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Study on Response of Foliar Application of 6-benzylammino Purine on Field and Post-harvest Life of Pak Choi

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ABSTRACT

The present study was carried to check the effect of 6-Benzylaminopurine (6-BAP) on the field and post-harvest life of pak choi, an underutilized vegetable crop, which was cultivated during rabi season of 2022-23. Pak choi seeds of the variety 'Tai Sai' was procured and sown in seedling trays. After their germination, at 2-3 leaves stage the seedlings were transplanted in the main field with a spacing of 30 x 30 cm. The growth regulator 6-BAP in form of aqueous solution at seven different concentrations viz. 0, 10, 20, 30, 40, 50 & 60 ppm, was provided as foliar applications twice at a gap of 10 days. For every concentration of 6-BAP application, 3 replications were maintained following a randomized block design (RBD) for the experiment. At growth stages, parameters like leaf length and number, plant diameter and height were documented at multiple times. After harvesting the yield was brought to the laboratory of the Department and further attributes like physiological loss of weight, chlorophyll and titratable acidity were noted at different intervals of storage. From the entire experiment it was observed that, the cytokinin based growth regulator helped in influencing the field and storage-based parameters of pak choi in a positive manner and to specify further the 6-BAP at a concentration of 10 ppm was found most appropriate for both the cases.

Key words: *6-BAP, Pak choi, Development, Harvest, Storage*

Introduction

For its high nutritional value, notably in terms of vitamins, minerals, and dietary fibers, pakchoi (*Brassica rapa* subsp. *chinensis*) is grown (Jeon *et al*., 2018). Pak choi features large, spoon-shaped, dark green leaves and thick, white leaf stalks. Pak choi is eaten in particular ways. According to Peirce (1987), the plant is mostly used for its leaves and leaf stalks. When these plants are young and little (15 cm and shorter leaves), they make excellent salad ingredients, and when the leaves are mature (once the plant top has reached 30 cm), they are utilized as food components (Esiyok *et al*., 2011). In addition to being used for ornamentation, it is also utilized to prepare soups and other foods (Siemonsma and Piluek, 1994). Due to its resemblance to other members of the Brassicaceae family, pak choi can be used as a substitute crop by vegetable growers.

Plant growth regulators (PGRS) have exceptional potential for boosting agricultural output and assisting in removing the numerous constraints brought on by genetics and environment. PGRS are essential for reducing stress and boosting flower set. Accord-

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ing to studies (Bharud *et al*., 1988; Nickell 1983), the exogenous use of PGRS increases the growth and yieldof different plants. BAP and its derivatives are active and widely accessible compounds that promote plant growth. BAP, also known as benzyl adenine, is a first-generation product coming under the category of synthetic based cytokinin which has shown its usefulness in adequately maintaining harvested horticulture products. Application of 6-benzylaminopurine is believed to be helpful in reducing weight loss, spoilage loss, exchange in coloring, texture, phytochemical components, and senescence (Clarke *et al*., 1994; Siddiqui *et al*., 2015; Zhang *et al*., 2014). Thus, the vegetable pakchoi was targeted for the experiment for checking its response towards foliar application of 6 BAP (applied as seed and foliar application) at the developmental and storage stages.

Materials and Methods

Pak Choi variety 'Tai Sai' was selected for the study. The field-based part of the experiment was conducted at the Agricultural Experimental Farm (University of Calcutta) at Baruipur, South 24 Parganas, West Bengal (India) during the winter season of 2022-23 (Dec to Feb). Secondly the lab-based part of the study was conducted in the laboratory of the Department of Horticulture, Institute of Agricultural Science, University of Calcutta. Basic materials required such as FYM, fertilizers, insecticide etc. were collected from Baruipur, South 24 Parganas (West Bengal; India) local market. Growth regulator 6-Benzylaminopurine was supplied from the Department of Horticulture itself. The details of the field and the post-harvest part of the experiment are summarized in Table 1.

For the pre-harvest study, readings were observed at 50thdays, 55thdays and 60thdays after transplanting (DAT). Attributes like leaf length (Draie, 2019), number of leaves per plant (Chaulagain *et al*., 2011), plant diameter and plant height were documented. For the post harvest study observation were recorded at 0, 10, 20 and 30th days of storage (DAS). Parameters like physiological loss of weight, chlorophyll content (Ranganna, 2003) and titratable acidity (AOAC, 2000) were noted. For the statistical analysis help of an online software was taken (Sheoran *et al*., 1998).

