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Influence of Fertilizer Levels and Foliar Application of 6-Benzylaminopurine on Flowering, Cut-flower Quality and Economic Returns of Statice (*Limonium sinuatum L.*)

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AS and NL designed the study. Author HP prepared the manuscript and wrote the first draft. Authors SG, RM and SP provided assistance with the research work and manuscript preparation. All authors read and approved the final manuscript.

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Abstract

The present investigation was conducted at the Experimental Farm, Division of Floriculture and Landscaping, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Main Campus, Chatha, Jammu and Kashmir, during 2024–2025. The experiment was laid out in a factorial randomized complete block design (RCBD) comprising 16 treatment combinations, each replicated thrice. The treatments consisted of four fertilizer regimes, viz., F_1, 100% recommended dose of fertilizers (RDF; 150:125:75 kg NPK ha^{-1}); F_2, 75% RDF + humic acid (HA) at 5 g m^{-2}; F_3, 50% RDF + HA at 10 g m^{-2}; and F_4, 25% RDF + HA at 15 g m^{-2}, along with four concentrations of 6-benzylaminopurine (BAP): B_1, control (no application); B_2, 50 ppm; B_3, 100 ppm; and B_4, 150 ppm. Among the fertilizer regimes, the application of 75% RDF + HA at 5 g m^{-2} resulted in the minimum number of

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days to flower spike emergence (106.61 days), first flowering (147.49 days), and harvesting of flower stems (163.82 days). This treatment also recorded the maximum inflorescence length (6.48 cm), flower longevity (47.81 days), and number of cut flower stems per plant (18.95). Among the BA concentrations, foliar application of 100 ppm BA resulted in the minimum number of days to flower spike emergence (105.98 days), first flowering (148.24 days), and harvesting of flower stems (164.23 days). It also recorded the maximum inflorescence length (6.09 cm), flower longevity (47.93 days), vase life (12.82 days), and number of cut flower stems per plant (17.08). The treatment combination of 75% RDF + HA at 5 g m^{-2} + 100 ppm BA recorded the highest benefit–cost ratio of 4.96. The same treatment combination also resulted in the highest gross income (₹29,50,560 ha^{-1}) and net income (₹24,55,620.30 ha^{-1}). The findings indicate that integrating reduced fertilizer application with humic acid soil application and 100 ppm BA foliar application can improve flowering performance and economic returns in statice cultivation.

Keywords: Statice; growth; flowering; benzyl adenine; humic acid.

1. Introduction

Statice is an excellent cut flower used as filler in both fresh and dried flower arrangements and is a favourite option for weddings and other special occasions (Fisher 2024; Laishram *et al*. 2024). It belongs to the family Plumbaginaceae and genus Limonium (Nataraj *et al*., 2009). Statice symbolizes remembrance either for success or as sympathy and is an important component of wreaths and bouquets (Singh *et al*., 2024). The plant is suitable for flower beds, borders, rock gardens and as a pot plant also (Kumar *et al*., 2022). Flowers are available in a wide array of colours, including white, purple, apricot, yellow, pink and blue and can be used either fresh or dried and hence its cultivation is highly profitable (Galage *et al*., 2021). *Limonium sinuatum* is the most commonly cultivated and widely recognised cut flower crop among the many species of the genus (Mellesse *et al*., 2013). Some of the prominent annual varieties of Limonium are Midnight Blue, Twilight, Lavender, Blue Bonnet, Iceberg, and Gold Coast, Amazon Bird, Gaint Blue Bird, Yellow Sun Bird (Galage *et al*., 2021; Kottayam *et al*., 2014). Breeding work on the genus has also been reported (Burchi et al., 2006).

Valuable and exotic crop statice has great potential for its cultivation, since it is grown on a limited scale under Jammu conditions. Farmers are still unaware of the crop and its potential. Very little research on this crop has been carried out under our conditions despite huge potential; therefore, the present investigation was carried out to study the influence of fertilization doses and benzyl adenine on flowering and economic profitability.

