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Effect of Foliar Sprays of Plant Regulators (IAA and GA) on the growth and yield of Knol Khol (*Brassica Oleracea* Linn. var. *gongylodes*)

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IN this modern era the vegetable has attained an important place in human diet like cereals and pulses. Among all the vegetables the cabbage group has some important vegetable crops. This group is interesting horticulturally, because of the great variety in the parts developed to a condition suitable for human foods. Knol Khol or Kholrabi. (*Brassica oleracea* Linn. var. *gongylodes*) as the latin name indicates, is a member of cabbage group of vegetables.

Today we have to face the problems of increasing yield and that too in a very short period due to rapid increase in population and consequent food crisis. Any practice which significantly shortens the time of producing higher yield may be of considerable practical value. The use of various plant regulators on the vegetable crops, such as Indole acetic acid and Gibberellic acid has created a considerable amount of scientific interest in recent years. Hence it was deemed of considerable utility to study the practicability of these plant regulators on the growth and yield of knol khol.

REVIEW OF LITERATURE

The utility of plant regulators was first investigated by Darwin (1381), whose results were further confirmed by Boysen (1911). Amlong and Naundorf (1937) reported that spraying plants with IAA at a concentration of m/100 accelerated vegetative growth and flowering.

Mitchel (1951) found that growth of bean plants was suppressed when they were sprayed with solution containing 300 mg/litre of IAA and weaker solution had no effect.

Bukovac and Wittwer (1956) showed that when gibberellin (10-20g. per plant) was applied to the growing point of leaf surface

of pea, bean, tomato, celery, capsicum, sweetcorn, squash, cucumber, lettuce and cabbage grown in nutrient solution, or soil, in the green house, the universal response was marked elongation of internodes.

Reed (1957) stated that spraying of certain plants with GA altered the shape of the new leaves that were produced for several weeks after treatment. Leaves of treated tomato plants developed smooth edges instead of the normal indented edges. Pepper leaf surfaces were rough instead of being smooth. The width and length of bean leaf blades were increased by 22 and 33 per cent. respectively and the length of bean petioles was increased by 50 per cent. with gibberellin treatment.

Rappaport. (1957) stated that GA at 100 and 200 g. per plant caused total stem elongation in early tomato. Stem elongation in young plant was increased at all concentrations between 2 and 450g. per plant. Fresh weight and dry matter were also increased.

Kurki (1958) studied the effect of GA on some horticultural plants. Among various plants treated with 0.25 mg. GA, lettuce flowered without forming hearts in an environment which kept untreated control vegetative. Dahlias flowered 7-9 days earlier than controls.

Peckett (1960) found that GA at 0.5 and 25 mg./l. caused small increase in the growth of excised roots of one pea variety but not of another variety. Root hairs development was strikingly stimulated in both varieties.

Jauhari *et al.* (1960) studied the effect of 0, 10, 25, 50, 100 and 250 ppm. GA on spinach seedlings after 40, 55 and 70 days of sowing and found maximum increase in the height and number of leaves at 10 ppm. concentration.

MATERIALS AND METHODS

The present investigations were conducted during 1964-65 at the Government Agricultural College Kanpur. Seeds of knol-khol variety White Vienna were procured from M/s Sutton and Sons, Calcutta and were sown in well prepared raised beds. The seedlings were transplanted in the experimental sub-plots on 27th October, 1964, at a distance of 45 cm. $\times$ 30 cm. row to row and plant to plant, respectively.

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Two plant regulators—Indole-acetic acid (IAA) and Gibberellic acid (GA) were taken for foliar application. Four concentrations of each plant regulator were used and thus there were nine treatments including control. They are given below :—

<i>Treatments</i>	<i>Plant Regulators</i>	<i>Concentrations</i>
T ₁	.. IAA ..	25 ppm.
T ₂	.. " ..	50 ppm.
T ₃	.. " ..	75 ppm.
T ₄	.. " ..	100 ppm.
T ₅	.. GA ..	10 ppm.
T ₆	.. " ..	20 ppm.
T ₇	.. " ..	40 ppm.
T ₈	.. " ..	80 ppm.
T ₉	.. Control (distilled water spray)	

Randomized block design was followed which had 9 treatments, replicated 4 times and thus there were 36 sub-plots. The size of each sub-plot was 300 cm. × 150 cm.