Table 1. Summary of the experiment
Part 1: Pre harvest study

Sl. No.	Experiment particulars	Inputs
1.	Transplanting stage	Seedlings at 2-3 leaf stages
2.	Spacing	30 × 30 cm
3.	Gross plot size	1.2 × 1.2 m
4.	Design	Randomized Block Design (RBD)
5.	Number of treatments	7 (T_1-Control, T_2- 10 ppm BAP, T_3- 20 ppm BAP, T_4- 30 ppm BAP, T_5- 40 ppm BAP, T_6- 50 ppm BAP, T_7- 60 ppm BAP)
6.	Application of treatments	1st Foliar spray at 30 days after transplanting (DAT) and, 2nd Foliar spray at 40th days after transplanting (DAT)
7.	Replication	3 (R1, R2, R3)
8.	Recommended dose of NPK	100:60:60 kg/ha
9.	Miscellaneous treatments	*Seeds were treated with Carbendazim 50 WP @ 2g/kg seed to avoid against Black rot (*Xanthomonas campestris*) incidence*Chlorpyriphos 50% + Cypermethrin 5% EC was sprayed @ 2g/L of water to control Pak choi striped flea beetle (*Phyllotretastriolata*).
Part 2: Post harvest study		
1.	Harvesting	At 60th days of transplanting (DAT)
2.	Number of treatments	No further post-harvest treatments were given, only the field based treatments (T1 –T7) were subjected to storage studies
3.	Packaging	LDPE packets
4.	Storage condition	Low temperature storage at 7-8^{0}C
5.	Design	Completely Randomized Design (CRD)
6.	Replication	3 (R1, R2, R3)

Results and Discussion

Pre harvest study

Leaf length

From Table 2 it is seen that T_1 (control) showed highest leaf length of 18.28 cm followed by T_2 (6-BAP 10 ppm) with 17.51 cm while lowest value was observed by T_5 (6-BAP 40 ppm) at 50 DAT. A similar trend was observed at 55 DAT where again T_1 (control) was recorded with the maximum leaf length of 21.89 cm followed by T_2 (6-BAP 10 ppm) with 21.26 cm whereas T_5 (6-BAP 40 ppm) recorded with the least length of leaves with 15.32 cm. However, on 60 DAT the pattern gets changed and T_2 (6-BAP 10 ppm) was having the maximum value of 26.91 cm and the lowest figure was recorded by T_5 (6-BAP 40 ppm) with 20.65 cm length of leaves.

Table 2. Effect of foliar spray of 6 BAP on leaf length (cm) at different development stages of Pak choi

Treatments	50 DAT	55 DAT	60 DAT
T_1	18.28	21.89	25.89
T_2	17.51	21.26	26.91
T_3	14.48	16.94	20.95
T_4	15.77	18.50	23.11
T_5	12.56	15.32	20.65
T_6	16.15	17.56	22.02
T_7	15.90	17.29	20.95
CD at 5%	2.923	3.754	3.341
S. Em±	0.938	1.205	1.072

No. of leaves per plant

This parameter gradually increased throughout the development period of the plants. On 50 DAT it was evident from Table 3 that T_1 (control) and T_2 (6-BAP 10 ppm) was having the maximum no. of leaves of 11.33 and T_5 (6-BAP 40 ppm) recorded the least no. of leaves of 8.67. Later in the next interval of reading maximum no. of leaves were however documented by T_2 (6-BAP 10 ppm) and T_7 (6-BAP 60 ppm) with 17.33 and T_5 (6-BAP 40 ppm) recorded the least no. of leaves of 13.11. Finally at 60 DAT, the maximum data was observed from T_2 (6-BAP 10 ppm) with 24.22 no of leaves which was closely followed by T_7 (6-BAP 60 ppm) with 24.11 no. of leaves while T_4 (6-BAP 30 ppm) recorded the lowest value with 19.89 no. of leaves.

