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Effect of foliar application of plant growth regulators on growth, yield and post harvest losses of potato (*Solanum tuberosum*)

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ABSTRACT

A field experiment was conducted during the winter *(rabi)* season of 2002 and 2003 to find out the suitable plant growth regulators for foliar spray to maximize seed potato yield. A total of 7 treatments including control were tested in randomized block design with 3 replications on 'Kufri Ashoka' potato (*Solanum tuberosum* L). The results indicated that plant growth regulators, like GA_3, NAA, TIBA and ethrel significantly increased seed size (25–75 g) tubers yield as well as total tuber yield. Significantly maximum total tuber yield (37.0 tonnes/ha) was achieved with GA_3 @ 200 ppm treatment, followed by ethrel (35.0 tonnes/ha) in comparison to control (30.4 tonnes/ha). The multiplication rate also varied from 12.8 to 14.6 with different plant growth regulators.The minimum rottage losses were observed with NAA treatment when tubers were kept for short-term storage after harvest at ambient conditions. At the end of the storage, significant dry matter increase was also observed with treatments ethrel, TIBA and NAA.

Key words: Dry matter, Plant growth regulators, Potato, Seed tuber yield, Storage

The potential yield of potato is 120 tonnes/ha, whereas the national average still stands at 18 tonnes/ha due to its low multiplication ratio ranging from 1:4 to 1:15. It is a highly input-intensive crop and requires huge quantity of seed tubers for its cultivation. The overall performance of the crop depends upon the metabolic activities of plant, particularly at its growth and developmental stages. To overcome the deficit in obtaining maximum production and productivity, the role of plant growth regulators play a vital role, even though they are required in very small quantity. The plant growth regulators have been reported to influence growth and play a significant role in increasing the yield by 10-15% by suppressing or stimulating plant growth (Sukumaran, 2000). Hence, the present investigation was undertaken to study the effect of foliar application of various plant growth regulators on growth, yield and post harvest losses of seed potato tubers kept for short term storage under ambient conditions.

MATERIALS AND METHODS

The field trials were conducted during winter (*rabi*) season of 2003 and 2004 at Central Potato Research Station, Gwalior. The soil was silty clay loam having 7.73 *p*H, 0.28% organic carbon, 0.10% N, 65 ppm P and 122 ppm K. The experiment comprised 7 treatments, viz T_1, GA_3 (gibberellic acid) @ 200 ppm; T_2, NAA (1-nephthalene acetic acid) @ 50 ppm; T_3, mepiquate chloride @ 150 ppm; T_4, TIBA @ 50 ppm; T_5, ethrel @ 250 ppm; T_6, 2–4, D @ 1 ppm and T_7: control (water spray). The treatments were replicated thrice in randomized block design. 'Kufri Ashoka' potato was used for the experimentation. Potato tubers (30-50 g) were taken out from cold store and spread in the shed for proper chitting. When tubers attained proper chitting, they were planted at 60 cm row spacing and 20 cm plant-to-plant spacing in gross plot size of 4.2 m by 4.0 m. Fertilizers were applied @ 150 kg N, 80 kg P_2O_5 and 100 kg K_2O/ha through ammonium sulphate, single superphosphate and muriate of potash respectively. Half dose of nitrogen and full dose of phosphorus and potash were applied as basal dose at final field preparation, while the remaining half dose of nitrogen in the form of urea was applied at earthing-up. The crop was irrigated 6 times at an interval of 15 days in order to provide sufficient moisture during growth and developmental phases. The crop was sprayed with all 6 plant growth regulators with their respective concentration; twice in a season at 25 and 50 days after planting. The biometric observations were recorded on 10 randomly selected plants from the experimental plot excluding the border rows. The haulms were destroyed manually at 80 days after planting. The pooled data were statistically analyzed using factorial randomized block design.

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RESULTS AND DISCUSSION

Effect on growth

Emergence percentage, stems/plant, days to tuber initiation and plant height at 30 days after planting showed non-significant differences among the treatments, whereas significant variation was observed only after application of plant growth regulator treatments. Table 1 reveals that significantly maximum plant height (75.0 cm) was obtained with GA_3 @ 200 ppm treatment, followed by NAA @ 50 ppm (56.6 cm) in comparison to control (48.2 cm). Other treatments except 2–4, D were also proved helpful in increasing height but the increase was non-significant. It confirms to earlier findings of Barche *et al.* (2000).This may be due to its ability to elongate cells and also increase cell division rate which is ultimately resulted into higher plant height.

