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Impact of Foliar Application of Growth Promoters (KNap and GA_3) and Nutrients on ZEA MAYS

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Foliar application of potassium naphthenate, gibberellic acid and nutrients made separately, or in combination with nutrients caused significant increase in various growth indices (except height and leaf number) and yield of *Zea mays* (var. ganga) over the control. The promoters proved to be superior to the nutrient solution. Of the two promoters, in general, gibberellic acid acted better with increasing concentration. Potassium naphthenate appeared to be much effective only at 2000 ppm. However, better results were not obtained when the promoters were applied with nutrients. Nevertheless, lower dose of gibberellic acid coupled with nutrients proved to be effective.

Introduction

GROWTH regulators now-a-days have been gaining momentum for being used extensively in economic exploitation of agricultural and horticultural products. These together with other cultural practices generate a sphere to be explored for increased production of economic importance.

Minute quantities of growth regulators can produce remarkable changes in growth and behaviour of biological species. The behaviour of regulators is peculiar. Depending upon the conditions, the same chemicals can promote or retard the growth without causing any mal-formation during growth and development[1]. The growth regulators used now-a-days, in general, are mainly auxins, gibberellic acid (GA_3), kinins, potassium naphthenate (KNap) and many other compounds of that nature. Auxins, GA_3 and the compounds of the type are usually used for the development of different organs of plants including fruit setting. KNap though not so prominent in stimulating growth of plants, but recently is being regarded as a growth promoter in some species of plants[2].

The application of growth promoters have caused the nutrient defficiency in plants. This has been attributed to the accelerated growth of plants and tremendous increase in the rate of biological activities therein[3,4]. Furthermore, Wolf and Haber[5] were of the opinion that the rate of uptake of nutrients was not at par with the promoter accentuated growth. Insufficient availability of nutrients may impede the attainment of maximal result. This postulation has been substantiated by the findings of Asadov[6] who obtained positive response using fertilizers in conjunction with growth promoters.

Maize, one of the important grain crops, considered to be responsive to the growth substances was selected to investigate the role of most powerful growth regulator—GA_3 and comparatively less powerful growth regulator-KNap, each alone, and in the presence of added nutrients. It was presumed that growth promoting substances along with nutrients would create better impact on growth and yield of maize than the respective treatments given individually.

Materials and Method

The seed bed was prepared with 150 maunds of cowdung per acre (The NPK content were not taken into account in the analysis of the results obtained). Nutrient solution was prepared according to the Long Ashton's formula with some modification and contained (g/*l*) NH_4NO_3, 20; $Na_2H\,PO_4$, H_2O, 12 ; KNO_3. 8 ; Ca (NO_3)$_2$, $4H_2O$, 3 ; Mg SO_4, 7 H_2O, 7.

Subsequently, the stock solution was diluted to make 0.1% and 0.05% solution. Aqueous solutions of potassium naphthenate (1000, 1500, 2000 and

2500 ppm) and gibberellic acid (1, 5 and 10 ppm) were made.

The experiments were arranged in a randomized block design. Seeds of *Zea mays* (var. ganga) sterilized with 0.1% $HgCl_2$ were dibbled at the rate of two seeds per hole with 30 cm × 45 cm spacing in the month of November. After a few days of germination the extra plants were uprooted and tap water was added as and when required.

The aqueous solutions were spread serially initially at an early age when the plants have established reasonably well in the soil (15 days after germination) and finally at the exuberant growth stage, and each was followed by the spray of nutrient solution on the next day.

The following observations were made :

i) Height after 30, 45 and 60 days,
ii) Total number of leaves after 20, 40 and 60 days,
iii) Fresh weights of cob and cob with sheath, dry weights of shoot, cob, and,
iv) Number of grains, yield and average weight/100 grains per cob.

Results and Discussion

The increase in height due to foliar application of KNap alone was not statistically significant (Table 1). However, in all levels of concentration

Table 1. Effect of promoters and nutrients on the height (cm/plant) and leaf/plant of maize plant.

