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Influence of chemicals on growth and flowering in potato (*Solanum tuberosum* L.) genotypes

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Abstract
Potato (*Solanum tuberosum* L.) is one of the most important and widely consumed tuber vegetables throughout the world and ranks fourth after rice, wheat and corn. A major hindrance in potato breeding is that many varieties either do not flower or have poor flowering habit. To attempt crossing in any plant or crop, flowering, is a prerequisite. The number of flowers produced depends on the genotype and their interaction with day length and temperature. Considering these points in view, the present study was carried out to study the effect of chemicals and interaction effect of chemicals and genotypes on plant growth and flowering in different potato genotypes under extended photoperiod. Nine potato genotypes were sprayed with five chemicals under extended photoperiod. Results revealed that genotypes HT/10-1554, HT/21-6, HT/21-13 and HT/21-10 were found responsive for flower production. Chemical application had additive effect on all flowering traits. GA_3 100 ppm application was superior for all reproductive parameters.

Keywords: Potato, chemicals, growth, flowering traits

Introduction
Potato (*Solanum tuberosum* L.) is one of the most important and widely consumed tuber vegetables throughout the world and ranks fourth after rice, wheat and corn. Cultivated potato is tetraploid (2n = 4X = 48) in nature. It contains substantial quantity of energy, edible proteins (2.8 g), starch (16.3 g), total sugar (0.6 g), crude fibre (0.5 g), carbohydrates (22.6 g) and vitamin C (25 mg) per 100 g of fresh weight of tubers (Bhuwaneshwari *et al*., 2013) [13]. In potato, ample availability of flowers is an indispensable requirement for development of new cultivars through hybridization (Jessup, 1958) [3]. To attempt crossing in any plant or crop, transition to reproductive phase, *i.e.*, the flowering, is a prerequisite. A major hindrance in potato breeding is that many varieties either do not flower or have poor flowering habit in subtropical plains.

Potato requires low temperature and short day conditions for tuber formation but long day (>16 hours) and moderate temperature (15-20 °C) to enhance flowering (Stewart *et al.*, 1981) [2]. The number of flowers produced depends on the genotype and their interaction with day length and temperature. In India hybridization programme is being carried out at Kufri (2500 MSL) in Himachal Pradesh where such conditions prevail during summer season. By altering the naturally occurring environmental condition (photoperiod), using heat tolerant genotypes and with application of chemicals, flowering may be promoted even in subtropical conditions.

Sharma *et al.* (2019) [6] observed highest number of floral buds and flowers per plant in Kufri Khyati but genotypes such as Kufri Surya, Kufri Jyoti, FC-3, Diamond and Lady Rosetta were not able to flower under given treatments *viz.*, silver thiosulphate and extended photoperiod. Kaddour *et al.* (2006) [4] reported that foliar application of 50 and 100 ppm GA_3 advanced flowering of *cv*. Cara of potato 12 and 13 days earlier respectively. Luthra and Khan (2000) [5], who reported that hormone application under long day condition increased plant height by 27% compared to long day condition alone. Considering these points in view, the present study was carried out to study the effect of chemicals and interaction effect of chemicals and genotypes on flower induction in different potato genotypes under extended photoperiod.

Material and Methods
The investigation was carried out at College of Horticulture, Venkataramannagudem, Dr. Y.S.R. Horticultural University, West Godavari district, Andhra Pradesh during *rabi* season of 2021-22. The experiment was laid out in 2 Factorial CRD with nine potato genotypes *viz.*,

HT/10-1554, HT/7-1329, HT/21-10, HT/21-9, HT/21-8, HT/21-13, HT/21-12, HT/21-6 and Kufri Surya with two replications. GA_3 (100 ppm), NAA (50 ppm), spermidine (20 ppm) and ethephon (200 ppm) treatments were given as foliar spray at weekly intervals after 35 days of planting. Extended photoperiod was provided by artificial illumination through white flood light for ten hours after sun set. Six LED lamps of 100 W each were installed over the plants for increasing photoperiod. Data on growth parameters *viz.*, plant height, plant spread, number of shoots per plant, number of nodes per plant and inter nodal length and reproductive parameters *viz.*, days to flowering, number of flower buds, number of flowers per plant, pollen viability, number of berries per plant and number of seeds per berry were collected from five randomly selected plants from each treatment in each genotype.