Cytokinins are compounds whose principal role is in cell division and influencing many other growth processes. Humic acid, being a natural resource, has a profound influence on growth and development. Positive and stimulatory effects of benzyl adenine and humic acid on growth and flowering of various ornamentals have been investigated by several researchers viz., Guddad *et al*. 2022 in Ixora, Eid and Abou-Leila 2006 in croton, Kaviya *et al.,* 2021 in Alstroemeria, Khushaba *et al.,* 2022 in oxalis, El-Sayed *et al*., 2023 in geranium, Baghele *et al*., 2016 in rosa hybrid, Singh and Bala 2018 in chrysanthemum, Wang *et al*., 2022 in rosa hybrid, Ara *et al*., 2022 in chrysanthemum, Gabrel *et al*., 2018 in chrysanthemum, Alzuhairi and Al-Sheikly 2022 in rose, Akshitha *et al*., 2023 in gypsophilla, Gulmezoglu *et al.,* 2024 in marigold, Gheware *et al*., 2025 in dahlia, Rachna and Rao 2025 in rose, Nikbakht *et al.,* 2008 in tuberose, El-Nashar 2021 in calendula.

A study of African marigold reported variation in growth and flowering responses according to the method of humic acid application (Bhati et al., 2025).

Azam et al. (2022) also documented responses of African marigold reproductive attributes to different foliar concentrations of humic acid.

In snapdragon, combined applications of humic acid and nitrogen sources affected vegetative development and flowering, with responses differing among nitrogen sources (Gulmezoglu et al., 2024).

Al-Dulaimy et al. (2025) examined the combined influence of humic acid and the cytokinin-type regulator forchlorfenuron on the growth and flowering of African marigold.

More recently, Huang et al. (2026) reported that 6-benzylaminopurine treatments influenced postharvest vase life in cut anthurium flowers.

1.1 Research Gap

Although studies involving humic acid, mineral fertilization and cytokinin-related treatments have been reported for other ornamental crops, the combined responses of statice to reduced fertiliser levels supplemented with humic acid and foliar benzyl adenine under Jammu conditions remain insufficiently documented in the literature discussed above.

1.2 Objective

The present study aimed to evaluate the effects of fertiliser levels supplemented with humic acid and foliar application of 6-benzylaminopurine on flowering, cut-flower quality, yield and economic returns of statice under Jammu conditions.

2. Materials and Methods

The study was conducted at the Experimental Farm of the Division of Floriculture and Landscaping, Sher-e-Kashmir University of Agricultural Sciences and Technology, Main Campus, Chatha, Jammu, Jammu and Kashmir, India (180009). The experimental site is situated at an elevation of 296 m above mean sea level (MSL), at a latitude of 33°55′ N and a longitude of 74°58′ E. The region receives an average annual rainfall of 1,000–1,200 mm and experiences considerable seasonal variations in temperature, with maximum temperatures reaching 45–46°C during summer and minimum temperatures ranging from 4 to 6°C during winter.

Limonium sinuatum (L.) Mill. cv. Qis White was selected as the experimental plant material, and the seeds were obtained from Pan America, India. Following thorough hoeing and weeding, nursery beds measuring 1.0 m in width, 3.0 m in length and 15 cm in height were prepared for seedling establishment. Well-decomposed farmyard manure (FYM) was incorporated into the nursery beds before sowing. Seeds were sown in rows spaced 5 cm apart at a depth of 3–4 cm. Subsequently, the furrows were covered with a mixture of FYM, soil and sand in a ratio of 2:1:1. The nursery beds were then covered with mulching material and irrigated gently using a watering can fitted with a fine rose. The mulch was removed following seed germination. Healthy seedlings bearing four fully developed leaves were transplanted into the main experimental field 30 days after sowing. Transplanting was undertaken at a spacing of 30 × 30 cm, accommodating 20 seedlings per experimental bed measuring 1.50 × 1.20 m. To minimise transplanting shock, seedlings were transplanted during the evening hours when ambient temperatures were relatively low. Light irrigation was provided immediately after transplanting to facilitate seedling establishment. Any seedlings that failed to survive were replaced with healthy seedlings within 10 days of transplanting to maintain the required plant population in each experimental plot. Thereafter, irrigation was applied as necessary throughout the crop growth period.

