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Effect of different chemicals on breaking dormancy, growth and flowering of gladiolus cultivars

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ABSTRACT

The effect of chemical treatments on breaking the dormancy of corms in Shabnum and Jyotsna cultivars of gladiolus was investigated. Shabnum took less number of days for corm sprouting and more number of days for flowering than the cv. Jyotsna. Spike length and number of florets per spike were maximum in the cv. Shabnum. Hydrogen cyanamide (HC) followed by thiourea (TU) were found to be superior in respect of per cent sprouting, days taken for sprouting, number of spikes per plot, number of corms per plant, corm size, corm weight, corm volume and weight of cormels. Promoters of alternate respiration (HC, TU and salicylic acid SA) were highly effective in breaking corm dormancy, whereas propyl gallate, a potential inhibitor of alternate respiration could not break the dormancy. Hydrogen cyanamide (1%), thiourea (2%) and salicylic acid (100 ppm) were found to be effective in breaking the dormancy and in improving growth and flowering of gladiolus.

Key words: Corm, dormancy, flowering, gibberellic acid, gladiolus, growth, hydrogen-cyanamide, potassium nitrate, propyl gallate, salicylic acid, thiourea.

INTRODUCTION

Freshly harvested corms and cormels of gladiolus are in a state of deep rest (dormancy) and do not sprout particularly under warmer climates. Low temperature treatment of corms at 4-5^{o}C for 3-4 months is the widely followed practice for breaking the dormancy which restricts the cultivation of gladiolus to only one season (*i.e.* winter). Physiological basis of corm or cormel dormancy has been ascribed to the accumulation of growth inhibiting substances, especially abscisic acid (ABA) in the corm tissues as well as in the scales encapsulating them. Some of the easily available and inexpensive chemicals like salicylic acid (SA), potassium nitrate (KNO_3), thiourea (TU), hydrogen cyanamide (HC), etc., although have ability to break dormancy in certain crops, their effect on gladiolus was not yet investigated.

Potassium nitrate has been found to break seed dormancy in many crops like groundnut (Kapur *et al*., 1) and potato (Sathiamoorthy and Nakamura, 2). Treatment with thiourea has been found to break endogenous dormancy in tuber crops like potato (Fazal *et al*., 3) and tuberose (Raja and Palanisamy, 4). Hydrogen cyanamide at low concentration (0.5 to 1%) in combination with a winter oil (dinitro-o-cresol or DNOC @ 3-4%) is recommended commercially for breaking the rest period in pome and stone fruits (Costa *et al*., 5). GA_3 (5 ppm) in combination with HC (0.5%) increased the number of sprouted tubers and the number of sprouts per tuber in potato (Herrera *et al*., 6). The effect of SA on breaking dormancy although not documented, its physiological effects opposite to the action of ABA were reported in many plant species (Raskin *et al*., 7). An attempt here is made to investigate the effect of different chemicals in breaking the dormancy of gladiolus corms.

MATERIALS AND METHODS

The present investigation was carried out for two years the College Farm, College of Agriculture, Rajendranagar, Hyderabad. The corms and cormels of gladiolus cvs. Jyotsna and Shabnum harvested in April were used in this experiment. These corms were about 20.5 (cv. Jyotsna) and 13.7 g (cv. Shabnum) and measured 4.3 (cv. Jyotsna) and 3.5 (cv. Shabnum) in diameter. All the measurements of weight (open top electronic balance) and diameter (Vernier callipers) were the average of 20 individual corms. There were seven treatments, *viz*., thiourea (TU) - 2%, hydrogen cyanamide (HC) -1%, potassium nitrate (KNO_3)-1%, salicylic acid (SA) - 100 ppm, gibberellic acid (GA_3) - 100 ppm and propyl gallate (PG) - 1%, each replicated thrice in a split plot design. Corms were soaked for 24 h in the respective treatments. The treated corms, 20 each were planted at a spacing of 40 cm × 20 cm and at a depth of 5 cm in a plot of 2.00 m × 1.20 m. Each treatment was replicated thrice. Corms and cormels were harvested separately from the individual plots during November in both years. Data were subjected to analysis of variance as applicable to split plot design. Number of days for 50% sprouting was calculated

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based on the days taken for the sprouting of half of the corms of the final stand as there was less than 50% sprouting in some of the treatments. The number of big cormels (≥ 1 cm dia.) and number of small cormels (≤ 1 cm dia.) per plot was counted and the average was worked out to record the number of big and small cormels per plant. There was branching of the spikes in some of the treatments and this was recorded as accessory inflorescence in those cases where the branch was minimum 50 cm in length.