Days of growth	Nutrients (%)	KNap (ppm) 0	1000	1500	2000	2500	L.S.D. (P=0.05)	GA_3 (ppm) 1	5	10	L.S.D. (P=0.05)
30		80.7	97.7	84.3	89.0	99.0	N.S.	84.3	86.7	89.7	N.S.
(20)		(9.3)	(8.7)	(9.3)	(10.7)	(8.3)	(N.S.)	(8.7)	(8.3)	(10.3)	(N.S.)
45	0	102.3	130.7	127.0	140.3	136.7	7.6	127.0	127.7	128.7	21.0
(40)		(10.7)	(12.7)	(11.3)	(12.3)	(11.7)	(N.S.)	(11.7)	(11.3)	(11.0)	(N.S.)
60		155.0	196.0	169.0	178.0	190.3	N.S.	177.0	163.7	178.7	N.S.
(60)		(14.3)	(14.3)	(13.7)	(14.2)	(14.0)	(N.S.)	(13.3)	(13.0)	(13.3)	(N.S.)
30		82.0	88.7	101.7	84.0	93.0		81.7	88.3	83.7	
(20)		(8.3)	(9.7)	(9.3)	(10.3)	(8.3)		(10.7)	(10.3)	(8.3)	
45	0.05	114.3	128.7	139.3	130.3	131.0		124.7	130.0	138.0	
(40)		(11.3)	(11.7)	(12.7)	(11.3)	(12.3)		(12.0)	(11.7)	(10.7)	
60		173.3	168.3	195.0	173.3	196.0		170.0	181.3	172.2	
(60)		(11.3)	(11.7)	(12.7)	(11.3)	(12.3)		(12.0)	(11.7)	(10.7)	
30		84.7	101.7	90.7	96.0	99.7		94.0	84.3	84.0	
(20)		(8.6)	(8.6)	(9.7)	(9.3)	(7.7)		(9.3)	(8.7)	(10.7)	
45	0.10	115.0	135.7	141.0	135.7	125.3		132.3	140.7	143.3	
(40)		(11.0)	(12.7)	(12.0)	(10.7)	(12.3)		(12.7)	(11.0)	(11.3)	
60		170.0	184.0	176.0	177.7	196.0		189.0	171.0	158.0	
(60)		(13.0)	(13.3)	(13.7)	(13.7)	(15.3)		(15.0)	(14.3)	(12.7)	

Figure in the parenthesis indicates leaf number.

of KNap there was increase over the control at the specified growth stages. Application of nutrients only showed the same impact as the KNap did. Evermore KNap with nutrients could not give improved results. In the early stage of growth, GA_3 alone failed to produce significant increase in height. However, nutrients (0.1%) with GA_3 (1 ppm) showed cumulating effect in lengthening the plant height. With the advancement of age of the plants, combination of GA_3 and nutrients caused casual height-increase. In the absence of nutrients, both the promoters showed some increase in height over the control irrespective of the doses. This confirms the findings of Writtwer and Bukovac[7] and Guzeeva[8] who reported that GA_3 caused increase in height of various plants. Roy[9] and Halima[10] also observed that the height of maize plants increased due to foliar application of KNap. The increase in height was attributed to an elongation of internodes due to the lengthening of cells and increased cell numbers[9,10].

The number of leaves counted after stipulated periods were inconsistent (Table 1). However, KNap showed better performance than GA_3 in this respect. On the other hand, GA_3 appeared to have reduced the leaf number at all levels compared with the control. As has already been stated quoting the findings of Roy[9] and Halima[10] that the promoter induced growth in maize plant is due to the elongation of internodes without affecting much the number of nodes. During exuberant growth, maize plants' internodes increase very rapidly making no concession for cell differentiation needed for the node formation. Evidently, where increased height were obtained the number of leaves are not in accordance.

Dry weight of shoots (without cob) increased significantly over the control (Table 2). The influence of KNap and GA_3 on the dry matter accumulation suggests that these growth promoters stimulate physiological and enzymatic activities in

Table 2. Effect of promoters and nutrients on the dry weight of shoot (without cob), fresh weights of cob and cob with sheath.

Growth indices	Nutrients %	KNap (ppm) 0	1000	1500	2000	2500	L.S.D. (P=0.05)	GA_3 (ppm) 1	5	10	L.S.D. (P=0.05)
Shoot (g/plant)		124.0	236.3	216.3	360.3	279.3	N.S	238.6	207.3	218.6	96.4
Cob with sheath (g/plant)	0	119.0	324.0	225.0	275.7	287.7	177.9	201.0	265.3	339.7	130.1
Cob (g/plant)		98.0	226.0	185.7	264.7	266.0	131.6	105.7	197.0	203.3	111.4
Shoot (g/plant)		243.7	270.0	325.7	257.3	304.8		221.3	258.7	280.3	
Cob with sheath (g/plant)	0.05	242.0	228.3	308.0	291.3	311.0		199.3	295.7	259.3	
Cob (g/plant)		193.7	174.0	326.3	256.7	284.0		172.7	242.7	152.0	
Shoot (g/plant		267.0	280.0	292.0	275.0	306.3		267.0	286.6	258.7	
Cob with Sheath (g/plant	0.10	197.7	284.0	350.3	340.0	325.0		251.7	228.3	341.3	
Cob (g/plant)		217.3	230.0	291.7	327.7	278.3		272.7	165.3	181.3	

