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Influence of storage duration and thiourea on bulb dormancy and flower yield of tuberose (*Polianthes tuberosa* L.) cv. Prajwal

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Abstract
Tuberose is a commercially important flower crop propagated through bulbs. Presence of dormancy in the bulbs for 6-8 weeks restricts its immediate use in the next season. Hence the present experiment was conducted by storing the bulbs for 0, 15, 30, 45 and 60 (farmers' practice) days and subsequently treating with three concentrations of thiourea (3, 4 and 5 per cent). The results showed that minimum number of days taken for sprouting (8.0 days) and the highest number of florets per spike (66.53) and flower yield per plot (4.18 kg) were recorded in 30 days stored bulbs treated with 3 per cent thiourea (T_{10}).

Keywords: Tuberose, bulb dormancy, ABA, GA, storage, thiourea, yield

Introduction
Tuberose is an important bulbous ornamental flowering plant belonging to the family Amaryllidaceae and is a native of Mexico. Tuberose flowers throughout the year and it is valued for its white waxy fragrant tubular flowers having longer vase-life with wide adaptability to varied soil and climatic conditions. Florets are star shaped, waxy and loosely arranged on the spikes that are 30-40 cm long. Single flowers are more fragrant than double. Flowers remain fresh for a longer time which helps for long distance transport and finds a distinct place in the flower market (Barba *et al*., 2012) [3]. Due to its immense export potential, cultivation of tuberose is gaining momentum day by day in India (Safeena *et al*., 2015) [11].
Tuberose is propagated commercially through bulbs. Presence of dormancy for 6-8 weeks in bulbs of tuberose restricts their immediate use in the subsequent season (Singh, 2006) [13]. Dormancy is an important adaptive mechanism that benefits survival of a species under unfavourable conditions (Juntilla, 1988) [7]. It is considered as a phase in the plant's life cycle during which the usual processes contributing to orderly growth and development are inhibited. Seeds and vegetative propagules like corms, tubers, bulbs, rhizomes, *etc*., of most plant species even under highly favourable conditions do not germinate/sprout immediately after maturity. The mechanism controlling dormancy in tuberose bulbs has not yet been elucidated. It has been reported that using thiourea treatment enables to break bulb dormancy in this crop (Bajji *et al*., 2007) [2]. Hence the present experiment was conducted with the objective to optimize the storage duration of tuberose bulbs and concentration of thiourea in breaking bulb dormancy.

Materials and Methods
The variety of tuberose used for the experimental study was Prajwal. It is a hybrid between Shringar and Mexican Single released from IIHR, Bangalore. Flowers are single type with slightly pinkish tinge at bud stage, white when fully open having a yield potential of 18 t ha^{-1}.
The bulbs were dipped in 3, 4 and 5 per cent concentrations of thiourea for 12 hours and shade dried for 1 hour. The soil was ploughed to fine tilth. Raised beds with paired rows (plot size of 2.88 sq. m with 45 x 45 cm spacing) were formed. Drip irrigation of one 16 mm lateral was laid out for every two rows of tuberose with a lateral spacing of 1.5 m and one dripper (4 lph) was provided for every two tuberose plants along the lateral. Drip irrigation was provided once in two days and fertigation once in a week. The experiment was laid out in Randomized Block Design with two replications. Recommended dosage of 200/200/200 NPK kg ha^{-1} was applied as per the recommendation of the TNAU crop production manual (TNAU, 2013) [14].

Table 1: The treatment details are given below.

Treatment details	
T_1	Freshly harvested bulbs without chemical treatment
T_2	Freshly harvested bulbs treated with thiourea 3%
T_3	Freshly harvested bulbs treated with thiourea 4%
T_4	Freshly harvested bulbs treated with thiourea 5%
T_5	15 days stored bulbs without chemical treatment
T_6	15 days stored bulbs treated with thiourea 3%
T_7	15 days stored bulbs treated with thiourea 4%
T_8	15 days stored bulbs treated with thiourea 5%
T_9	30 days stored bulbs without chemical treatment
T_{10}	30 days stored bulbs treated with thiourea 3%
T_{11}	30 days stored bulbs treated with thiourea 4%
T_{12}	30 days stored bulbs treated with thiourea 5%
T_{13}	45 days stored bulbs without chemical treatment
T_{14}	45 days stored bulbs treated with thiourea 3%
T_{15}	45 days stored bulbs treated with thiourea 4%
T_{16}	45 days stored bulbs treated with thiourea 5%
T_{17}	60 days stored bulb (Control) – Farmers practice