RESULTS AND DISCUSSION

Cultivar Shabnum took significantly minimum number of days (15.48) for sprouting compared to cv. Jyotsna (34.19) (Table 1), which indicated that number of days for sprouting is a varietal character. Genotypic variation in respect of days to sprouting was also reported much earlier by Ginzburg (8). The results show that HC (11.50) followed by TU (18.50) were highly effective in reducing the number of days for 50% sprouting and in increasing the sprouting percentage (95.83 and 87.50, respectively). Chemicals like SA, GA_3 and KNO_3 were also found to be effective in reducing the number of days for sprouting. Treatment with PG resulted in maximum number of days for sprouting and lowest sprouting percentage.

The effect of HC and TU in reducing the number of days for sprouting and increasing the sprouting percentage can be attributed to two reasons. The first being their effect in reducing the ABA, levels the prime factor, imposing dormancy in corms and cormels, and thereby changing the endogenous hormonal balance in favor of promoters. Secondly, increase in quantum of alternate respiration due to these treatments.

Several workers reported the ability of HC in reducing the levels of ABA in the treated buds of many fruit crops like in grape (Or *et al*., 9). ABA is considered to be a principal endogenous regulator of dormancy in gladiolus corms and cormels (Jung *et al*., 10). A gradual decrease in inhibitors in the corms during storage has been shown to be an important factor allowing release from dormancy (Hosoki, 11). Therefore, HC and TU might have also showed similar effect here while promoting the sprouting percentage in gladiolus. Promotion of alternate respiration with TU treatment was reported by Rajani (12) during germination of *ber* (*Zizyphus mauritiana* Lam) seed. The occurrence of alternate respiration mediated by alternate oxidase (AOX) and its positive correlation during seed germination has been reported in crops like chickpea (Burguillo and Gregorio, 13). It is proposed that alternative pathway of respiration provides something essential for the completion of the earlier stages of seed germination. Similar effect of TU in increasing the alternate respiration might have resulted in breaking of dormancy and increasing sprouting percentage in gladiolus also.

Salicylic acid, gibberellic acid and potassium nitrate were also found to be highly potential in breaking the dormancy of gladiolus corms and cormels. The possible action of SA in breaking the dormancy might be similar to that of TU. It stimulates alternate oxidase (AOX) and in turn promotes alternate respiration (Chen and Klersig, 14). On the other hand, SA was found to reverse the physiological effects promoted by ABA in many plant species (Raskin *et al*., 7). These may be the reasons, SA significantly reduced the number of days for sprouting and also increased the sprouting

Table 1. Effect of pre-planting chemical treatments of corms on sprouting behavior in gladiolus cvs. Jyotsna and Shabnum.

Treatment	Days to 50% sprouting*			Days to final sprouting			Per cent sprouting		
	Jyotsna	Shabnum	Mean	Jyotsna	Shabnum	Mean	Jyotsna	Shabnum	Mean
Thiourea (2%)	27.67	9.33	18.50	28.67	12.33	20.50	83.33	91.67	87.50
Hydrogen cyanamide (1%)	14.67	8.33	11.50	23.67	11.67	17.67	98.33	93.33	95.83
Potassium nitrate (1%)	25.00	13.00	19.00	33.33	16.67	25.00	83.33	90.00	86.67
Propyl gallate (1%)	39.33	19.33	29.33	39.33	19.33	29.33	38.33	25.00	31.67
Salicylic acid (100 ppm)	35.00	10.67	22.83	34.67	14.67	24.67	76.67	81.67	79.17
Gibberellic acid (100 ppm)	39.00	10.33	24.67	42.33	15.00	28.67	75.00	86.67	80.83
Control	36.67	18.67	27.67	37.33	18.67	28.00	46.67	30.00	38.33
Mean	31.05	12.81		34.19	15.48		71.67	71.19	
CD at 5%									
Variety (V)			4.55			1.81			N.S.
Treatment (T)			7.48			7.94			16.07
Interaction (V x T)			7.48			NS			NS