many plants[2,11]. Between the promoters, KNap appeared to be better than GA_3 and acted best at 2000 ppm. Nutrient solution along with GA_3 or KNap failed to produce any significant result. However, the nutrients promoted the activity of GA_3 fairly well in comparison with KNap. Petersburgskii *et al*[12] also observed that nutrients in the presence of growth regulators can increase the rate of photosynthesis, sugar content and nitrogen metabolism in various species of plants.

The fresh weight of cob without sheath increased significantly over the control (Table 2). Better results, however, were not obtained when promoters were applied with nutrients. KNap and GA_3 behaved equally well and proved to be superior to the nutrient solution alone. The fresh and dry weights of cob increased significantly (Tables 2 and 3). However, the weights did not increase with concentration of KNap. In contrast, the weights increased with concentration of GA_3 within the

Table 3. Effect of promoters and nutrients on the dry weight of cob, number of grains and yield per cob.

Indices	Nutrients	KNap (ppm)					L.S.D. (P=0.05)	GA_3 (ppm)			L.S.D. (P=0.05)
	%	0	1000	1500	2000	2500		1	5	10	
Dry weight (g/cob)		68.0	158.0	133.3	197.0	190.3	N.S.	91.7	118.3	141.3	N.S.
Grain Number/cob	0	235.7	445.7	337.0	568.0	449.0	149.6	291.0	442.0	484.0	170.7
Yield (g/cob)		43.3	106.7	71.3	151.3	115.7	44.3	79.7	105.3	131.3	52.1
Dry weight (g/cob)		136.0	137.0	195.7	161.7	190.3		100.3	151.7	89.0	
Grain number/cob	0.05	415.3	366.7	604.7	447.3	453.3		395.3	419.3	355.3	
Yield (g/cob)		97.0	61.0	160.0	144.0	101.0		95.6	101.7	114.3	
Dry weight (g/cob)		142.7	144.3	167.7	180.7	175.7		173.0	99.7	148.3	
Grain number/cob	0.10	426.7	449.7	446.7	492.3	472·7		486.2	501.5	498.3	
Yield (g/cob)		82.3	95.0	130.0	135.3	147.0		111.3	119.0	119.7	

dose limit. As in the previous cases, nutrients with KNap could not produce much too impact, but with GA_3 seems to have positive effect with a few exceptions.

Either of the promoters and/or nutrients caused a significant increase in the number of grains and yield per cob and weight of 100 grains over the control (Table 3 and 4). Promoters induced increase in grain number and yield were found dependent on concentration unlike the growth parameters. Number of grains and yield per cob posses a positive correlation ($r=+0.897$, $P=0.001$) with dry matter accumulation (Table 2). KNap at

Table 4. Effect of promoters and nutrients on the weight (g)/100 grains.

Promoters		Nutrients (%)			L.S.D.
	(ppm)	0	0.05	0 10	(P=0.05)
	0	18.7	23.5	19.2	7.5
	1000	24.1	16.6	20.8	
KNap	1500	20.9	26.5	30.7	
	2000	26.7	32.0	26.7	
	2500	26.2	22.1	31.1	
	1	25.8	22.1	22.3	N,S.
GA_3	5	24.3	24.3	25.4	
	10	27.6	32.9	24.6	

2000 ppm appeared to be much effective to produce the grain number and yield (Table 3) as was in dry matter production (Table 3), while GA_3 gave increasing values with concentration. Furthermore, lower does of GA_3 with nutrients proved to be as efficient as higher concentration of GA_3 alone and in combination with nutrients. The present finding is in accord with that of Abdullaev and Tagieve[13] who found better yield due to foliar application of KNap and GA_3 in various plants. Nutrient solution was found not complementary to the promoters. This is contarary to the result reported by Misra *et al*[14] and Ashour *et al*[15] who noticed that the application of NPK in soil increased the effectiveness of promoters in yielding maximum yield.

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