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Effect of Dormancy Breaking Substances on Corm and Cormel Characters and Biochemical Changes in Gladiolus

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Abstract

The present experiment was conducted at ICAR- Directorate of Floricultural Research, Pune to study the effect of different dormancy-breaking substances on corm and cormel characters and biochemical changes occurring in gladiolus. Treatment consisted of potassium nitrate (1.5%), thiourea (2%), benzylaminopurine (100 ppm), cold stratification (at 4°C) and control. The experiment was laid-out in completely randomized design with four replications. The results demonstrated that the application of various dormancy breaking substances at different concentrations significantly impacted corm and cormel characteristics. Earliness in corm sprouting (30.69 days) and maximum buds active per corm (6.68) were observed with application of BAP at 100 ppm. The results also revealed that BAP at 100 ppm exhibited the highest corm yield per plant (3.06), as well as the highest cormels yield per plant (10.75). Additionally, BAP at 100 ppm resulted in the highest cormels weight (2.86 g). Moreover, application of potassium nitrate 1.5% resulted in maximum corm diameter (4.33 cm) and maximum corm weight (14.49 g). Biochemical analysis revealed that BAP-treated corms showed the highest soluble sugars 96.87 mg/g) and cytokinin (21,233.33 µg/kg), with the lowest abscisic acid content (18.17 µg/kg). Increased cytokinin and reduced abscisic acid levels indicate a role in dormancy breaking.

Keywords: dormancy, BAP, gladiolus, potassium nitrate, corm and cormels, TSS, ABA, cytokinin

Introduction

Gladiolus, also known as "Sword Lily" is prized for its long spikes, multicoloured flowers, and excellent vase life. Commercial cultivation of gladiolus is becoming popular in recent years, owning to its significant export potential and the favorable growing conditions found in many parts of the country. Gladiolus is an herbaceous plant belonging to the family Iridaceae. It is commercially propagated by corms which is an underground modified stem that provides nutrients during sprouting (Sajjad et al. 2015). However, freshly harvested gladiolus corms and cormels have a dormancy period that prevents immediate germination, even under optimal conditions creating hindrances in the year-round cultivation. Dormancy involves complex, physiological, and biochemical processes without visible growth. Also, poor

multiplication rate (each corm producing 1–2 corms) is a major constraint in gladiolus. Typically, a single bud emerges from a mother corm, but when multiple buds sprout, it promotes the production of propagules, thereby enhancing propagation efficiency (Holkar et al. 2024). Alleviation of corm dormancy and yield can be improved by the use of different plant growth regulators (PGRs) have been reported by many authors. BAP a synthetic cytokinin increases the chlorophyll development and synthesis and promotes axillary branching and shoot differentiation which ultimately increases the corm and cormels production (Holkar et al. 2024). With the traditional cold treatment method, dormancy in gladiolus corms limits year-round flower production. PGRs present a viable alternative to break dormancy and improve growth, beneficial for commercial cultivation.

MATERIALS AND METHODS

Plant material and treatments: Freshly harvested corms were taken to the laboratory for cleaning, grading and descaling. The descaled dormant corms were soaked in a solution of 6-benzylaminopurine (BAP) at 100 ppm for 12 hours followed by potassium nitrate at 1.5% and thiourea at 2% for 24 hours. The control corms were soaked only in distilled water for 24 hours. Corms for stratification treatment were placed at 4°C for 2 months. The treated corms were planted 4-5 cm deep in pots at ICAR-Directorate of Floricultural Research, Pune.

Corm and cormel characters: The days required for sprouting, the number of sprouted buds per corm, number of corms per plant and number of cormels per plant were counted. Corm weight, corm diameter and cormel weight was measured.

Biochemical analysis:

The freshly harvested corms were soaked in a solution of 6-benzylaminopurine (BAP) at 100 ppm for 12 hours followed by potassium nitrate at 1.5% and thiourea at 2% for 24 hours. The control corms were soaked only in distilled water for 24 hours. Corms for stratification treatment were placed at 4°C for 24 hours. The biochemical parameters were quantified at 0 hours, 12 hours, 24 hours and 48 hours of incubation after treatment.