*Days taken for sprouting of half of the total number of corms.

percentage. The concentration of SA, however seems to be critical in breaking the dormancy and promoting alternate respiration. SA at 150 ppm significantly promoted seed germination in ber (Rajani, 12) and at 1000 ppm in carrot (Rajasekaran *et al*., 15). In gladiolus also, SA at slightly higher concentration might be as effective as that of HC or TU. GA_3 also increased sprouting percentage significantly over control. Its effect is not exactly determined, might be through alteration of hormonal balance in favor of promoters, or through promotion of alternate respiration. These results confirm the earlier reports of promotion effects of GA_3 on the sprouting of gladiolus corms (Kirad *et al*., 16). The effect of KNO_3 in increasing the sprouting percentage may be due to its accumulation in the embryo where it acts osmotically to increase water uptake. Besides water uptake, it has nutritional effect on protein synthesis (McIntyre *et al*., 17). But in gladiolus so far hormonal balance and alternate respiration rather than water supply influences release of dormancy significantly. Perhaps this may be the reason KNO_3 was not as effective as HC or TU.

In the present study, propyl gallate did not show any effect on breaking corm and cormel dormancy instead maintained dormancy at par with control. Gladiolus corms or cormels show alternate respiration and the total respiration was found to increase drastically with the release of dormancy (Hosoki, 18). The inhibitors of alternative pathway of respiration like propyl gallate were reported to inhibit germination in several crops (Kasai *et al*., 27). Propyl gallate was found to inhibit biosynthesis of ethylene, an effective agent for breaking dormancy of gladiolus corms and cormels. Hence either by inhibiting alternate respiration or by inhibiting ethylene bio-synthesis, PG could not break corm dormancy. Storage of corms and cormels without allowing them to sprout is an important problem in gladiolus. During transport through sea shipment, which takes few weeks to few months, prevention of sprouting is highly essential. Based on the results of this study, it can be stated that PG can effectively be used as sprouting suppressant for increasing the storage life of corms and thereby enabling their safe shipment for export. This can also be used for extending the planting season of gladiolus in the domestic sector.

All the chemicals except propyl gallate were more or less equally effective in reducing the number of days to flowering and increasing the spike length, number of florets per spike and number of primary and secondary inflorescences (Fig. 1; Table 2). As the days for sprouting were reduced significantly by HC, flowering was also 13 days early in this treatment compared to control (85.17 days). SA (72.33 days) and KNO_3 (72.17 days) seem to have significant influence in promoting flowering. GA_3 (109.50 cm and 18.79 Nos.), SA (105.50 cm and 17.67 nos.) and HC (104.50 cm and 18.29 Nos.) were effective in increasing the spike length and number of florets per spike, respectively. Number of florets per spike was in proportion to the length of the spike produced by respective treatments.

The number of primary inflorescences was also significantly increased by all the treatments except propyl gallate. Thiourea and salicylic acid were highly effective in increasing the number of accessory inflorescences (branching of spike). Salicylic acid seems to have favorable effects on gladiolus flowering, *viz*., advancing the flowering, increasing the number of

Table 2. Effect of pre-planting chemical treatment of corms on number, length and per cent of spikes with accessory inflorescences in gladiolus cvs. Jyotsna and Shabnum.