Table 3. Effect of foliar spray of 6 BAP on number of leaves at different development stages of Pak choi

Treatments	50 DAT	55 DAT	60 DAT
T_1	11.33	16.78	23.22
T_2	11.33	17.33	24.22
T_3	9.44	14.44	20.89
T_4	9.56	13.67	19.89
T_5	8.67	13.11	20.11
T_6	10.00	15.44	21.89
T_7	10.89	17.33	24.11
CD at 5%	1.334	1.762	2.138
S. Em±	0.428	0.566	0.686

Plant diameter

Plant diameter (Table 4) at the initial day of observation showed the maximum data of 35.63 mm for T_1 (control) which was then followed by T_2 (6-BAP 10 ppm) with 29.58 mm and further followed by T_6 (6-BAP 50 ppm) with 26.38 mm. For the second observation at 55 DAT, T_1 (control) as like as 50 DAT was again found superior against others. Lastly even at the end of field study T_1 (control) was noted with highest plant diameter of 49.91 mm followed by T_2(6-BAP 10 ppm) with 43.45 mm. The lowest plant diameter taken at 60 DAT was seen in T_5 (6-BAP 40 ppm).

Table 4. Effect of foliar spray of 6 BAP on plant diameter (mm) at different development stages of Pak choi

Treatments	50 DAT	55 DAT	60 DAT
T_1	35.63	39.53	49.91
T_2	29.58	33.60	43.45
T_3	20.30	23.46	35.80
T_4	23.41	26.05	35.05
T_5	16.20	19.98	32.35
T_6	26.38	27.91	38.81
T_7	23.21	27.21	38.48
CD at 5%	9.441	10.165	10.121
S. Em±	3.030	3.263	3.249

Plant height

Plant height (Table 5) recorded for the various treat-

Table 5. Effect of foliar spray of 6 BAP on plant height (cm) at different development stages of Pak choi

Treatments	50 DAT	55 DAT	60 DAT
T_1	18.37	23.93	28.53
T_2	18.61	22.87	27.68
T_3	14.57	18.47	23.38
T_4	17.11	19.80	24.38
T_5	12.99	16.55	21.84
T_6	17.73	18.00	23.89
T_7	15.77	19.08	23.84
CD at 5%	2.995	3.855	3.215
S. Em±	0.961	1.237	1.032

ment showed that on the first observation, T_2 (6-BAP 10 ppm) was highest with 18.61 cm which was closely succeeded by T_1 (control) with the plant height 18.37 cm. Again, at the next observation data T_1 (control) and T_2 (6-BAP 10 ppm) were found significantly superior than other treatment with respect to this parameter. Finally at 60 DAT the same trend continued depicting T_1 (control) and T_2 (6-BAP 10 ppm) the best treatments.

Post harvest study

Physiological loss in weight

During 10 days of storage (Table 6), T_4 (6-BAP 30 ppm) showed the maximum weight loss of 5.81% followed by T_7 (6-BAP 60 ppm) with 5.21%. The least weight loss of 2.18% was seen for T2 (6-BAP 10 ppm). At 20 days of storage the highest weight loss of 10.51% was seen for T_7 (6-BAP 60 ppm) and for the last days of observation T_7 (6-BAP 60 ppm) showed a similar trend of maximum weight loss as like of 20 DAS of 20.02% and T_2 (6-BAP 10 ppm) came to be the most prominent treatment with respected to with very less reduction of 8.36%.

Table 6. Effect of foliar spray of 6 BAP on physiological loss of weight (%) at different storage stages of Pak choi

Treatments	10 DAS	20 DAS	30 DAS
T_1	4.93	8.12	17.13
T_2	2.18	4.31	8.36
T_3	2.39	5.73	12.05
T_4	5.81	10.24	19.91
T_5	4.80	8.25	15.17
T_6	3.83	7.93	14.95
T_7	5.21	10.51	20.02
CD at 5%	0.512	NS	NS
S. Em±	1.073	1.890	4.408

Total chlorophyll content

The total chlorophyll content as evident (Table 7) decreased throughout the storage period of pak choi. The maximum content of total chlorophyll was observed for majority of treatment at the day of storage. Which there after got gradually deteriorated for the treatments as per observation taken on other intervals. Rate of chlorophyll deterioration was combatively slow for 10thday and 20th day observation. However, the final reading at 30thday, the loss of chlorophyll expedited. Here at 30thday the maximum chlorophyll with-holding was seen for T_5 (6-BAP 40 ppm) with 3.41 mg/g and T_7 (6-BAP 60 ppm) documented the highest chlorophyll loss with final chlorophyll content of 2.39 mg/g.