Total soluble sugars were measured spectrophotometrically according to the protocol of Riazi et al., (1985). Abscisic acid and cytokinin were extracted and analyzed using LC-MS/MS. A homogeneous 1.0 g of powdered sample was weighed into sample container containing 20 mL of acidified methanol (1% formic acid). The mixture was vortexed for 5 min and centrifuged at 4 degrees Celsius at 10,000 rpm for 10 min. The supernatant was passed through 0.2 lm nylon membrane filter. The extract was diluted 1:1 with deionized water and 10 µL of sample was injected to LC–MS/MS analysis.

The LC-MS/MS system with Sciex ExionLC UHPLC and Sciex Qtrap 6500+ mass spectrometer was used for quantification of phytohormones. The system for analysis, identification and quantification was controlled by Analyst 1.7.3 software.

Statistical analysis:

The experiment was laid out in completely randomized design (CRD) with four replications. Collected data was statistically analyzed through Analysis of Variance (ANOVA), and treatment means were further compared through least significant difference (LSD) test. All the statistical analyses were performed using OPSTAT software at a significance level of $p \leq 0.05$.

RESULTS AND DISCUSSION

Sprouting behavior of corms: Effect of dormancy breaking substances on sprouting behaviour was studied and data have been presented in Table 1. The application of BAP at 100 ppm reduced the number of days required for sprouting (30.69 days), this variation might be due to change in endogenous hormone levels, potentially triggering dormancy break and premature sprouting, this result are in line with the findings of Kumar et al. (2011), Padmalatha et al. (2013), Sajjad et al. (2020) and Sajjad et al. (2021). Maximum number of days (74.72) to sprout was required by cold stratification treatment. In control corms 1.52 buds were activated per corm while treatment (BAP at 100 ppm) activated the highest buds per corm (6.68) this might be due to cell division and shoot differentiation. Application of BAP, an important cytokinin, exhibits the capability of inducing multiple shoot morphogenesis, leading to sprouting of multiple sprouts from a single corm. Similar findings were reported by Nandania et al. 2023 in gladiolus.

Corm and cormel characters: The dormancy breaking substances had significant influence on all the corm and cormel producing parameters under study viz. number of corms and cormels per plant, diameter of corm, weight of corm and weight of cormels (Table 2). Treatment with BAP at 100 ppm yielded maximum (3.06) number of corms per plant. There was significant effect of different treatments on corms production. Corms treated with BAP 100ppm yielded maximum number of corms per plant. This might be due to the fact that BAP has promoted the sink activity of developing corms and cormels at the expense of flower spike, this might be the reason for increase in number of corms and poor quality of spikes (Roy et al. 2017). The treatment potassium nitrate at 1.5% recorded maximum diameter (4.33 cm) and weight of corm (14.49 cm). The variation in the diameter and weight of the corm was directly influenced by the mobilization of metabolites from leaves to flowers during harvesting, with enhanced plant growth resulting in larger corms. These findings are consistent with the results reported by Havale et al. (2008), Dogra et al. (2012), Montessori et al. (2012), Padmalatha et al. (2013), Sajjad et al. (2015), and Tamrakar et al. (2018). Application of BAP at 100 ppm yielded maximum (10.75) cormels per plant and maximum weight (2.86g). The variation in the number of cormels per plant maybe due to changes in the hormonal balance of cormels which alter the ratio of growth promoters to inhibitors, maintaining sink activity and resulting in enhanced cormel production. This might be due to the direct correlation between weight of cormels and number of cormels per plant. Also, the increase in cormel weight observed in BAP treated plants may be attributed to the accumulation of sufficient food reserves during the initial growth stages, facilitated by reduced plant height. This stored energy was subsequently allocated to cormel development, leading to enhanced weight gain. These results align with previous findings by Rashid (2018), Tamrakar et al. (2018), and Khan et al. (2011) in gladiolus.