Effect on yield-attributing characters

It was found that application of GA_3 @ 200 ppm gave significantly higher number of tubers/plant (8.5) and tuber yield (510 g) over control with 6.6 tubers/plant and 430 g tuber yield/plant, followed by NAA and Ethrel (Table 1). In a recent study, Alexopoulos *et al*. (2007) also found that foliar application of gibberellic acid increased vegetative growth (fresh and dry weights) and the number of tubers/plant grown from true potato seed. Similarly, Arora *et al*. (1998) also reported that twice spraying of growth regulators at 40 and 50 days after planting was found to increase the number of stems/hill and tuber yield (kg/hill) significantly over untreated control.

Multiplication rate of tubers on number and weight basis was higher in GA_3 treatment (8.5 and 14.6), whereas it was lowest in control (6.6 and 12.3). Better efficiency of GA_3 treated plants is attributed to the higher number of tubers and tuber yield/plant.

Effect on yield

The data presented in Table 2 indicated that tuber number (lakh/ha) and tuber yield (tonnes/ha) increased significantly and substantially with the application of plant growth regulators compared to control. Significantly maximum total number of tubers (5.84 lakh/ha) and total tuber yield (37.0 tonnes/ha) was obtained by the application of GA_3 @ 200 ppm as foliar spray at 25 and 50 days after planting, followed by application of ethrel @ 250 ppm (35.0 tonnes/ha) compared to control (4.52 lakh/ha and 30.4 tonnes/ha). This increase in tuber yield was due to increase in tuber size, as the proportion of seed size tubers (2.72 lakh/ha and 13.7 tonnes/ha) and large size tubers (1.98 lakh/ha and 21.7

Table 1 Growth and yield-attributing characters as influenced by foliar spray with plant growth regulators

Treatment	Emergence (%)	Stems/ plant	Tuber initiation (days)	Plant height (cm)		Tubers/ plant	Tuber yield/ plant (g)	Multiplication rate	
				30 DAP	75 DAP			By no.	By weight
GA_3 @ 200 ppm	97.6	4.3	23.5	28.4	75.0	8.5	510	8.5	14.6
NAA @ 50 ppm	97.2	4.5	23.1	28.7	56.6	8.3	500	8.3	14.3
MC @ 150 pppm	97.7	4.1	23.2	25.0	53.0	7.0	472	7.0	13.0
TIBA 50 ppm	97.8	4.3	23.9	24.6	47.3	7.1	470	7.1	13.4
Ethrel @ 250 ppm	96.8	4.3	23.2	26.8	49.7	7.8	489	7.8	14.0
2-4, D @ 1 ppm	97.2	4.2	23.1	25.3	48.0	6.9	470	6.9	12.8
Control (water spray)	97.9	4.1	23.5	24.4	48.2	6.6	430	6.6	12.3
S Em ±					3.38	0.25	20.5		
CD (P=0.05)	NS	NS	NS	NS	7.37	0.61	44.75		

DAP, Days after planting

Table 2 Graded tuber number and yield of potato as influenced by foliar spray with plant growth regulators

Treatment	Tuber no. (lakh/ha)				Tuber yield (tonnes/ha)			
	<25 g	25–75 g	>75 g	Total	<25 g	25–75 g	>75 g	Total
GA_3 @ 200 ppm	1.14	2.72	1.98	5.84	1.60	13.7	21.7	37.0
NAA @ 50 ppm	1.02	2.64	1.60	5.26	1.52	13.8	19.3	34.6
MC @ 150 ppm	0.76	1.86	2.15	4.77	1.14	8.6	23.9	33.6
TIBA @ 50 ppm	0.82	2.06	2.00	4.88	1.33	9.8	23.0	34.1
Ethrel @ 250 ppm	1.08	2.30	2.11	5.49	1.72	11.0	22.3	35.0
2–4, D @ 1 ppm	0.78	1.78	2.14	4.70	1.05	8.2	21.9	31.2
Control (water spray)	0.86	1.70	1.96	4.52	1.15	8.6	20.6	30.4
S Em ±	0.06	0.12	0.04	0.22	0.05	0.54	0.60	0.95
CD (P=0.05)	0.13	0.31	0.10	0.64	0.14	1.82	1.93	2.76