Results

Days to sprouting of bulbs

Significant differences were observed among the thiourea treatments and bulb storage treatments. Storing the bulbs for 60 days (T_{17} – control) recorded the maximum number of days for sprouting (18.50) whereas 30 days stored bulbs treated with thiourea at 3 per cent (T_{10}) registered the earliest mean number of days for sprouting (8.0) (Table 2 and Fig. 1)

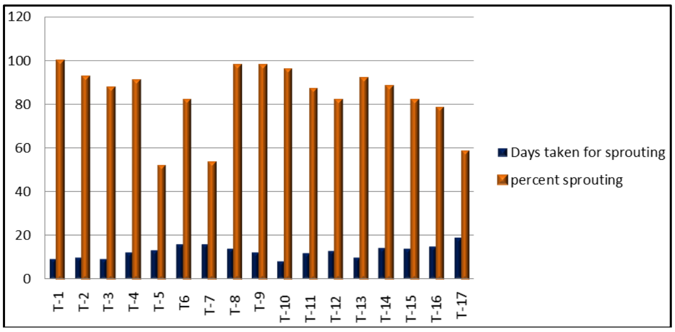

Fig 1: Effect of thiourea and storage duration on days taken for sprouting and per cent sprouting of tuberose bulbs

Table 2: Effect of thiourea and storage duration on days taken for sprouting of tuberose bulbs

Treatment details		Days taken for sprouting
T_1	Freshly harvested bulbs	9.00
T_2	Freshly harvested bulbs + thiourea 3%	9.50
T_3	Freshly harvested bulbs + thiourea 4%	9.00
T_4	Freshly harvested bulbs + thiourea 5%	12.00
T_5	15 days stored bulbs	13.00
T_6	15 days stored bulbs + thiourea 3%	15.50
T_7	15 days stored bulbs + thiourea 4%	15.50
T_8	15 days stored bulbs + thiourea 5%	13.50
T_9	30 days stored bulbs	12.00
T_{10}	30 days stored bulbs + thiourea 3%	8.00
T_{11}	30 days stored bulbs + thiourea 4%	11.50
T_{12}	30 days stored bulbs + thiourea 5%	12.50
T_{13}	45 days stored bulbs	9.50
T_{14}	45 days stored bulbs + thiourea 3%	14.00
T_{15}	45 days stored bulbs + thiourea 4%	13.50
T_{16}	45 days stored bulbs + thiourea 5%	14.50
T_{17}	60 days stored bulbs (Control)	18.50
Mean		12.4118
SEd		1.4889
CD (P = 0.05)		3.1564 **

Per cent sprouting

When comparing the mean effects of soaking and storage treatments, freshly harvested bulbs (T_1) registered a maximum of 100 per cent sprouting (Fig 1). 15 days stored bulbs (T_5) 52 per cent followed by 15 days stored bulbs treated with thiourea 4 per cent (T_7) 53.57 per cent.

Number of florets per spike

Increased number of florets (66.53) was registered in 30 days stored bulbs treated with thiourea 3 per cent (T_{10}), while 60 days stored bulbs (T_{17}) recorded minimum number of florets per spike (15.00). Number of florets showed significant differences between the bulb soaking and storage treatments (Table 3).

Table 3: Effect of thiourea and storage duration of bulbs on number of florets per spike

Treatment details		Number of floret per spike
T_1	Freshly harvested bulbs	36.95
T_2	Freshly harvested bulbs + thiourea 3%	36.30
T_3	Freshly harvested bulbs + thiourea 4%	56.10
T_4	Freshly harvested bulbs + thiourea 5%	53.45
T_5	15 days stored bulbs	21.00
T_6	15 days stored bulbs + thiourea 3%	46.85
T_7	15 days stored bulbs + thiourea 4%	47.00
T_8	15 days stored bulbs + thiourea 5%	40.74
T_9	30 days stored bulbs	35.79
T_{10}	30 days stored bulbs + thiourea 3%	59.00
T_{11}	30 days stored bulbs + thiourea 4%	50.50
T_{12}	30 days stored bulbs + thiourea 5%	38.10
T_{13}	45 days stored bulbs	23.15
T_{14}	45 days stored bulbs + thiourea 3%	28.50
T_{15}	45 days stored bulbs + thiourea 4%	26.00
T_{16}	45 days stored bulbs + thiourea 5%	20.50
T_{17}	60 days stored bulbs (Control)	15.00
Mean		37.3482
SEd		7.1348
CD (P = 0.05)		15.1254 **

Flower yield per plot

Flower yield per plot (2.88 m^2) ranged from 1.89 kg in T_5 to 4.18 kg in T_{10} for the treatments (Table 4).