Biochemical parameters: Effect of dormancy breaking substances on biochemical parameters was studied and data have been presented in Table 3. Highest value of abscisic acid content (149.33 µg/kg) was observed in control corms. A gradual decrease in abscisic acid content is recorded in treated corms compared to control corms except for cold stratification treatment. Treatment of thiourea showed minimum decrease (18.17µg/kg) in abscisic acid in corms. Corms treated with BAP exhibited (21,233.33 µg/kg) cytokinin which was highest among all treatments. The increase in endogenous cytokinin content by application of BAP can be correlated with the days required for sprouting. These outcomes are in line with the findings of Desta and Amare (2024), that in potato tubers, cytokinin is mainly responsible for the termination of dormancy and showed that cytokinin treatments terminated dormancy earlier than GAs treatments. The total soluble sugars content in non-treated corms was 2.37 mg/g which was increased to

maximum value of 6.87 mg/g in treatment (BAP at 100 ppm). The increase in levels of soluble sugars might be due breakdown of starch during dormancy release. A similar trend, of rise in soluble sugars due to starch degradation was reported by Chrungoo and Farooq (1985) in corms of Crocus sativus, and Panneerselvam and Jaleel (2008) in foot yam and turmeric.

Table 1. Effect of dormancy breaking substances on sprouting behaviour in freshly harvested gladiolus corms.

Treatment	Treatment details	Number of corms per plant	Corm diameter (cm)	Corm weight (g)	Number of cormels per plant	Cormel weight (g)
T_0	Control (water)	1.26	3.35	10.23	4.95	0.98
T_1	Potassium nitrate 1.5%	1.48	4.33	14.49	9.84	1.49
T_2	Thiourea 2%	1.77	4.02	12.97	5.16	0.98
T_3	Cold stratification at 4°C	1.37	3.85	11.57	5.21	1.92
T_4	6-BAP 100 ppm	3.06	2.97	8.31	10.75	2.86
	SE(m) ±	0.25	0.17	0.72	0.96	0.21
	CD at 5 %	0.76	0.52	2.18	2.91	0.65

Table 2. Effect of dormancy breaking substances on quantitative character in gladiolus.

Treatment	Treatment details	Days required for sprouting (days)	Number of buds activated per corm
T_0	Control (water)	44.49	1.52
T_1	Potassium nitrate 1.5%	35.76	2.33
T_2	Thiourea 2%	33.76	2.45
T_3	Stratification at 4°C for 2 months	74.72	2.16
T_4	6-BAP 100 ppm	30.69	6.68
	SE(m) ±	2.38	0.26
	CD at 5 %	7.25	0.80

Table 3. Effect of dormancy breaking substances on biochemical parameters in gladiolus corms after treatment.

Treatment	Treatment details	Abscisic Acid (ABA) content (µg/kg)				Cytokinin content (µg/kg)				Total Soluble Sugar (TSS) Content (mg/g)			
		0 hours	12 hours	24 hours	48 hours	0 hours	12 hours	24 hours	48 hours	0 hour	12 hours	24 hours	48 hours
T_0	Control (water)	149.33	122.00	154.67	323.67	0.00	0.00	0.00	0.00	2.37	2.40	2.44	2.49

T_1	Potassium nitrate 1.5%	129.33	88.88	138.33	283.67	0.00	0.00	0.00	0.00	3.52	3.79	3.86	3.92
T_2	Thiourea 2%	58.17	18.17	92.40	174.33	16.133	0.00	0.00	0.00	4.53	4.83	5.13	5.33
T_3	Cold stratification at 4°C	90.00	223.67	352.33	440.33	20,800.00	27.03	0.00	0.00	2.84	2.80	2.81	2.94
T_4	6-BAP 100 ppm	88.90	73.47	91.63	146.67	21,233.33	12,600.00	4,766.67	15,133.33	5.38	6.54	6.56	6.87

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Conclusion

The study found that corms treated with BAP at 100 ppm sprouted earliest, followed by those treated with thiourea at 2%. The number of sprouted buds per corm showed significant positive correlations with the number of corms produced, enhancing rapid multiplication. BAP treatment also produced the highest number of corms and cormels, followed by KNO3. Biochemical analysis revealed a decrease in ABA content and an increase in CK and TSS during dormancy release. The application of growth substances is crucial for regulating corm dormancy and promoting early sprouting.

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