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Effect of Pre Harvest Application of Growth Substances on Storage Life of Garlic

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A B S T R A C T

The study investigated the effect of growth substances on the storage life of garlic conducted during the year 2022-2023 at the Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Ten pre-harvest treatments including Cycocel at 500, 1000, and 1500 ppm; Brassinolide at 0.25, 0.50, and 1.00 ppm; and Paclobutrazol at 500, 1000 and 1500 ppm; and a control treatment, all replicated thrice in a Randomized Block Design (RBD) were sprayed 20 and 30 days before the harvest of a garlic crop. Among the treatments, minimum physiological loss in weight (19.42 %), sprouting (0.57 %), total losses (34.82 %) and maximum Marketable bulbs (65.18 %) were obtained with the pre harvest spray of T2 (CCC @ 1000) ppm after six months of storage study. Notably, the CCC at 1000 ppm treatment minimized storage losses as compared to the control, effectively maintaining the post-harvest quality of garlic.

Introduction

Garlic is one of the most important commercial bulb vegetable crop and is next to onion in importance. It is commonly used as a spice and also for medicinal purpose. It is used for flavouring of various vegetarian and non-vegetarian dishes. Garlic is often used for culinary purposes. In general, garlic has higher nutritive value as compared to other bulbous crops. It is a rich source of carbohydrates (29%), proteins (6.3%), minerals (0.3%) and essential oils (0.1-0.4 %) and also contains fat, vitamin C, and sulphur (Memane *et al.,* 2008). Ascorbic acid content is very high in green garlic. In addition to this, garlic has several medicinal values. It has antibacterial (Arora and Kaur, 1999), antifungal (Hughes and Lawson, 1991), antiviral (Meng *et al.,* 1993) and antiprotozol properties (Reuter *et al.,* 1996). It is beneficial to cardiovascular and immune system and has antioxidant and anticancer properties (Harris *et al.,* 2001). It also has the antimicrobial effects against many

viruses, bacteria, fungi and parasites. The inhalation of garlic oil or garlic juice has generally been recommended by doctors against the cases of pulmonary tuberculosis, rheumatism, sterility, impotency, cough, lung diseases and a specific remedy for sour eyes and earache.

Garlic storage is vital for extending its availability to customers throughout the year without compromising quality. There are a number of factors that control physiology and metabolic activity of garlic, from the date of planting until they reach the customer. In commercial and domestic storage, garlic bulbs are exposed to environmental conditions, including temperature, humidity, light, etc., which may result in quality changes related to high catabolism of substrates, primarily carbohydrates. Sprouting, weight loss, hallow bulb, and rotting are the main processes that cause losses during long-term storage and decrease market quality of garlic. During storage under ordinary conditions, losses due to rotting, sprouting and drying can occur. Hence, improvement of storage life of garlic is a great challenge before us, because during times of over-supply at harvesting in May-June, market price is reduced and the time when there is no garlic production prices are very high. Therefore, for regular supply and fair profit, it is necessary to increase the shelf-life of garlic without compromising quality deterioration. Plant Growth substances play an important role in increasing self-life of garlic under ambient temperature conditions. Therefore, it is imperative to study the effect of other growth substances on storage-life of garlic (Sharma *et al.,* 2010).

Materials and Methods

The present study was conducted using the Bhima purple cultivar of garlic at the Instructional farm, Department of Vegetable Science, Dr. Panjabrao Deshmukh Krushi Vidyapeeth, Akola during the Rabi season of 2022-23. The experiment was initiated on October, following a randomized block design with three replications for each treatment combination.

The ten treatments comprised of Cycocel at 500, 1000, and 1500 ppm; Brassinolide at 0.25, 0.50, and 1.00 ppm; and Paclobutrazol at 500, 1000 and 1500 ppm; and a control treatment. The cloves were sown at a spacing of 15 cm x 10 cm in a plot having size of 2.0 x 1.0 m^2. The spray of growth substances was done twice i.e. 1st at 30 days before harvest of crop and 2^{nd} at 20 days before harvest of crop and water was applied as foliar spray in control plots. The standard cultural practices recommended were followed to ensure a healthy crop stand. The sample size of uniform bulb is 3 kg were taken for study. Bulbs was stored for six month and observations were recorded at monthly interval. The mean values of data were subjected to analysis of variance as described by Panse and Sukhatme (1967).

Results and Discussion

Effect of pre harvest application of growth substances on physiological loss in weight (%) of garlic

The data presented in Table 1 revealed that the minimum physiological weight loss (19.42 %) after six months of storage recorded in T_2 (CCC 1000 ppm). In contrast, T_{10} (control) exhibited the highest physiological loss (31.05%). In this study, the physiological loss in weight of garlic bulbs increased gradually over the storage period across all treatments. This weight loss is a key factor influencing storage life. Cycocel play significant role by inhibiting respiration, which helps to reduce moisture loss from the bulbs, as noted by Anbukkarasi *et al.,* (2013). Similar trends have been observed by Kumara and Patil (2015) in garlic.