Table 7. Effect of foliar spray of 6 BAP on total chlorophyll content (mg/g) at different storage stages of Pak choi

Treatments	0 DAS	10 DAS	20 DAS	30 DAS
T_1	6.45	6.54	6.18	3.11
T_2	6.55	5.76	5.43	3.07
T_3	6.42	6.37	6.34	3.04
T_4	6.24	5.94	5.63	2.98
T_5	6.42	6.16	5.85	3.41
T_6	6.37	5.94	5.74	2.71
T_7	6.57	6.15	5.86	2.39
CD at 5%	0.099	0.104	0.092	0.087
S. Em±	0.032	0.034	0.030	0.029

Titratable acidity

This particular attribute inpak choi leaves during storage (Table 8), for the treatments increased on the 10 days of storage as compare to initial day of packaging. Here on the 10 days T_2 (6-BAP 10 ppm) was observed with the maximum titratable acidity content of 0.69% and the lowest amount of titratable acidity of 0.53% was seen for T_7 (6-BAP 60 ppm). However, at the 20 days of observation the titratable acidity content decreased again in comparison to the reading of acidity for the 10 days. Here on 20 days the maximum acidity content was seen by T_1 (control), T_6 (6-BAP 50 ppm) and T_5 (6-BAP 40 ppm) with the values of 0.56%, 0.53% and 0.52% respectively.

Table 8. Effect of foliar spray of 6 BAP on titratable acidity (%) at different storage stages of Pak choi

Treatments	0 DAS	10 DAS	20 DAS
T_1	0.62	0.58	0.56
T_2	0.50	0.69	0.49
T_3	0.51	0.56	0.48
T_4	0.47	0.56	0.47
T_5	0.54	0.59	0.52
T_6	0.46	0.62	0.53
T_7	0.30	0.53	0.31
CD at 5%	0.126	0.093	0.117
S. Em±	0.041	0.030	0.038

Conflict of Interest: There is no conflict of interest.

The length and amount of leaves are determined genetically, although multiple studies showed that the use of PGRS had an impact on the number of leaves. The maximum numbers of leaves were seen at T_2 (6-BAP 10 ppm). Similar to this, Khadr *et al*.

(2020) treated 6-Benzylaminopurine to carrots (*Daucus carota* subsp. *sativus*) at various concentration treatments and discovered that BAP greatly enhanced the number of leaves. The plant's diameter also noticeably increased at T_1 (control), and T_2 (6-BAP 10 ppm). For storage studies at 10 DAS, 20 DAS, and 30 DAS of monitoring, T_2 (6-BAP 10 ppm) showed the least physiological weight loss. Other fruits, including mangosteen, cherimoya, and apricot, have also shown 6-BAP's efficiency in decreasing weight loss during postharvest storage (Efendi *et al*., 2015). Also, it was seen that T_5 (6-BAP 40 ppm) had the highest total chlorophyll with-holding, whereas T_7 (6-BAP 60 ppm) had the lowest. According to Tsujita and Andrew (1967), 30-ppm 6-BAP concentrations were more successful at preserving the chlorophyll content of cabbage during storage. Lastly T_7 (6-BAP 60 ppm) underwent a quick loss of titratable acidity, as compared to the pak choi treated ones which underwent a delayed loss of acidity after BAP treatments.

Conclusion

Entirely from the study it is summarized that 6-Benzylaminopurine significantly influenced the field and post-harvest life of Pak choi plant in a positive manner. Observation at the field level showed that among all the applied treatments, T_2 (6-BAP 10 ppm) was found better, showing a good effect for various developmental parameters of the pak choi plant. According to different post-harvest parametric analysis T_2 (6-BAP 10 ppm) was again found to be most superior, compared to other treatments, as it maintained various storage attributes like physiological loss of weight, total chlorophyll content and titratable acidity.

Conflict of Interest: None

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