Fertiliser was applied to each plot as per the experimental treatments. Urea, Diammonium Phosphate (DAP) and muriate of potash (MOP) were used to supply nitrogen, phosphorus and potassium, respectively. Humic acid was applied as soil drench and benzyl adenine was applied as a foliar spray at 30 and 60 days after transplanting (DAT) as per the treatment details. The experimental plots were maintained free from weeds through regular manual weeding, while irrigation was provided according to crop requirements throughout the growing period. No incidence of insect pest infestation or disease was observed during the experimental period. The economic feasibility of the different treatments was evaluated by estimating the cost of cultivation, gross returns and net returns associated with each treatment. Net returns were calculated by deducting the total cost of cultivation from the corresponding gross returns. The recorded experimental data were subjected to statistical analysis using OPSTAT software, and the critical difference (CD) was calculated at the 5% level of significance to assess differences among treatment means.

2.1 Experimental Details

A.	Crop	: Statice (*Limonium sinuatum* L.)
B.	Variety	: QIS white
C.	Design	: Randomized Completely Block Design (RCBD) Factorial
D.	Number of factors	: 02
E.	Total number of treatments	: 16
F.	Total number of replications	: 03
G.	Plot size	: 1.5m x 1.2m
H.	Spacing	: 30 x 30 cm
I.	Total no. of plants	:20

2.2 Treatment Details

Factor 1: Fertilizers Doses (4 Levels)

1. F_1: 100 % RDF (150:125:75 kg NPK/ha, Control)
2. F_2: 75 % RDF + 5 gm/m^2 Humic acid (HA) soil application
3. F_3:50% % RDF + 10 gm/m^2 Humic acid (HA) soil application
4. F_4:25 % RDF + 15 gm/m^2 Humic acid (HA) soil application

Full dose of PK and half dose of N was given as basal dose. Remaining half dose of N was given after 30DAT. Soil drench of humic acid was done after 30 and 60 DAT. Humic acid was dissolved in water as per the schedule and then applies per plot.

Factor 2: Benzyl Adenine Doses (4 Levels)

1. B_1: No application (Control)
2. B_2:50 ppm Benzyl Adenine (BA)
3. B_3:100 ppm Benzyl Adenine (BA)
4. B_4:150 ppm Benzyl Adenine (BA)

Two foliar sprays of benzyl adenine were applied at 30 and 60 days after transplanting (DAT).

2.3 Economic Analysis

The economic viability of the different treatments was evaluated by estimating the net profit generated under each treatment. Net profit was calculated by considering the total cost of cultivation and the corresponding gross returns, with net returns determined by deducting the cultivation costs from the gross returns.

(1) **Cost of treatment:** The cost of treatments was worked out for 1 ha area considering the working area as 8000 m^2.

Cost of treatment comprises various inputs viz., cost of seedlings, cost of materials, and chemicals used and labour cost for carrying out different operations.

(2) **Gross income:** It was calculated by multiplying the flower yield per hectare under each treatment by the prevailing selling price of ₹2 per stem or ₹24 per bunch. Subsequently, net income was determined for each treatment by deducting the total cost of cultivation from the corresponding gross income.

(3) The B: C ratio was calculated as the ratio between net returns and cost of cultivation.

