45)	0.145(7.90)	0.165(7.23)	0.143(6.38)
0.05	0	0.230(10.94)	0.192(8.51)	0.186(8.26)	0.125(5.58)
	0.50	0.225(10.11)	0.177(8.00)	0.187(8.44)	0.127(5.70)
	0.75	0.225(10.19)	0.162(7.34)	0.187(8.40)	0.130(5.82)
	1.00	0.225(10.20)	0.162(7.37)	0.195(8.70)	0.138(6.19)
	1.25	0.221(10.05)	0.160(7.27)	0.200(8.80)	0.142(5.91)
	1.50	0.220(10.35)	0.157(7.41)	0.204(9.09)	0.150(6.65)
	3.00	0.215(10.35)	0.155(7.46)	0.220(9.64)	0.152(6.68)
0.10	0	0.250(10.05)	0.192(8.33)	0.195(8.66)	0.135(6.00)
	0.50	0.250(10.69)	0.180(7.70)	0.205(9.60)	0.142(6.29)
	0.75	0.237(10.41)	0.175(7.66)	0.212(9.33)	0.144(6.31)
	1.00	0.237(10.78)	0.177(8.06)	0.215(9.34)	0.150(6.52)
	1.25	0.232(10.58)	0.162(7.60)	0.237(10.07)	0.154(6.57)
	1.50	0.225(10.59)	0.170(8.00)	0.237(10.10)	0.150(6.38)
	3.00	0.217(10.48)	0.157(7.59)	0.250(10.46)	0.180(7.53)

At each sampling stage, values were simply compared with the control.

Table 2. Effect of KNap, C_3 and nutrients on chlorophyll content of jute leaves expressed as O.D./unit area (outside parentheses) and O.D./unit weight (within parentheses).

Nutrients (%)	C_3 (ppm)	KNap (ppm)	After two weeks Chlorophyll a	After two weeks Chlorophyll b	After three weeks Chlorophyll a	After three weeks Chlorophyll b
0	0	0	0.225(10.01)	0.155(6.95)	0·162(7.08)	0.125(5.45)
		5	0.245(11.11)	0.185(8.31)	0.167(7.16)	0.127(5.45)
		10	0.302(12.95)	0.250(10.36)	0.182(7.24)	0.145(5.46)
		30	0.325(13.45)	0.262(11.07)	0.220(9.31)	0.157(6.67)
		50	0.300(13.11)	0.195(8.52)	0.232(9.49)	0.16 (6.53)
0	1	0	0.240(10.60)	0.180(7.27)	0.205(8.20)	0.152(6.10)
		5	0.220(9.41)	0.162(6.95)	0.120(9.36)	0.145(6.66)
		10	0.247(10.67)	0.170(7.31)	0.220(9.31)	0.162(6.66)
		30	0.262(11.30)	0.172(7.41)	0.247(10.65)	0.170(7.32)
		50	0.275(11.40)	0.174(7.25)	0.250(9.60)	0.175(6.76)
0.05	0	0	0.267(11.97)	0.200(8.33)	0.250(9.40)	0.160(6.52)
		5	0.262(10.40)	0.230(9.11)	0.212(9.02)	0.150(5.66)
		10	0.225(12.69)	0.192(8.14)	0.205(9.37)	0.145(6.66)
		30	0.230(10.34)	0.167(7.33)	0.295(7.88)	0.145(5.85)
		50	0.217(8.75)	0.160(7.44)	0.160(6.91)	0.122(5.05)
0.05	1	0	0.245(11.66)	0.175(8.33)	0.237(10.55)	0.155(6.88)
		5	0.250(10.70)	0.210(8.98)	0.237(8.92)	0.160(6.01)
		10	0.263(10.40)	0.230(9.10)	0.237(9.48)	0.160(6.53)
		30	0.300(12.06)	0.207(8.34)	0.262(11.31)	0.172(7.43)
		50	0.312(13.09)	0.210(8.98)	0.275(11.39)	0.175(7.25)

At all sampling stage, values were simply compared with the control.

In short, the presence of nutrients helped the higher concentration of KNap significantly.

Similarly, the foliar application of C_3 in asscciation with nutrients virtually showed the similar behaviour like KNap-nutrient combination in the chlorophyll content of leaves at the specified periods of sampling (Tables 1–2). Moreover, due to the limited doses, it is not perhaps justified to draw any conclusion. Spray application of C_3 in presence of KNap showed its real nature, *i. e.*, C_3 inhibited the influence of the promoter on the chlorophyll content of leaves at the first stage of sampling (Tables 1–2). In other words, their interaction is negative. Nevertheless, at the second stage of sampling, incompatibility between the two growth regulators, oppositely directed in nature, disappeared and subsequently synergistic effect was observed.

The combined effect of KNap, C_3 and nutrients on the chlorophyll content of leaves, generally produced the results comparable to that of simply KNap treated ones after two weeks of their application (Tables 1–2). It seems that nutrients and C_3 in combination with KNap have failed to show any influence on chlorophyll content of leaves. However, interactions among themselves were considerable. The better result is, however, obtained after three weeks of application of the misture of KNap, C_3 and nutrients. Chlorophyll content of the leaves under the treatments increased singnificantly at the second stage of sampling. It appears that apparent dormant activity (up to first stage of sampling) of nutrients and C_3 became oblivious. The critical examination of the data (Tables 1–2) indicate that nutrients probably co-operated with KNap and C_3 exhibited its counteracting activities. But this is in no way conclusive. Further investigation is necessary for the elucidation of the phenomena.

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