Table 4: Effect of thiourea and storage duration on flower yield per plot (plot size: 2.88 m^2)

Treatment details		Flower yield per plot (kg)
T_1	Freshly harvested bulbs	2.97
T_2	Freshly harvested bulbs + thiourea 3%	2.55
T_3	Freshly harvested bulbs + thiourea 4%	2.30
T_4	Freshly harvested bulbs + thiourea 5%	3.18
T_5	15 days stored bulbs	1.89
T_6	15 days stored bulbs + thiourea 3%	3.48
T_7	15 days stored bulbs + thiourea 4%	3.48
T_8	15 days stored bulbs + thiourea 5%	3.58
T_9	30 days stored bulbs	2.66
T_{10}	30 days stored bulbs + thiourea 3%	4.18
T_{11}	30 days stored bulbs + thiourea 4%	3.63
T_{12}	30 days stored bulbs + thiourea 5%	3.82
T_{13}	45 days stored bulbs	3.44
T_{14}	45 days stored bulbs + thiourea 3%	3.43
T_{15}	45 days stored bulbs + thiourea 4%	3.50
T_{16}	45 days stored bulbs + thiourea 5%	3.20
T_{17}	60 days stored bulbs (Control)	2.26
Mean		3.1468
SEd		0.3184
CD (P = 0.05)		0.6750 **

Discussion

Influence of thiourea and storage duration on bulb dormancy and yield of tuberose

Freshly harvested tuberose bulbs undergo a period of dormancy that is regulated by changes in the endogenous levels of promotive or inhibitory substances as indicated by Misra and Singh (1989) [8]. Abscissic acid was found to be the major endogenous inhibitor that controls the sprouting of cormels and it decreases with release of dormancy in Gladiolus (Ginzurg, 1973). ABA may play a role in the early stages of rest in tuberose bulbs and some kind of promotive force becomes dominant during the later stages to override the possible effects of endogenous ABA (Nagar, 1995) [9].

In the present study, storing the bulbs for 30 days and treating with thiourea 3 per cent significantly improved the sprouting of the bulbs and promoted early sprouting when compared to control. Thiourea is known to overcome the endogenous dormancy of several seed crops and also crops producing corms and tubers. Thiourea simulated sprouting at 1 per cent concentration but not at 3 per cent as reported by Al-Fayyad and Kasrawi (1992) [1]. In the studies on gladiolus, Padmalatha *et al*. (2013) [10] reported earlier sprouting and higher sprouting percentage in corms treated with thiourea 2 per cent. The effect of thiourea in reducing the number of days to sprouting can be attributed to two reasons. The first is the effect in reducing the levels of ABA, the prime factor for imposing dormancy in corms and tubers and thereby changing the hormonal balance in favour of promoters. Second is the increase in quantum of alternate respiration in corms due to the treatment. Thiourea at lower concentration *i.e*., 3 per cent was found to be effective and that might be due to optimum absorption of chemicals by tubers, which might have been further utilized for physiological processes to influence favourably the sprouting parameters.

Hundred per cent sprouting was recorded in freshly harvested bulbs (Fig.1). This may be due to the presence of higher food reserves present in the bulbs of tuberose immediately after harvest and as they are stored, food materials are accumulated and dormancy is induced in the bulbs. The results are in accordance with the observations of Hosseini *et al*. (2011) [6] who reported that treatment of freshly harvested tubers with thiourea was more effective in breaking dormancy than the treatment of tubers which were stored for a week after harvest. Freshly harvested tubers have newly formed thin skin and this may have facilitated the sprouting of tubers.

Increase in floret number per spike results in increased yield with thiourea treatment at lower concentrations. And this might be due to large accumulation of photosynthates during flower development. This result was in accordance with the observations of Sahu *et al*. (1993) [12].

Flower yield of any crop is determined using different yield components. Yield attributing characters *viz.,* number of flowers per spike, number of spikes per clump, diameter of flower, flower weight and spike weight have a definite role in commercial cultivation of tuberose. The yield in untreated thiourea was generally lower compared to thiourea treated plants which clearly demonstrates the importance of thiourea in the synthesis of auxin and cytokinin in enhancement of cell division and chlorophyll accumulation. The reduction in number of florets per spike and flower yield per plot with longer storage duration may be because of physiological factor such as depletion of carbohydrates in the tubers as in accordance with Clark (1995) [4].

Conclusion

The present study led to the inference that 30 days stored bulbs treated with thiourea 3 per cent (T_{10}) resulted in maximization of flower yield per plot with 96 per cent sprouting efficiency.

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