$$\text{B: C Ratio} = \frac{\text{Net returns}}{\text{Cost of cultivation}}$$

3. Results and Discussion

3.1 Effect of Fertilization and 6-benzyl Aminopurine Application on Flowering Parameters

Fertilization and benzyl adenine (BA) significantly influenced flowering traits, including spike emergence, first flowering, spike harvest, inflorescence length, flower longevity, and vase life. The earliest spike emergence (106.61 days) was recorded with 75% RDF + 5 g/m² humic acid, while 100 ppm BA resulted in the minimum days to spike emergence (105.98 days). The earliest emergence among interactions was observed in F_4B_3 (103.29 days). 75% RDF + 5 g/m² humic acid also produced the earliest first flowering (147.49 days), whereas 100 ppm BA reduced days to first flowering (148.24 days). The minimum value among interactions was recorded in F_1B_3 (144.65 days). The shortest duration to flower stem harvest was obtained with 75% RDF + 5 g/m² humic acid (163.82 days) and 100 ppm BA (164.30 days), while F_2B_3 (162.21 days) was the best interaction. Maximum inflorescence length (6.48 cm) was recorded with 75% RDF + 5 g/m² humic acid; BA and interaction effects were non-significant. The longest flower longevity (47.81 days) and highest vase life (12.46 days) were also achieved with 75% RDF + 5 g/m² humic acid. Among BA treatments, 150 ppm BA gave maximum flower longevity (48.41 days), while 100 ppm BA resulted in the highest vase life (12.82 days). The strongest interaction effects were F_2B_4 for flower longevity (50.19 days) and F_3B_3 for vase life (13.70 days). Overall, 75% RDF + 5 g/m² humic acid, combined with 100–150 ppm BA, proved most effective for improving flowering and postharvest quality traits.

Humic acid enhanced nutrient absorption and enriched soil fertility, while mineral nutrition supplied essential nutrients in balanced proportions. This combination resulted in improved plant vigour, which in turn contributed to an increase in the average fresh weight of the flowers. The synergy between humic acid and mineral nutrition supports optimal flower development, leading to a more substantial and healthier bloom, resulting in a reduced time to the opening of the first flower, noticeable increase in the number of flowers per plant and extended vase life, highlighting their potential for optimizing floral yield in ornamental horticulture. Similar results were obtained by Gulmezoglu *et al*., (2024) on marigold, Nikbakht *et al*., (2008) in gerbera. Increased flower numbers and earliness in flowering with the incorporation of humic acid alongside NPK fertilization arise from HA's promotion of root nutrient uptake, chelating N for cytokinin-like signalling via fulvic acid fractions, which upregulate IPT genes and meristematic activity in inflorescence primordia, hastening bud initiation. Paired with P for energy metabolism and K for phloem loading, this shortened days to first flower by stimulating earlier floral transition. In geranium, 1/2 NPK + 150 ppm HA maximised branches and flowers via superior N-assimilation (Nikbakht *et al*., 2008). Similarly, HA-NPK combinations advanced 50% flowering in marigolds by 5–10 days through improved soil aeration and mycorrhizal symbiosis (El-Naggar and Imhmd, 2023). Increasing doses of benzyl adenine (BA) significantly improved flower quality, extended vase life, increased flower numbers per plant of statice and advanced flowering earliness in the present study, with optimal gains at 100 and 150 ppm. These multifaceted benefits reflect BA's predominant role as a synthetic cytokinin overcoming natural floral transition barriers and curtailing ethylene-mediated decline (Paull 2001; Nambiar *et al*., 2012). Earliness in flowering, as evident reductions in days to first bloom were also observed in lilies and anemones through upregulated cytokinin oxidases curbing dormancy (Situma *et al.,* 2015; Janowska 2004). Enhanced flower quality and vase life resulted from BA's antagonism of senescence, inhibiting chlorophyll breakdown, protease

Table 1. Influence of fertilization and benzyl adenine on flowering of statice (*Limonium sinuatum* L.)