Stock solutions of 100 ppm. IAA and 80 ppm. GA were made and lower concentrations were made by diluting them with distilled water. The sprayings of plant regulator solutions were done directly on the foliage of the whole plant by a hand atomizer. It was done in the evening on 14th November, 1964.

Six plants from each sub-plot were randomly selected and records on growth of the plants and knobs at weekly intervals were taken.

EXPERIMENTAL FINDINGS

The observations taken on various aspects are given below :—

1. (a) *Average height of the plants :—*

The data of average height recorded at the time of harvesting on 10.1.65 are summarized in Table I.

It is evident from Table I that T₅ (10 ppm. GA) gave the highest average height of the plant, which was closely followed by T₃, T₂, T₆, T₇, T₄, T₁, T₈ and T₉, in the recoding order. The analysis of variance of the data shows that the heights of the plants under T₅ were significantly superior to all the treatments excepting T₃, T₂ and T₆. The height of the plants under control was the least.

(b) *Spread of the plants :—*

Observations on the spread of the plants in the north-south direction are recorded in Table II.

It is clear from Table II that T_5 gave the best spread from third week of December, while T_3 gave the maximum spread from 22.11.64 to 20.12.64. The plants under T_9 (control) exhibited the minimum spread throughout the period of observation.

2. Study of Root :—

(a) Length of primary root :—

The average length in each treatment measured at the time of harvesting is summarized in Table III.

Table III shows that T_3 gave the highest length of primary root and was closely followed by T_7 and T_8 , which were superior to the remaining treatments. The plants under control produced the least root length and were significantly inferior to T_3 and T_7 .

(b) Average number of secondary roots :—

The average number of secondary roots was counted at the time of harvesting on 10.1.65 and the data are recorded in Table IV.

A perusal of Table IV shows that the highest average number of secondary roots in T_3 was 2.687. It was followed by T_8 , T_2 , and T_6 . The control plants produced the lowest number of secondary roots. Fig. I depicts the rooting of plants in various treatments.

3. Study of knob :—

(a) Diameter of the knob in the horizontal position :—

The measurement of diameter of the knob in horizontal position was taken at the time of harvesting and the data are summarized in Table V.

It is evident from Table V that T_5 gave the highest average diameter (8.01 cm.) and was significantly superior to T_3 and T_6 . These were significantly superior to the remaining treatments including control.

(b) Fresh weight of the knobs :—

The average fresh weight of the knobs recorded at the time of harvesting is given in Table VI.

It is evident from Table IV that the plant regulator sprays markedly increased the fresh weight of the knobs. The maximum weight of the knob was obtained in T_1 , which was closely followed by T_6 . The weight of knobs

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under these treatments was significantly superior to the remaining treatments. The control produced the lowest weight of the knob.

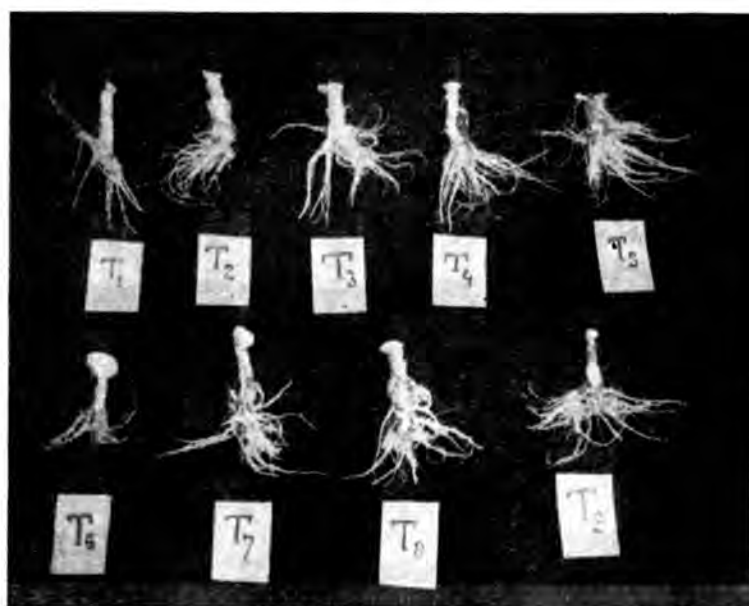


Fig. 1—Rooting of knol khol under different treatments.

