Pak J. Bot 13(1): 69-75, 1981.

EFFECT OF SOME GROWTH REGULATORS ON PLANT GROWTH, TUBER INITIATION, YIELD AND CHEMICAL COMPOSITION OF POTATO (*SOLANUM TUBEROSUM* L.)

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Abstract

Effects of some growth regulators on growth, yield and composition of potato (*Solanum tuberosum* L.) have been studied. GA_3 increased shoot extension, leaf area, number of leaves, stolons and tubers but decreased dry matters of stem, leaf and tuber. IAA and K increased dry matters of stem and leaf but decreased leaf number and leaf area, the number of stolons and tubers either decreased or were not affected. Yield of tuber increased with IAA used alone or in combinations with GA_3.

Total sugars increased with GA_3 used alone and combinations with IAA and K while starch content decreased with GA_3 and increased with IAA and IAA+K treatments. Ascorbic acid content was higher in GA_3 and was not affected significantly with IAA and K. Protein nitrogen decreased only with GA_3 while total nitrogen did not differ significantly with the treatments.

Introduction

Growth promotors and inhibitors control the plant growth, tuberization and yield in potato (Bodlaender & Algra, 1966; Krauss, 1976; Bisaria, 1977; Dimalla & Van Staden, 1977; Kumar & Baijal, 1977,79). Racca & Tizio (1968), Kumar & Wareign (1974) reported the changes in the content of gibberellin like substances in relation to tuberization mechanism. Ito & Kato (1951) have elucidated auxin induced plant growth and tuberization in potato. The role of cytokinins in tuber initiation has been reported by Palmer & Smith (1969) and Kumar & Baijal (1979).

Chemical composition of the potatoes may also be changed by applications of certain growth regulators (Chao & Wang, 1957; Kumar & Baijal, 1978, 80). The Present paper describes the effects of indoleacetic acid (IAA), gibberellic acid (GA_3), kinetin (K) and their combinations on plant growth, tuberization, yield and chemical composition of potato.

Materials and Methods

Pot trials were conducted during the winter season (November to January, 1980) using healthy seed tubers of potato (*Solanum tuberosum* L.) cv. Kufri Chandramukhi

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following randomized block design. Each set of 10 seed tubers was soaked in IAA (50 ppm), GA_3 (1,5 and 10 ppm), K (1 and 5 ppm) and their combinations for 24 hr and replicated three times. These concentrations were selected on the basis of the experiment conducted by Kumar (1976). A single seed tuber was planted in 9" earthenware pots filled with garden soil and farmyard manure in 1:2 ratio. The pots were kept well watered and clear of weeds during the course of experiment. Observations were recorded at the final harvest (90 days after planting) on different parameters of growth and number of stolons and tubers. Minimum size of the stolon counted was 0.5 cm and for the tuberization was 1.0 cm diameter. Analysis of sugar (Snell & Snell, 1955), total nitrogen (Snell & Snell, 1955), protein nitrogen (Snell & Snell, 1955), ascorbic acid (Bessey & King, 1933), and starch (Studiecommissie, 1941) were carried out in triplicate. The data were analysed statistically.

Results and Discussion

Hormonal treatments except K enhanced shoot extension, however, maximum stem length was attained with GA_3 (10 ppm) when used in combination with IAA indicating an additive effect (Table 1). Conflicting evidence exist concerning the effect of GA(s) on fresh and dry matter production of different plant parts (Rappaport, 1957). In the present experiment IAA and K increased dry weight of stem and leaf while GA_3 decreased these parameters and had shown an antagonistic effect when used in combinations of GA_3+K and GA_3+IAA. GA_3 produced thin, smaller and pale green coloured leaves, increased leaf number and leaf area but decreased leaf dry weight while IAA decreased the number of leaves but leaf area and leaf dry weight did not change significantly when compared with controls (Table 1). K treatments decreased leaf number and area but increased their dry weight. Both IAA and K treatments produced fleshy and dark green coloured leaves in contrast to GA_3. Inhibition in leaf number by IAA and K was partially reversed by GA_3 combinations. Total chlorophyll content increased with IAA and K and decreased with GA_3, however, GA_3 induced inhibition was reversed when used in combination with IAA+K (Table 1).