Effect of pre harvest application of growth substances on sprouting (%) of garlic

There was no sprouting recorded during 30, 60, 90 and 120 days after storage of garlic (Table 2). After180 days of storage T_2 (CCC 1000 ppm) recorded the minimum sprouting incidence (0.57 %) While, T_{10} (Control) recorded the maximum sprouting incidence (3.29%).

Sprouting incidence is an important parameter which determines the quality of the bulbs after six months of the storage. This effect may be due to ability of cycocel to prolong dormancy and inhibit sprout initiation, likely due to reduced neck thickness, minimized cell division, and the suppression of apical dominance. Treatments observed sprouting loss during the 150-180 DAS mark correlates with findings from Chope *et al.,* (2012), who noted that as storage time extends, endogenous abscisic acid (ABA) levels in onion bulbs decline. This decrease in ABA, part of the growth inhibitory complex, results in an increase in growth promoters, thereby facilitate sprouting. Overall, the results support the use of cycocel to enhance storage life by minimizing sprouting in garlic bulbs.

Effect of pre harvest application of growth substances on Total losses (%) of garlic

Total losses of stored garlic bulbs increased with an increase in storage period (Table 3). The minimum total losses (34.82 %) were recorded in the treatment T_2 (Cycocel 1000 ppm) and maximum total losses were noticed in the treatment T_{10} (57.00 %). The increase in percentage of total loss of bulbs in the control treatment might be due to rotting, sprouting, and physiological weight loss during storage. Maximum weight loss as a result of rotting, sprouting, moisture loss, and physiological loss in weight was also reported by Biswas *et al.,* (2010) in onions. But total loss was minimum in the pre-harvest spraying treatments with growth retardants like cycocel than in the control. This might be due to the anti-gibberellin action of growth retardants, which might have facilitated the maintenance of the quality of bulbs in storage with respect to inhibition of sprouting, leading to a reduction in moisture and a physiological loss in weight. This result is in agreement with Rahman and Isenberg (1974) in onion.

Table.1 Treatment Details

Treatment no.	Treatment	Remark
T_1	CCC 500 ppm	Spray 20 and 30 days before harvest
T_2	CCC 1000 ppm	Spray 20 and 30 days before harvest
T_3	CCC 1500 ppm	Spray 20 and 30 days before harvest
T_4	BR 0.25 ppm	Spray 20 and 30 days before harvest
T_5	BR 0.50 ppm	Spray 20 and 30 days before harvest
T_6	BR 1.00 ppm	Spray 20 and 30 days before harvest
T_7	PBZ 500 ppm	Spray 20 and 30 days before harvest
T_8	PBZ 1000 ppm	Spray 20 and 30 days before harvest
T_9	PBZ 1500 ppm	Spray 20 and 30 days before harvest
T_{10}	Control	No Spray

Table.2 Effect of pre-harvest treatment of growth substances on physiological loss in weight (%) of garlic during storage

Treatments	Physiological weight loss (%)						Change in PLW (%)
	Storage period (days)						
	30	**60**	**90**	**120**	**150**	**180**	
T_1: CCC 500 ppm	3.52	8.14	10.46	13.37	16.38	22.23	18.71
T_2: CCC1000 ppm	3.46	5.48	7.65	10.61	14.66	19.42	15.96
T_3: CCC1500 ppm	3.81	7.80	12.15	12.39	15.29	20.54	16.73
T_4: BR 0.25 ppm	4.25	8.67	10.31	11.89	17.34	24.32	20.07
T_5: BR 0.50 ppm	4.47	7.33	12.30	13.56	16.30	23.58	19.11
T_6: BR 1.0 ppm	4.35	6.78	11.33	13.61	16.21	22.46	18.11
T_7: PBZ 500 ppm	4.29	7.68	10.48	12.03	15.49	22.87	18.58
T_8: PBZ 1000 ppm	3.81	6.15	9.16	10.98	14.47	20.41	16.60
T_9: PBZ 1500 ppm	4.50	7.45	10.52	11.84	15.26	21.78	17.28
T_{10}: Control	4.57	10.62	15.28	18.54	22.48	31.05	26.48
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	
SE (m) ±	0.15	0.05	0.30	0.20	0.08	0.70	
CD at 5 %	0.43	0.14	0.88	0.58	0.24	0.21	

Table.3 Effect of pre-harvest treatment of plant growth substances on sprouting (%) of garlic bulbs during storage

Treatments	Sprouting (%)						Change In sprouting (%)
	Storage period (days)						
	30	60	90	120	150	180	
T_1: CCC 500 ppm	0.00	0.00	0.00	0.00	1.08	2.53	3.61
T_2: CCC1000 ppm	0.00	0.00	0.00	0.00	0.18	0.57	0.75
T_3:CCC1500 ppm	0.00	0.00	0.00	0.00	0.72	1.92	2.64
T_4: BR 0.25 ppm	0.00	0.00	0.00	0.00	1.38	2.88	4.26
T_5: BR 0.50 ppm	0.00	0.00	0.00	0.00	1.26	2.69	3.95
T_6: BR 1.0 ppm	0.00	0.00	0.00	0.00	1.51	2.36	3.87
T_7: PBZ 500 ppm	0.00	0.00	0.00	0.00	0.76	1.92	2.68
T_8: PBZ 1000 ppm	0.00	0.00	0.00	0.00	0.41	1.29	1.70
T_9: PBZ 1500 ppm	0.00	0.00	0.00	0.00	0.81	2.15	2.96
T_{10}: Control	0.00	0.00	0.00	0.00	2.17	3.29	5.46
F test	-	-	-	-	Sig.	Sig.	
SE (m) ±	-	-	-	-	0.03	0.03	
CD at 5 %	-	-	-	-	0.09	0.10	