4. Average yield :—

The total yield per plot in each replication was obtained by weighing knobs in kg. at the time of harvesting. The per acre yield was worked out from these data. The quantitative values are presented in Table VII.

Table VII shows that the yield under T_1 was the highest while the control plots gave the lowest yield. The analysis of the data shows the yield under the treatment T_5 and T_6 did not differ among themselves, though they were significantly superior to the remaining treatments.

It can be concluded from these results that 10 ppm. of GA and 75 ppm of IAA were effective in increasing the per plot and consequently per acre yield of knol khol.

DISCUSSION

The present investigations reveal that foliar application with IAA and GA brought marked differences in growth and yield of knol khol (*Brassica oleracea* Linn var. *gongylodes*).

In the present study maximum average height was obtained under T_5 (10 ppm. GA) and was closely followed by T_8 (75 ppm. IAA). However, higher concentrations of GA were not helpful in increasing the height of the plant. Similar results have been recorded by Jauhari *et al.* (1960), who found maximum increase in height of spinach plant with 10 ppm. of GA.

The results of the present investigation reveal that 50 and 75 ppm. IAA and 40 ppm. GA increased the length of primary root significantly, whereas 10 ppm. GA and 100 ppm. IAA were not so effective. There was no marked effect of hormone in increasing the number of secondary roots. Even then, 10 ppm. GA and 75 ppm. IAA gave good average than other concentrations of GA and IAA. Similarly, Rajumov (1960) reported that 0.1 per cent gibberellic acid produced smaller roots in plants.

The largest diameter was observed under 10 ppm. GA and was followed by 75 ppm. IAA which also increased the diameter of knobs. Higher concentrations of GA and lower concentrations of IAA were not helpful in this regard. But in all treatments the size of knob was better than that of control. Mc Cubbin (1957) found that 50 ppm. GA applied to cabbage, cauliflower, and lettuce transplants produced small marketable heads.

The fresh weight of knob was found superior with 10 ppm. GA and was followed by 75 ppm. IAA. The lowest weight was recorded in the control. The weights of the remaining treatments were higher than the control. Thus, lower concentrations of IAA and Higher concentrations of GA were not helpful in increasing the weight of knobs significantly.

The yield of crop per acre increased by using the plant regulators. The increase in yield of crop was found better in treated plots than that of the control. 10 ppm. GA gave better yield than other concentrations of IAA and GA. The yield per acre was 4679.67 Kg. Chhonkar and Singh (1964) reported that yield of heads of cabbage was significantly higher with GA than control.

SUMMARY AND CONCLUSIONS

(1) Of all the treatments, 10 ppm. GA gave the highest average height and was closely followed by 75 ppm IAA.

(2) The spread of the plant was also more in 10 ppm. GA and 50 ppm. of IAA.

(3) Maximum root length was found with 75 ppm. IAA which was 8.15cm. and minimum was 6.66cm. in control. 75 ppm. IAA gave maximum number of secondary roots and it was followed by 10 ppm. GA.

(4) Diameter of the knob in horizontal position was found to be maximum with 10 ppm. GA and 75 ppm. IAA.

(5) 10 ppm. of GA and 75 ppm. of IAA gave maximum weight of knob as well as yield.

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It can be concluded from these results that 10 ppm. GA and 75 ppm. IAA were found to be effective in increasing the growth and yield of knol khol.