Fertilizer doses	Flower emergence (days)					First flowering (days)				
	6-Benzyladenine (ppm)				Mean	6-Benzyladenine (ppm)				Mean
	B_1(0ppm)	B_2(50 ppm)	B_3 (100 ppm)	B_4 (150 ppm)		B_1(0ppm)	B_2(50 ppm)	B_3 (100 ppm)	B_4 (150 ppm)	
F_1-100 % RDF (150:125:75 kg NPK/ha)	108.91	109.43	111.44	106.72	109.13	155.63	148.88	144.65	147.21	149.09
F_2-75 % RDF + 5 gm/m^2 Humic acid soil drench	109.42	107.34	105.62	104.06	106.61	148.03	145.71	149.14	147.07	147.49
F_3-50% % RDF + 10 gm/m^2 Humic acid soil drench	107.01	106.78	103.58	113.20	107.64	157.12	155.64	148.44	151.31	153.13
F_4-25 % RDF + 15 gm/m^2 Humic acid soil drench	111.78	110.80	103.29	111.92	109.45	155.04	145.08	150.71	151.17	150.50
Mean	109.28	108.59	105.98	108.98		155.63	148.88	144.65	147.21	149.09
Factors				**C.D.$_{(0.05)}$**	**SE(m)**				**C.D.$_{(0.05)}$**	**SE(m)**
Fertilizer Doses (F)				1.46	0.51				2.94	1.02
6-Benzyladenine (B)				1.46	0.51				2.94	1.02
Interaction (F X B)				2.92	1.01				5.89	2.04

Table 1. Influence of fertilization and benzyl adenine on flowering of statice (*Limonium sinuatum* L.) (Contd...)

Fertilizer doses	Days to harvesting of flower stem					Inflorescence length (cm)				
	6-Benzyladenine (ppm)					6-Benzyladenine (ppm)				
	B_1(0ppm)	B_2(50 ppm)	B_3 (100 ppm)	B_4 (150 ppm)	Mean	B_1(0ppm)	B_2(50 ppm)	B_3 (100 ppm)	B_4 (150 ppm)	Mean
F_1-100 % RDF (150:125:75 kg NPK/ha)	170.96	164.67	166.21	162.45	166.07	5.38	5.62	5.86	6.14	5.75
F_2-75 % RDF + 5 gm/m^2 Humic acid soil drench	165.98	165.67	160.21	163.42	163.82	6.37	6.50	6.45	6.61	6.48
F_3-50% % RDF + 10 gm/m^2 Humic acid soil drench	172.98	165.59	169.30	166.40	168.57	5.43	5.67	5.88	6.11	5.77
F_4-25 % RDF + 15 gm/m^2 Humic acid soil drench	172.95	166.64	161.19	167.46	167.06	5.53	5.62	6.18	5.13	5.62
Mean	170.72	165.64	164.23	164.93		5.68	5.85	6.09	6.00	
Factors				**C.D.$_{(0.05)}$**	**SE(m)**				**C.D.$_{(0.05)}$**	**SE(m)**
Fertilizer Doses (F)				2.02	0.67				0.36	0.12
6-Benzyladenine (B)				2.02	0.67				NS	NS
Interaction (F X B)				4.04	1.34				NS	NS

Table 1. Influence of fertilization and benzyl adenine on flowering of statice (*Limonium sinuatum* L.) (Contd...)

Fertilizer doses	Flower longevity (days)					Vase life (days)				
	6-Benzyladenine (ppm)					6-Benzyladenine (ppm)				
	B_1(0ppm)	B_2(50 ppm)	B_3 (100 ppm)	B_4 (150 ppm)	Mean	B_1(0ppm)	B_2(50 ppm)	B_3 (100 ppm)	B_4 (150 ppm)	Mean
F_1-100 % RDF (150:125:75 kg NPK/ha)	42.41	44.91	49.65	49.15	46.53	10.20	11.40	12.80	11.20	11.40
F_2-75 % RDF + 5 gm/m^2 Humic acid soil drench	43.43	47.92	49.69	50.19	47.81	10.80	12.44	13.39	13.20	12.46
F_3-50% % RDF + 10 gm/m^2 Humic acid soil drench	42.42	45.92	48.67	49.16	46.54	10.24	10.80	13.70	13.40	12.04
F_4-25 % RDF + 15 gm/m^2 Humic acid soil drench	40.40	43.92	43.68	45.15	43.29	9.20	9.60	11.40	12.90	10.78
Mean	42.17	45.67	47.92	48.41		10.20	11.40	12.80	11.20	11.40
Factors				**C.D.$_{(0.05)}$**	**SE(m)**				**C.D.$_{(0.05)}$**	**SE(m)**
Fertilizer Doses (F)				2.20	0.73				0.62	0.21
6-Benzyladenine (B)				2.20	0.73				0.62	0.21
Interaction (F X B)				4.40	1.46				1.23	0.42

Table 1. Influence of fertilization and benzyl adenine on flowering of statice (*Limonium sinuatum* L.) (Contd...)