The outgrowth of the stolons and tuber initiation were favoured by GA_3 whereas IAA and K either did not affect or decrease them. However GA_3 (10 ppm) counteracted the effects of IAA and K on stolon development as well as tuber production. It may be mentioned that gibberellins inhibit tuberization in potato (Okazawa, 1960). This indicate that GA(s) evokes different responses on tuberization in potato, however, specific range of concentrations of GA(s) may prove to be favourable for tuber initiation individually or by interacting with some other growth regulating substances. Ito & Kato (1951), Palmer & Smith (1969) have reported that IAA and cytokinins induce tuber formation in potato which was not observed in the present experiment.

Table 1. Effect of some growth regulators on plant growth, stolon development, tuberization, and yield in potato (*Solanum tuberosum* L.) cv. Kufri Chandramukhi.

Hormonal treatment (ppm)	Stem length (cm)	Stem dry weight (g)	Leaf number	Leaf area (cm^2)	Leaf dry weight (g)	Total chlorophyll (a+b) (mg/g leaf tissue)	Stolon number	Tuber number	Tuber dry matter (yield) (g)
Control	12.68	0.35	30.6	2105.00	4.20	0.90	35.5	8.33	17.60
IAA, 50	15.62	0.42	18.0	2075.13	4.20	1.22	23.0	8.79	22.02
GA_3, 1	13.53	0.23	42.53	2550.62	4.20	0.80	40.0	9.29	17.02
GA_3, 5	16.29	0.25	42.90	2440.62	3.50	0.72	40.0	10.99	11.92
GA_3, 10	17.58	0.30	45.00	2633.56	3.38	0.65	45.0	15.86	12.43
K, 1	11.51	0.45	27.77	1786.72	4.65	0.96	34.0	8.14	14.78
K, 5	10.45	0.41	27.54	1992.95	4.36	0.99	35.0	8.05	12.60
IAA, 50+GA_3, 1	15.00	0.47	25.20	2423.06	3.73	0.91	38.0	9.72	18.07
IAA, 50+GA_3, 5	16.50	0.47	33.20	2399.70	4.32	0.88	39.0	10.40	19.84
IAA, 50+GA_3, 10	24.65	0.73	37.30	2485.37	4.78	0.88	41.0	12.10	23.07
IAA, 50+K, 1	15.99	0.51	26.28	1894.50	3.10	1.02	30.0	7.20	19.88
IAA, 50+K, 5	14.40	0.46	25.53	1831.35	3.69	1.06	27.0	7.70	18.03
GA_3, 1+K, 1	17.20	0.44	34.00	2252.35	2.61	0.82	36.0	9.00	12.51
GA_3, 1+K, 5	15.17	0.41	36.19	2231.30	3.10	0.85	34.0	9.88	17.14
GA_3, 5+K, 1	17.58	0.42	36.03	2420.75	1.80	0.81	34.0	9.00	9.90
GA_3, 5+K, 5	16.58	0.42	36.72	2315.50	2.05	0.85	36.0	10.67	13.24
GA_3, 10+K, 1	19.36	0.45	37.39	2626.00	2.36	0.78	42.0	11.40	8.97
GA_3, 10+K, 5	18.14	0.35	36.37	2483.90	3.31	0.75	40.2	14.80	15.62
IAA, 50+GA_3, 1+K,1	14.98	0.59	33.20	2105.20	4.53	1.14	33.0	10.60	20.31
IAA, 50+GA_3, 5+K,1	23.05	0.52	36.37	2189.20	4.53	1.14	32.0	13.30	21.20
IAA, 50+GA_3, 10+K,1	23.27	0.49	36.85	2252.35	4.49	1.16	38.0	16.00	20.76
IAA, 50+GA_3, 1+K,5	14.20	0.49	33.04	2020.80	4.74	1.10	34.0	9.00	21.02
IAA, 50+GA_3, 5+K,5	15.62	0.45	35.83	2041.85	4.77	1.16	36.0	10.60	21.49
IAA, 50+GA_3, 10+K,5	21.90	0.42	36.41	2128.36	3.50	1.12	39.0	14.20	17.48
C.D. at 5%	6.43	0.38	4.12	64.42	0.30	0.06	6.5	1.64	0.68

Table 2. Influence of some growth regulators on chemical composition of potato tuber.