Treatment	Number of spikes per plot			Spike length (cm)			Per cent spikes with accessory inflorescence		
	Jyotsna	Shabnum	Mean	Jyotsna	Shabnum	Mean	Jyotsna	Shabnum	Mean
Thiourea (2%)	22.00	21.00	21.50	86.00	102.00	94.00	36.54	37.96	37.25
Hydrogen cyanamide (1%)	25.00	23.00	24.00	101.00	108.00	104.50	24.11	29.97	27.04
Potassium nitrate (1%)	19.67	21.33	20.50	93.67	104.33	99.00	25.81	26.44	26.12
Propyl gallate (1%)	6.67	4.67	5.67	74.33	93.67	84.00	15.93	28.89	22.41
Salicylic acid (100 ppm)	18.67	20.33	19.50	96.67	114.33	105.50	26.63	41.67	34.15
Gibberellic acid (100 ppm)	17.67	18.67	18.17	102.67	116.33	109.50	24.09	34.96	29.52
Control	7.67	6.00	6.83	86.00	95.00	90.50	20.87	21.67	21.27
Mean	16.76	16.43		91.48	104.81		24.85	31.65	
CD at 5%									
Variety (V)			NS			NS			NS
Treatment (T)			5.08			9.67			12.46
Interaction (V x T)			NS			NS			NS

Table 3. Effect of pre-planting chemical treatment of corms on number of corms and cormels production in gladiolus.

Treatment	Number of corms per plant			Number of big cormels per plant			Number of small cormels per plant		
	Jyotsna	Shabnum	Mean	Jyotsna	Shabnum	Mean	Jyotsna	Shabnum	Mean
Thiourea (2%)	1.31	1.36	1.34	1.26	2.01	1.63	4.27	4.24	4.26
Hydrogen cyanamide (1%)	1.29	1.28	1.29	1.18	2.17	1.68	4.46	3.92	4.19
Potassium nitrate (1%)	1.14	1.15	1.15	0.79	1.47	1.13	3.61	3.89	3.75
Propyl gallate (1%)	0.91	1.00	0.95	1.18	1.00	1.09	3.23	4.17	3.70
Salicylic acid (100 ppm)	1.19	1.24	1.22	1.31	1.51	1.41	4.23	4.68	4.45
Gibberellic acid (100 ppm)	1.23	1.27	1.25	1.32	1.45	1.38	4.23	4.76	4.50
Control	0.96	1.04	1.00	0.84	1.23	1.04	3.35	3.23	3.29
Mean	1.15	1.19		1.13	1.55		3.91	4.13	
CD at 5%									
Variety (V)			NS			NS			NS
Treatment (T)			0.15			0.31			1.12
Interaction (V x T)			NS			0.31			NS

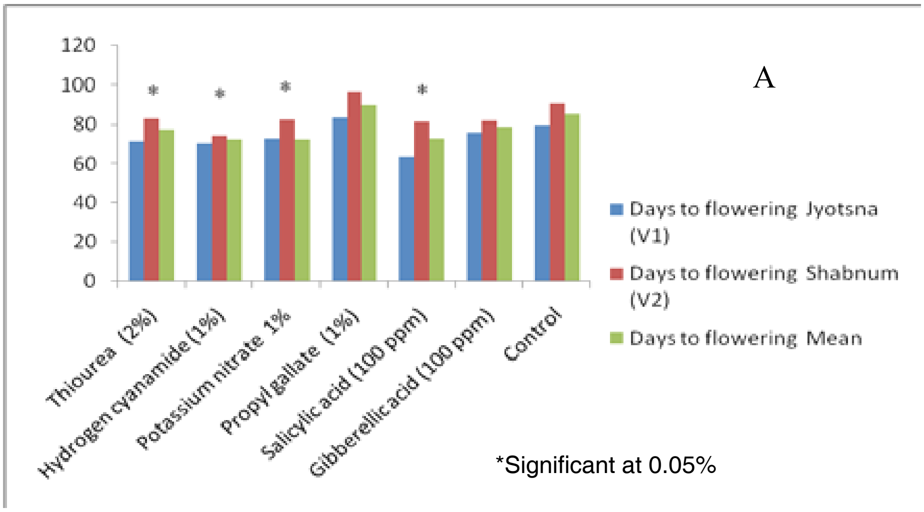
Table 4. Effect of pre-planting chemical treatment of corms on weight of cormels in gladiolus.