Fertilizer doses	Number of flower bunches					Number of cut stem per plant				
	6-Benzyladenine (ppm)				Mean	6-Benzyladenine (ppm)				Mean
	B_1(0ppm)	B_2(50 ppm)	B_3 (100 ppm)	B_4 (150 ppm)		B_1(0ppm)	B_2(50 ppm)	B_3 (100 ppm)	B_4 (150 ppm)	
F_1-100 % RDF (150:125:75 kg NPK/ha)	38.80	39.63	45.80	41.30	41.38	17.16	18.83	18.66	19.66	18.58
F_2-75 % RDF + 5 gm/m^2 Humic acid soil drench	37.63	46.30	42.13	44.30	42.59	17.99	18.16	20.49	19.16	18.95
F_3-50% % RDF + 10 gm/m^2 Humic acid soil drench	44.63	38.80	44.80	46.47	43.68	14.16	14.66	15.16	15.66	14.91
F_4-25 % RDF + 15 gm/m^2 Humic acid soil drench	42.47	38.97	42.80	41.80	41.51	12.16	13.16	13.99	14.16	13.37
Mean	40.88	40.93	43.88	43.47		15.37	16.20	17.08	17.16	
Factors				**C.D.$_{(0.05)}$**	**SE(m)**				**C.D.$_{(0.05)}$**	**SE(m)**
Fertilizer Doses (F)				NS	NS				0.99	0.34
6-Benzyladenine (B)				2.83	0.98				0.99	0.34
Interaction (F X B)				5.67	1.96				1.98	0.68

Table 2. Influence of fertilization and benzyl adenine on Benefit: Cost ratio

Treatments	Total cost of cultivation (Rs.)	Yield per ha (number of cut stems)	Gross income (Rs.)	Net income (Rs.)	B:C ratio
100 % RDF + (Control)	506559.60	1235520	2471040	1964480.40	3.88
100 % RDF +50 ppm (BA)	511349.60	1355760	2711520	2200170.40	4.30
100 % RDF +100 ppm (BA)	516079.60	1343520	2687040	2170960.40	4.21
100 % RDF +150 ppm (BA)	517559.60	1415520	2831040	2313480.40	4.47
75 % RDF + 5 gm/m^2 Humic acid + (Control)	485419.70	1295280	2590560	2105140.30	4.34
75 % RDF + 5 gm/m^2 Humic acid +50 ppm (BA)	490209.70	1307520	2615040	2124830.30	4.33
75 % RDF + 5 gm/m^2 Humic acid +100 ppm (BA)	494939.70	1475280	2950560	2455620.30	4.96
75 % RDF + 5 gm/m^2 Humic acid +150 ppm (BA)	496419.70	1379520	2759040	2262620.30	4.56
50 % RDF + 10 gm/m^2 Humic acid + (Control)	464279.80	1019520	2039040	1574760.20	3.39
50 % RDF + 10 gm/m^2 Humic acid +50 ppm (BA)	469069.80	1055520	2111040	1641970.20	3.50
50 % RDF + 10 gm/m^2 Humic acid +100 ppm (BA)	473799.80	1091520	2183040	1709240.20	3.61
50 % RDF + 10 gm/m^2 Humic acid +150 ppm (BA)	475279.80	1127520	2255040	1779760.20	3.74
25 % RDF + 15 gm/m^2 Humic acid + (Control)	443139.90	875520	1751040	1307900.10	2.95
25 % RDF + 15 gm/m^2 Humic acid +50 ppm (BA)	447929.90	947520	1895040	1447110.10	3.23
25 % RDF + 15 gm/m^2 Humic acid +100 ppm (BA)	452659.90	1007280	2014560	1561900.10	3.45
25 % RDF + 15 gm/m^2 Humic acid +150 ppm (BA)	454139.90	1019520	2039040	1584900.10	3.49