Hormonal treatment (ppm)	Total sugar (mg/100 g fresh weight)	Starch (% fresh weight)	Ascorbic acid (mg/100 g fresh weight)	Total nitrogen (mg/100 g fresh wt)	Protein nitrogen (mg/100 g fresh wt)
Control	0.11	17.0	8.00	0.978	0.098
IAA, 50	0.13	20.2	8.40	0.978	0.101
GA_3, 1	0.22	16.8	10.12	0.968	0.084
GA_3, 5	0.22	16.0	10.25	0.978	0.074
GA_3, 10	0.24	14.0	10.45	0.987	0.065
K, 1	0.11	17.2	8.04	0.963	0.098
K, 5	0.10	17.5	7.00	0.963	0.110
IAA, 50+GA_3, 1	0.14	17.0	8.30	0.987	0.098
IAA, 50+GA_3, 5	0.20	16.0	8.50	0.963	0.097
IAA, 50+GA_3, 10	0.28	16.2	10.20	1.072	0.104
IAA, 50+K, 1	0.08	19.2	7.12	1.084	0.096
IAA, 50+K, 5	0.08	20.0	7.62	0.963	0.108
GA_3, 1+K, 1	0.12	17.1	7.00	0.990	0.100
GA_3, 1+K, 5	1.13	17.0	7.50	0.989	0.107
GA_3, 5+K, 1	0.15	16.8	8.62	1.001	0.108
GA_3, 5+K, 5	0.17	17.4	8.02	1.013	0.113
GA_3, 10+K, 1	0.19	15.0	10.12	1.098	0.107
GA_3, 10+K, 5	0.20	14.8	10.70	1.030	0.108
IAA, 50+GA_3, 1+K, 1	0.18	17.2	8.70	1.077	0.096
IAA, 50+GA_3, 5+K, 1	0.20	17.4	8.80	1.016	0.097
IAA, 50+GA_3, 10+K, 1	0.23	16.0	11.04	0.963	0.098
IAA, 50+GA_3, 1+K, 5	0.20	17.4	7.10	1.025	0.096
IAA.50+GA_3, 5+K, 5	0.20	17.8	8.0	0.990	0.107
IAA, 50+GA_3, 10+K, 5	0.23	16.2	10.94	1.014	0.108
C.D. at 5%	0.02	0.82	0.06	0.002	0.001

Tuber yield decreased by GA_3 and K but increased by IAA treatment (Table 1). Interesting results have been observed in IAA+GA_3 and IAA+GA_3+K combinations. In such combinations probably tuber number was increased by GA_3 incorporation and an additive effect of IAA on tuber yield was also maintained. Tuber yield was therefore, higher in comparision to controls (Table 2) but in IAA+K and GA_3+K combinations, neither tuber yield could be increased by IAA nor tuber number by GA_3 incorporation. This indicates that K combination with GA_3 and IAA had depressed the favourable effects of IAA and GA_3.

Data on chemical composition of potatoes indicate that total sugar content increased with various treatments except in K and IAA+K treatments. Kumar & Baijal (1978) have also reported increase in sugars in potatoes with GA_3. Starch content was higher in IAA and IAA+K treatments, decreased with GA_3 and was not affected significantly with K and Ga_3 when used in combinations with IAA, and IAA+K. Decreased starch content with GA_3 may be due to its promoting effect on amylase activity in tubers as earlier reported by Kumar & Baijal (1978). Ascorbic acid content increased with GA_3 (1-10 ppm), combinations of 10 ppm of GA_3 with IAA, K or IAA+K and decreased with other treatments. It was interesting to note that ascorbic acid and total sugars were higher in GA_3 than IAA and K treated sets. Increase in sugars with GA_3 may be due to increased amylase activity (Kumar & Baijal, 1978). Which may further be converted into ascorbic acid through various metabolic reactions as earlier reported by Chinoy et al. (1967). Total nitrogen content did not differ significantly with the treatments (Table 2) while protein nitrogen decreased with GA_3 and either increased or not effected with IAA and K treatments which confirms the earlier findings of Kumar & Baijal (1980). Since total nitrogen did not differ with the treatments, therefore, it appears that protein nitrogen in GA_3 treated sets has been changed into some other forms of nitrogen.

Acknowledgements

The authors are thankful to Dr R.N. Gupta, Principal and Dr. A.P. Shamshery, Head of the Botany Department for the facilities provided and to Drs. Arun Kumar, Vijay Kumar and A.K. Shukla for many sided help. One of the authors (P.K.) is thankful to U.G.C., New Delhi for financial assistance.

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