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TABLE 1.—Average height of knol khol plants at the time of harvest on 10.1.65

<i>Replication</i>			<i>R</i> ¹	<i>R</i> ²	<i>R</i> ³	<i>R</i> ⁴	<i>Total</i>	<i>Mean</i>					
Treatments													
T ₁	..	..	21.66	..	26.00	..	18.50	..	23.33	..	89.49	..	22.37
T ₂	..	..	24.53	..	23.80	..	26.00	..	24.87	..	99.20	..	24.80
T ₃	..	..	27.24	..	24.57	..	22.92	..	25.48	..	100.21	..	25.05
T ₄	..	..	23.00	..	25.50	..	21.56	..	22.60	..	92.64	..	23.11
T ₅	..	..	27.63	..	24.84	..	27.00	..	26.19	..	105.66	..	26.41
T ₆	..	..	25.55	..	26.00	..	24.00	..	22.77	..	98.32	..	24.58
T ₇	..	..	25.66	..	23.48	..	20.83	..	24.56	..	94.53	..	23.63
T ₈	..	..	21.73	..	20.50	..	23.00	..	23.12	..	88.35	..	22.08
T ₉	..	..	22.00	..	19.50	..	21.67	..	23.81	..	86.98	..	21.74

S.E. = 0.995

C.D. at 5% = 2.053.

TABLE II.—Average spread of plants in north-south direction in cms. at weekly intervals

<i>Treatments</i>		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
<i>Dates</i>										
22.11.64	..	.. 18.50 ..	17.00 ..	17.62 ..	16.29 ..	17.00 ..	16.00 ..	15.16 ..	17.16 ..	14.33
29.11.64	..	.. 22.60 ..	22.65 ..	23.42 ..	21.55 ..	22.48 ..	21.30 ..	20.78 ..	22.00 ..	20.16
6.12.64	..	.. 27.33 ..	28.40 ..	29.00 ..	26.53 ..	27.92 ..	26.46 ..	27.25 ..	26.00 ..	25.13
13.12.64	..	.. 32.22 ..	33.43 ..	35.52 ..	32.21 ..	33.62 ..	32.53 ..	33.00 ..	32.25 ..	32.40
20.12.64	..	.. 38.36 ..	40.45 ..	42.02 ..	37.63 ..	41.52 ..	38.00 ..	38.97 ..	37.82 ..	36.45
27.12.64	..	.. 40.20 ..	43.66 ..	42.15 ..	41.70 ..	44.64 ..	42.31 ..	40.46 ..	40.00 ..	39.17
3. 1.65	..	.. 40.35 ..	43.87 ..	42.46 ..	41.75 ..	44.65 ..	42.42 ..	40.53 ..	40.08 ..	39.35
10. 1.65	..	.. 40.37 ..	43.92 ..	45.52 ..	41.95 ..	44.75 ..	52.45 ..	40.60 ..	40.10 ..	39.40

TABLE III—Average length of primary roots of knol khol in cms.

Replications	Treatments					Total	Mean
	R_1	R_2	R_3	R_4	R_5		
T_1	8.41	7.00	5.93	7.55	..	28.89	7.22
T_2	8.26	6.52	7.34	7.45	..	29.57	7.39
T_3	8.06	9.00	7.23	8.30	..	32.59	8.15
T_4	7.28	7.10	7.03	6.50	..	27.91	6.98
T_5	7.21	7.05	6.14	7.14	..	27.54	6.89
T_6	8.00	5.25	7.25	7.02	..	27.52	6.88
T_7	8.21	6.52	8.12	7.90	..	30.75	7.69
T_7	7.33	6.21	7.05	8.04	..	28.63	7.16
T_9	7.43	5.63	6.40	7.20	..	26.66	6.66

S.E. = 0.384

C.D. at 5% = 0.792.

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TABLE IV

Table IV.—Average number of secondary roots of Knol Khol

Replications	R ₁	R ₂	R ₃	R ₄	Total	Mean
Treatments :						
T ₁	.. 23.16	.. 27.00	.. 21.33	.. 29.00	.. 100.49	.. 25.12
T ₂	.. 22.66	.. 31.83	.. 22.16	.. 30.16	.. 106.81	.. 26.70
T ₃	.. 25.50	.. 29.66	.. 24.00	.. 28.33	.. 107.49	.. 26.87
T ₄	.. 33.33	.. 23.66	.. 16.00	.. 31.16	.. 104.15	.. 26.04
T ₅	.. 18.50	.. 25.00	.. 25.50	.. 38.00	.. 107.00	.. 26.75
T ₆	.. 23.26	.. 32.16	.. 18.00	.. 33.00	.. 106.32	.. 26.58
T ₇	.. 36.33	.. 23.00	.. 19.11	.. 24.66	.. 103.10	.. 25.77
T ₈	.. 22.00	.. 26.33	.. 26.16	.. 26.33	.. 100.82	.. 25.29
T ₉	.. 30.83	.. 16.33	.. 20.50	.. 30.50	.. 98.16	.. 24.54

TABLE V

Table V.—Average diameter of knob in horizontal position in cms.