Results and Discussion

Growth parameters

Data on plant height and plant spread are presented in Tables 1 and 2. Genotype HT/21-10 and Kufri Surya had recorded the highest plant height (51.02 cm) and plant spread (50.62 cm) at 60 DAP. Genotype HT/21-9 recorded the highest number of shoots per plant (4.37) and inter nodal length (5.83 cm) whereas maximum number of nodes per plant (10.36) was noticed in HT/10-1554. Genotypes with minimum number of nodes and maximum plant height were recorded with more inter nodal length. Effect of chemicals was found significant for all growth parameters except for number of nodes per plant. Highest values for all the growth parameters were recorded when potato genotypes were sprayed with GA_3 100 ppm which might be due to its role in enhancement of plant growth by affecting either cell expansion or cell division or both (Kumar *et al*., 2007) [8]. Interaction effect of chemicals and genotypes was significant for all growth parameters except number of shoots per plant and number of nodes per plant. Genotype HT/21-10 and Kufri Surya sprayed with GA_3 100 ppm recorded highest plant height (58.60 cm) and plant spread (54.20 cm) at 60 DAP. Maximum number of shoots per plant (4.60) and number of nodes per plant (10.90) were recorded in HT/21-9 and HT/10-1554 with ethephon 200 ppm whereas the highest inter nodal length (6.70 cm) was observed in HT/21-9 sprayed with spermidine 20 ppm.

Reproductive parameters

Data collected on days to flowering, number of flower buds and number of flowers per plant are presented in Tables 3, 4 and 5. Significant difference was observed among genotypes for days to flowering, number of flower buds and number of flowers per plant and pollen viability. HT/21-6 took minimum number of days (37.10 days) to flower and recorded maximum number of flowers per plant (20.90). Highest number of flower buds (24.82) was observed in HT/10-1554 followed by HT/21-6. Pollen viability was not noticed in genotypes such as HT/07-1329, HT/21-8 and Kufri Surya. Berries were produced in HT/21-10, HT/21-13 and HT/21-6. Genotype HT/21-10 recorded maximum pollen viability (58.19%) and number of seeds per berry (6.90). All reproductive parameters were significantly influenced by chemicals. GA_3 100 ppm recorded minimum number of days (43.83 days) to flower and highest number of flower buds per lant (23.67), number of flowers per plant (19.17), number of berries per plant (0.78), number of seeds per berry (4.17). Pollen viability was observed maximum in spermidine 20 ppm. Effect of GA_3 was found to be superior among all the chemical treatments. This might be due to its strong influence on flowering and could be substitute for photoperiodic induction in long day plants (Kumar *et al*., 2007) [8] and on enhancing the photosynthetic assimilates especially total carbohydrates in which the floral buds might receive more nourishment that helps to develop complete flowers. Among interactions, HT/21-13 with GA_3 100 ppm and spermidine 20 ppm took minimum number of days (35 days) to flower. HT/10-1554 and HT/21-6 with GA_3 100 ppm spray recorded the highest number of flower buds per plant (28.90) and number of flowers per plant (25.20) respectively. Maximum number of berries per plant (6.0) were observed in HT/21-13 with GA_3 100 ppm. HT/21-10 with GA_3 100 ppm recorded highest number of seeds per berry (23.50). Similar results were reported by Luthra and Khan (2000) [5], Kaddour *et al.* (2006) [4], Zaghlool *et al.* (2007) [7] and Sharma *et al.* (2019) [6] in potato.

Table 1: Plant height of potato as influenced by genotypes and chemical sprays at 60 DAP

Plant height (cm) at 60 DAP						
Genotype	Chemical					Mean
	GA_3	NAA	Spermidine	Ethephon	Water	
HT/10-1554	52.70	50.40	49.70	50.20	40.30	48.66
HT/07-1329	48.60	39.00	39.80	36.30	36.90	40.12
HT/21-10	58.60	50.60	51.30	51.10	43.50	51.02
HT/21-9	41.80	36.40	42.70	34.10	33.10	37.62
HT/21-8	41.90	35.00	37.10	35.60	33.80	36.68
HT/21-13	45.50	37.90	34.20	33.50	33.40	36.90
HT/21-12	51.70	46.00	43.50	41.20	40.40	44.56
HT/21-6	53.80	48.40	41.60	42.20	41.60	45.52
Kufri Surya	49.40	49.90	50.40	50.00	41.10	48.16
Mean	49.33	43.73	43.37	41.58	38.23	

	G	C	GXC
S.Em±	0.26	0.20	0.59
CD (P = 0.05)	0.76	0.56	1.69

Table 2: Plant spread of potato as influenced by genotypes and chemical sprays at 60 DAP