Table.4 Effect pre-harvest treatments of growth substances on total losses (%) of garlic during storage**.**

Treatments	Total losses (%)						Change in total losses (%)
	Storage period (days)						
	30	60	90	120	150	180	
T_1: CCC 500 ppm	3.52	8.14	14.72	21.62	31.19	42.10	38.58
T_2: CCC1000 ppm	3.46	5.48	9.59	17.33	23.11	34.82	31.36
T_3: CCC1500 ppm	3.81	7.80	15.99	20.34	27.70	40.78	36.97
T_4: BR 0.25 ppm	4.25	8.67	14.62	20.52	28.97	47.67	43.42
T_5: BR 0.50 ppm	4.47	7.33	15.91	22.90	30.12	43.22	38.75
T_6: BR 1.00 ppm	4.35	6.78	14.79	20.45	28.66	43.46	39.11
T_7: PBZ 500 ppm	4.29	7.68	15.73	20.97	28.69	45.33	41.04
T_8: PBZ 1000 ppm	3.81	6.15	11.63	18.82	24.70	38.54	34.73
T_9: PBZ 1500 ppm	4.50	7.45	15.47	21.24	29.92	45.30	40.80
T_{10}: Control	4.57	10.62	20.84	30.81	41.10	57.00	52.43
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	
SE (m) ±	0.15	0.05	0.30	0.20	0.08	0.09	
CD at 5 %	0.43	0.14	0.86	0.58	0.25	0.25	

Table.5 Effect of pre-harvest treatment of growth substances on marketable bulbs (%) of garlic during storage

Treatments	Marketable bulbs					
	Storage period (days)					
	30	60	90	120	150	180
T_1: CCC 500 ppm	96.30	91.86	85.28	78.38	68.81	57.90
T_2: CCC1000 ppm	96.73	94.52	90.41	82.67	76.89	65.18
T_3: CCC1500 ppm	96.35	92.20	84.01	79.66	72.30	59.22
T_4: BR 0.25 ppm	95.65	91.33	g85.38	79.48	71.03	52.33
T_5: BR 0.50 ppm	94.91	92.67	84.09	77.10	69.88	56.78
T_6: BR 1.0 ppm	95.44	93.22	85.21	79.55	71.34	56.54
T_7: PBZ 500 ppm	95.47	92.32	84.27	79.03	71.31	54.67
T_8: PBZ 1000 ppm	96.66	93.85	88.37	81.18	75.30	61.46
T_9: PBZ 1500 ppm	95.34	92.55	84.53	78.76	70.08	54.70
T_{10}: Control	94.28	89.38	79.16	69.19	58.90	43.00
F table	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m) ±	0.11	0.05	0.30	0.20	0.08	0.09
CD at 5 %	0.32	0.14	0.86	0.58	0.25	0.26

Effect of pre harvest application of growth substances on marketable bulbs (%) of garlic

As the storage period for garlic bulbs extended from 30 to 180 days, the percentage of marketable bulbs decreased. The treatment with Cycocel at 1000 ppm (T_2) achieved the highest marketable bulb percentages from 96.73 % to 65.18 % after 30 to 180 days of storage respectively. Conversely, the control treatment (T_{10}) had the lowest marketable bulbs percentages from 94.28 to 43.00 % over the same time intervals. The marketability of garlic bulbs at the end of the storage period was influenced by the rates of physiological loss in weight, rotting, and sprouting.

These findings align with those of Munshi Ram *et al.,* (2018) in onions, reinforcing the effectiveness of growth substances like Cycocel in enhancing the marketable quality of stored garlic. The physiological loss in weight, sprouting and total losses increased with the advancement of storage period where as marketable bulbs decreases. Pre-harvest application of CCC @ 1000 ppm20 and 30 before harvesting resulted in the minimum physiological loss in weight (19.42 %), minimum sprouting (0.57%) and minimum total losses (34.82 %) also recorded highest percentage of marketable bulbs (65.18%) at the end of storage period of 180 days. From the above results, it could be concluded that, pre-harvest spraying of cycocel at 1000 ppm was found to be significant for minimising post-harvest losses after six months storage study of garlic.

Author Contributions

Khushali A. Dahule: Investigation, formal analysis, writing—original draft. A. M. Sonkamble: Validation, methodology, writing—reviewing. S. M. Ghawade:—Formal analysis, writing—review and editing. S. O. Bawkar: Investigation, writing—reviewing. S. D. Jadhao: Resources, investigation writing—reviewing. Nikita Sharnagat: Validation, formal analysis, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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