Treatment	Weight of big cormels per plant			Weight of small cormels per plant		
	Jyotsna	Shabnum	Mean	Jyotsna	Shabnum	Mean
Thiourea (2%)	1.87	2.11	1.99	4.31	3.35	3.83
Hydrogen cyanamide (1%)	2.43	2.01	2.22	3.87	3.08	3.48
Potassium nitrate (1%)	1.84	1.55	1.70	3.53	2.89	3.21
Propyl gallate (1%)	2.40	0.94	1.67	2.36	2.83	2.60
Salicylic acid (100 ppm)	2.67	1.49	2.08	3.49	3.36	3.42
Gibberellic acid (100 ppm)	2.81	1.44	2.12	3.92	3.62	3.77
Control	1.25	1.15	1.20	2.63	2.29	2.46
Mean	2.18	1.53		3.44	3.06	
CD at 5%						
Variety (V)			0.57			NS
Treatment (T)			0.73			0.89
Interaction (V x T)			0.73			NS

accessory inflorescences along with increase in spike length and number of florets per spike. It appears that slightly higher concentration might be of much better use not only in dormancy breaking but also in improving the flowering performance.

The two cultivars, Jyotsna and Shabnum did not differ in respect of number of corms produced per plant (Table 3). Cultivar Jyotsna, however, was superior in respect of individual corm characteristics. Corm size (6.82 cm), weight (90.14 g) and volume (92.86 ml) were highest in the cv. Jyotsna (Table 5). This confirms the genotypic variation between the two cultivars observed earlier in respect of sprouting. Thiourea (1.34), HC (1.29), GA_3 (1.25) and SA (1.22) significantly improved the number of corms produced per plant over control (1.00) and propyl gallate (0.95). These treatments were also equally effective in improving the individual corm characteristics. The number of big cormels, weight of big and small cormels was also significantly improved by HC, TU, GA_3 and SA (Tables 3 & 4). The number of small cormels was highest with GA_3 (4.50) and SA (4.45).

Soaking of corms in the aqueous solutions of HC, TU, SA or KNO_3 break their dormancy which otherwise would be in rest position for about 4-5 months eliminating their use for immediate planting in the following season. These dormancy breaking chemicals especially hydrogen cyanamide and thiourea



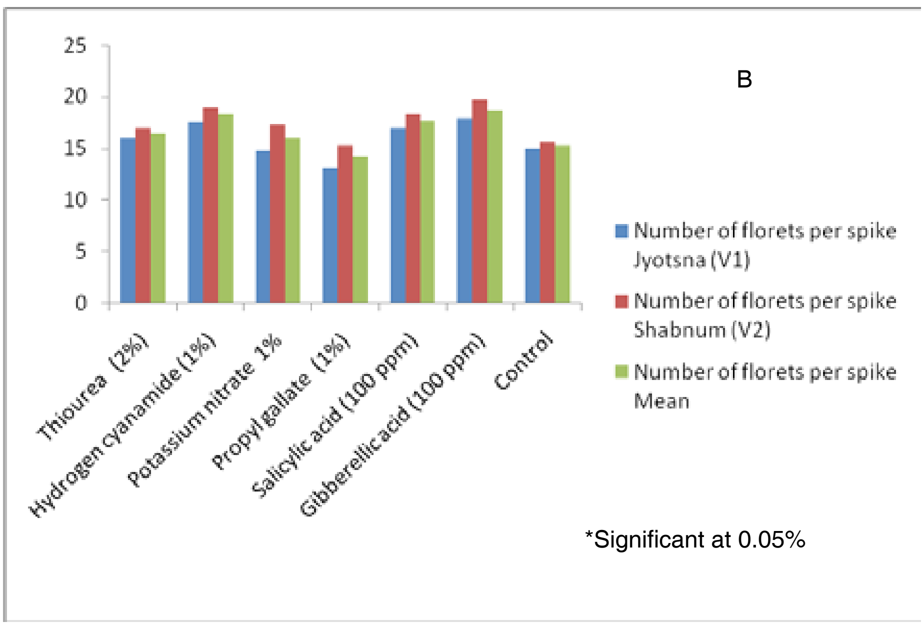


Fig. 1. Effect of pre-planting chemical treatment of corms on days to flowering (A) and number of florets per spike (B) in gladiolus.