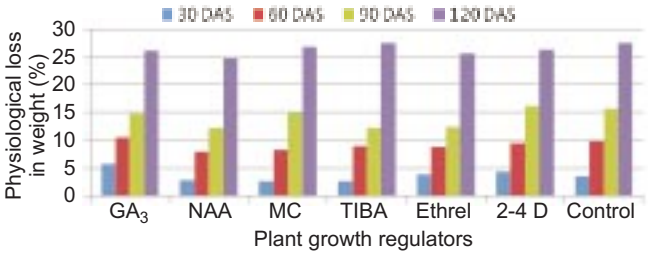

Fig 1 Effect of foliar spray of plant growth regulators on physiological losses in weight of potato tubers

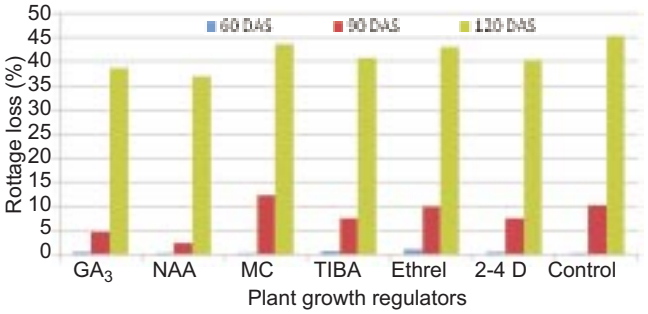

Fig 2 Effect of foliar spray of plant growth regulators on rottage of tubers during post harvest storage

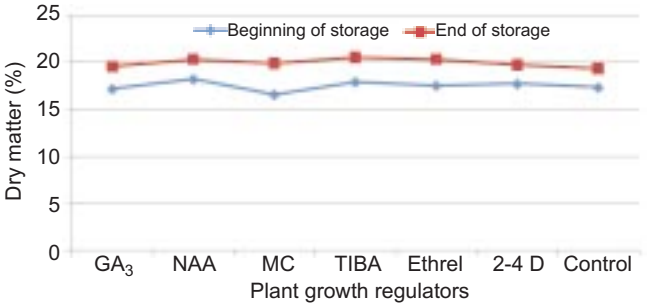

Fig 3 Effect of foliar spray of plant growth regulators on dry matter content of potato tubers during post harvest storage

tonnes/ha) are highest in GA_3 treatment over other plant growth regulators and control. Therefore, the proportion of allocation of assimilates to the tubers treated with GA_3 @ 200 ppm must have been more which resulted in higher tuber yield. It confirms to earlier findings of Ghosh *et al.* (2000).

Overall a general trend was observed in this study that the treatments producing maximum seed size tubers also produced less oversize tubers but slightly more small size tubers. In terms of percentage increase in tuber yield with plant growth regulators compared to control its value ranged from 4.0 to 14.8. The findings are in close agreement with Kooner *et al.* (1999). Hence, the increase in yield may be contributed by superiority in vegetative growth in terms of increased plant height, number of stolons/hill, number and weight of tubers/plant etc. Furthermore, the multiplication rate also varied with different plant growth regulator treatments. This rate varied from 12.8 to 14.6 with different growth regulators as compared to control (12.3) on weight basis (Table 1).

Effect on postharvest losses

It was noticed that the postharvest losses of potato tubers were also influenced by different plant growth regulator treatments. Various post harvest attributes influenced by use of plant growth regulators are depicted in Figs 1, 2, 3. It is clear from Fig 1 that the physiological loss in weight in all treatments increased with the storage period. The treatments like NAA, TIBA and ethrel showed less physiological losses up to 90 days of storage in comparison to control but after that similar trend was recorded in the physiological loss in weight of tubers.

In case of losses due to rottage, it was found that up to 60 days after storage (DAS) there was insignificant difference among treatments for rottage loss but when storage period reached to 90 days, only NAA showed significantly less (36%) rottage losses over control (Fig 2). Maximum rottage loss was observed with mepiquate chloride but the difference was insignificant than control. Dry matter content of the harvested tubers was also increased over a period of time, when they were subjected to storage for short term. Treatments like NAA, TIBA and ethrel registered significant increase in the dry matter of tubers over control. Other treatments were proved insignificant for this attribute (Fig 3). These results are in close agreement with the findings of Sukumaran (2002) in potato.

The result revealed that plant growth regulators, like GA_3, NAA, TIBA and ethrel may be used as foliar spray (at 25 and 50 DAP) for getting higher tuber number and total tuber yield and lower postharvest losses from 'Kufri Ashoka' potato.

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