Replications	R ₁	R ₂	R ₃	R ₄	R ₅	Total	Mean
Treatments :							
T ₁	.. 6.21	.. 7.56	.. 6.03	.. 4.83	..	24.63	.. 6.16
T	.. 6.41	.. 5.63	.. 7.68	.. 6.38	..	26.10	.. 6.52
T ₂	.. 8.63	.. 7.03	.. 7.46	.. 6.74	..	29.86	.. 7.46
T ₄	.. 5.34	.. 7.74	.. 5.50	.. 6.10	..	22.68	.. 6.17
T ₅	.. 8.19	.. 10.08	.. 7.05	.. 6.72	..	32.04	.. 8.01
T ₆	.. 7.01	.. 7.56	.. 6.54	.. 6.58	..	27.69	.. 6.92
T ₇	.. 6.57	.. 6.68	.. 6.07	.. 7.39	..	26.71	.. 6.16
T ₈	.. 5.06	.. 7.51	.. 5.57	.. 6.44	..	24.58	.. 6.14
T ₉	.. 3.83	.. 7.70	.. 5.33	.. 5.81	..	22.67	.. 5.67

S. E. = .128

C. D. at 5% = .264.



TABLE VI—Average fresh weight of knobs in kg. at harvest

<i>Replications</i>	<i>R₁</i>	<i>R₂</i>	<i>R₃</i>	<i>R₄</i>	<i>Total</i>	<i>Mean</i>
<i>Treatments</i>						
T ₁	.. 0.0366	.. 0.2616	.. 0.0825	.. 0.1208	.. 0.5015	.. 0.1254
T ₂	.. 0.1750	.. 0.1416	.. 0.1233	.. 0.1850	.. 0.6249	.. 0.1562
T ₃	.. 0.3208	.. 0.3125	.. 0.2916	.. 0.1400	.. 1.0648	.. 0.2662
T ₄	.. 0.1375	.. 0.083	.. 0.1458	.. 0.1616	.. 0.5332	.. 0.1333
T ₅	.. 0.2833	.. 0.5541	.. 0.1691	.. 0.1108	.. 1.1173	.. 0.2793
T ₆	.. 0.3000	.. 0.2583	.. 0.958	.. 0.1525	.. 0.8066	.. 0.2014
T ₇	.. 0.6641	.. 0.2458	.. 0.1100	.. 0.1150	.. 0.5349	.. 0.1337
T ₈	.. 0.6614	.. 0.2583	.. 0.0558	.. 0.1291	.. 0.5048	.. 0.1262
T ₉	.. 0.1600	.. 0.2000	.. 0.0808	.. 0.0600	.. 0.5008	.. 0.1252
S.E.	= .0032					
C.D.	at 5% = .056					

TABLE VII—Average yield of knobs

<i>Yield</i>	<i>Per plot</i> <i>in kgs.</i>	<i>Per acre in</i> <i>kgs.</i>	<i>Quintals</i> <i>per acre</i>
<i>Treatments</i>			
T ₁	.. 3.999	.. 2233.285	.. 22.33285
T ₂	.. 4.684	.. 2616.014	.. 26.16014
T ₃	.. 6.299	.. 3417.991	.. 34.17991
T ₄	.. 3.786	.. 2013.481	.. 20.13481
T ₅	.. 8.379	.. 4679.671	.. 46.79671
T ₆	.. 8.026	.. 4482.521	.. 44.82521
T ₇	.. 4.011	.. 2250.143	.. 22.50143
T ₈	.. 3.761	.. 2100.518	.. 21.00518
T ₉	.. 3.756	.. 2097.726	.. 20.97726

S.E. = .207

C.D. at 5% = .427