can effectively be used for planting corms and cormels in the following season, *i.e.*, June-July to November. So that the propagules, *i.e.*, corms and cormels can be produced in large scale before the commencement of regular planting season, *i.e.*, November-December. Also, the concentration of salicylic acid to be used may be standardized for its commercial use.

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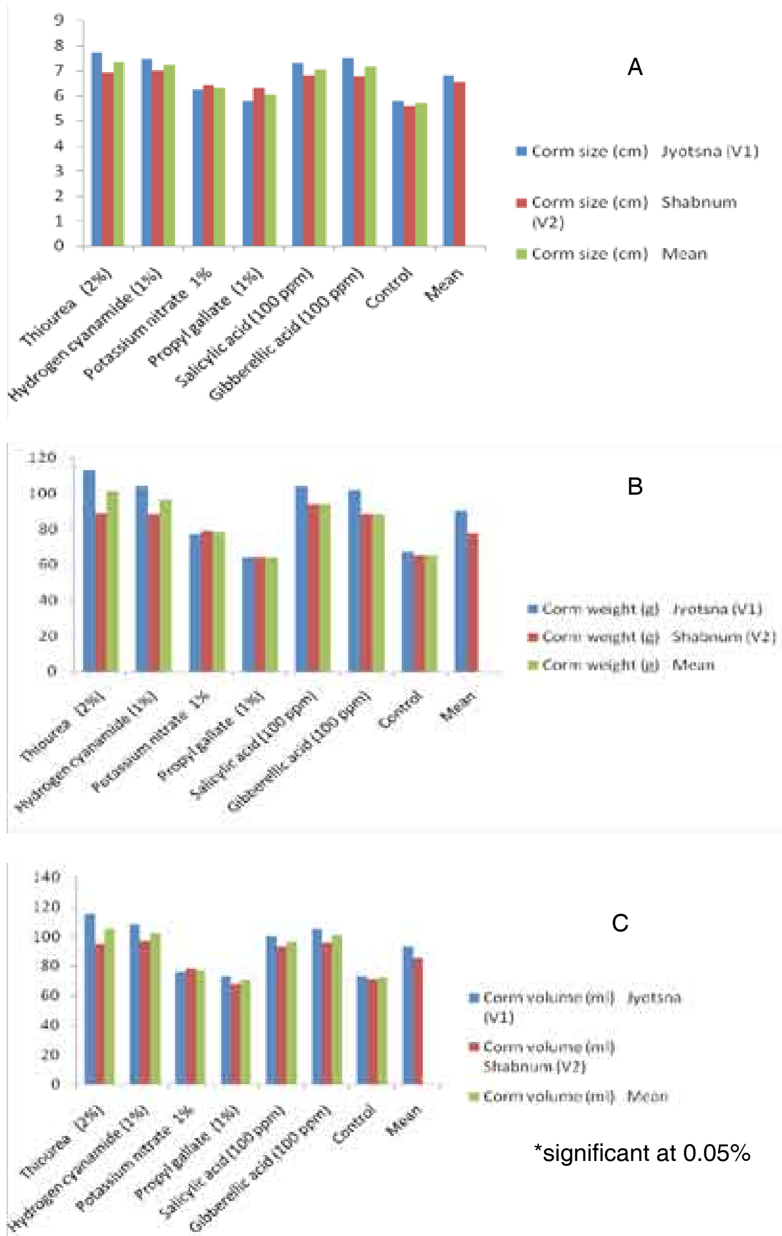

Fig. 2. Effect of pre-planting chemical treatment of corms on corm size (A), weight (B) and volume (C) in gladiolus.

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