Plant spread (cm) at 60 DAP						
Genotype	Chemical					Mean
	GA_3	NAA	Spermidine	Ethephon	Water	
HT/10-1554	49.90	46.90	45.60	46.80	43.70	46.58
HT/07-1329	47.60	47.00	43.00	46.70	42.40	45.34
HT/21-10	52.60	50.90	49.90	52.60	45.50	50.30
HT/21-9	42.80	42.10	42.10	43.80	43.20	42.80
HT/21-8	44.70	41.10	43.00	44.50	42.40	43.14
HT/21-13	44.30	40.30	44.30	44.90	42.80	43.32
HT/21-12	48.80	45.30	45.60	45.50	44.60	45.96
HT/21-6	48.00	45.40	45.60	47.80	45.20	46.40
Kufri Surya	54.20	49.30	48.90	54.00	46.70	50.62
Mean	48.10	45.37	45.33	47.40	44.06	

	G	C	GXC
S.Em±	0.40	0.30	0.90
CD (P = 0.05)	1.14	0.85	2.56

Table 3: Days to flowering in potato as influenced by genotypes and chemical sprays

Days to flowering						
Genotype	Chemical					Mean
	GA_3	NAA	Spermidine	Ethephon	Water	
HT/10-1554	42.00	43.00	47.50	47.00	47.00	45.30
HT/07-1329	44.00	46.00	49.00	47.00	47.50	46.70
HT/21-10	40.50	42.50	44.50	45.00	49.00	44.30
HT/21-9	47.50	48.00	45.50	47.50	46.00	46.90
HT/21-8	47.50	48.50	49.00	48.50	50.00	48.70
HT/21-13	35.00	38.50	35.00	39.00	40.50	37.60
HT/21-12	50.50	51.00	52.50	50.50	51.50	51.20
HT/21-6	36.00	38.00	37.00	35.50	39.00	37.10
Kufri Surya	51.50	54.50	57.50	55.00	58.50	55.40
Mean	43.83	45.56	46.39	46.11	47.67	

	G	C	GXC
S.Em±	0.44	0.33	0.98
CD (P = 0.05)	1.26	0.94	2.81

Table 4: Number of flower buds per plant in potato as influenced by genotypes and chemical sprays

Number of flower buds per plant						
Genotype	Chemical					Mean
	GA_3	NAA	Spermidine	Ethephon	Water	
HT/10-1554	28.90	27.60	26.60	23.60	17.40	24.82
HT/07-1329	20.70	18.60	16.80	17.60	11.00	16.94
HT/21-10	25.20	21.50	20.50	18.10	12.20	19.50
HT/21-9	27.70	18.40	16.60	14.60	7.20	16.90
HT/21-8	21.10	19.00	19.30	14.90	11.90	17.24
HT/21-13	21.70	23.00	20.20	22.40	12.20	19.90
HT/21-12	27.30	16.60	15.80	16.50	10.10	17.26
HT/21-6	30.30	23.90	24.30	23.90	19.00	24.28
Kufri Surya	10.10	9.70	12.30	6.50	5.00	8.72
Mean	23.67	19.81	19.16	17.57	11.78	

	G	C	GXC
S.Em±	0.18	0.13	0.39
CD (P = 0.05)	0.50	0.37	1.12

Table 5: Number of flowers per plant in potato as influenced by genotypes and chemical sprays

Number of flowers per plant						
Genotype	Chemical					Mean
	GA_3	NAA	Spermidine	Ethephon	Water	
HT/10-1554	24.50	22.70	20.00	23.00	13.50	20.74
HT/07-1329	12.80	14.90	14.90	13.80	11.00	13.48
HT/21-10	20.00	21.70	17.80	17.50	14.00	18.20
HT/21-9	22.50	16.80	15.90	15.50	12.10	16.56
HT/21-8	18.80	15.40	16.90	14.20	12.80	15.62
HT/21-13	20.10	21.30	21.10	16.90	11.40	18.16
HT/21-12	18.80	16.20	15.70	16.80	10.20	15.54
HT/21-6	25.20	20.60	23.30	22.50	12.90	20.90
Kufri Surya	9.80	9.20	8.80	8.30	4.40	8.10
Mean	19.17	17.64	17.16	16.50	11.37	

	G	C	GXC
S.Em±	0.21	0.16	0.47
CD (P = 0.05)	0.60	0.45	1.35

Conclusion

In the present investigation, among nine genotypes studied, the genotypes HT/10-1554, HT/21-6, HT/21-13 and HT/21-10 were found to be good for flower production. These genotypes can be further studied for potato breeding programme in tropical and subtropical regions. Chemical application had additive effect on all flowering traits but response varied with genotypes. Response of the genotypes HT/10-1554, HT/21-6, HT/21-13 and HT/21-10 with GA_3 100 ppm were superior for all reproductive parameters. The results of the current study revealed that the chemicals could induce flowering in all genotypes in the study under extended photoperiod.

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