activation, and ethylene biosynthesis while protecting cell wall integrity and antioxidant capacity. Extended vase life with BA application may also be due to thylakoid stabilization and delayed petal wilting, preserving turgor and colour retention (Starman *et al*., 2019; Paull, 2001). These benefits result from HA's biostimulant properties amplifying NPK efficacy through enhanced nutrient availability (Nikbakht *et al*., 2008; Akshitha *et al*., 2022). Improvements in flower quality and vase life result from HA's role in increasing antioxidant defences (SOD, CAT) and delaying senescence by mimicking auxins to maintain cell turgor, lignin deposition and ethylene suppression. NPK supplies increased with K-mediated stomatal regulation and N for protein stability, extending gypsophila vase life via preserved membrane integrity (Akshitha *et al*., 2022; El-Naggar and Imhmd, 2023). This integration optimizes resource use, reducing NPK by 25% to 50%, ideal for sustainable floriculture. Reduction in ethylene synthesis occurs due to application of humic acid which may be the cause of longer vase life. Related postharvest responses have been reported in cut dahlias (Bergmann et al., 2019).

3.2 Effect of Fertilization and 6-benzyl Aminopurine Application on Yield Parameters

The number of flower bunches per plant was not significantly affected by fertilization treatments (Table 1). However, BA application exerted a significant influence, with 100 ppm BA producing the maximum number of flower bunches per plant (43.88), which was statistically comparable with 150 ppm BA. A significant interaction effect was observed, with treatment F_3B_4 recording the highest number of flower bunches per plant (46.47), remaining statistically comparable with F_1B_3, F_1B_4, F_2B_2, F_2B_3, F_2B_4, F_3B_1, F_3B_3, F_4B_1, F_4B_3 and F_4B_4.

The number of cut flower stems per plant was significantly influenced by both fertilization and BA application (Table 1). Among the fertilization treatments, the highest number of cut flower stems per plant (18.95) was recorded with 75% RDF + 5 g m^{-2} humic acid. Among the BA treatments, 100 ppm BA produced the maximum number of cut flower stems per plant (18.66), which was significantly superior to the other treatments. The interaction effect was also significant, with the highest number of cut flower stems per plant (20.49) recorded under F_2B_3, which was statistically comparable with F_1B_2, F_1B_3, F_1B_4, F_2B_4 and F_3B_4.

The enhancement in flower bunches and cut flower stem production following BA application may be attributed to its cytokinin-mediated stimulation of axillary bud outgrowth, increased meristematic activity and enhanced floral differentiation. Benzyl adenine promotes cytokinin signalling through AHK receptors, leading to the upregulation of IPT and Flowering Locus T (FT) genes, thereby favouring floral meristem development over vegetative growth (Janowska 2004; Xie *et al.,* 2025). The superior response observed at 100 ppm BA suggests that this concentration was adequate to maximise cytokinin activity, while a further increase to 150 ppm did not produce a significant additional response. Similar findings were reported by Nambiar *et al.,* (2012), who observed that foliar application of BA (200–300 ppm) in Dendrobium hybrids accelerated floral bud differentiation and significantly increased the number of inflorescences. The present results corroborate these findings, indicating that BA effectively enhances reproductive growth by promoting the development of flowering shoots, thereby increasing the production of marketable cut flower stems.

3.3 Effect of Fertilization and 6-benzyl Aminopurine Application on Benefit: Cost Ratio

While evaluating the cost of production for different treatments it was observed that the treatment combination of 75 % RDF + 5 gm/m^2 Humic acid +100 ppm (BA) revealed the highest benefit–cost ratio, i.e., 4.96 (Table 2). The same treatment combination also recorded the highest gross income (Rs. 2950560/- ha) and net income (Rs. 2455620.30/-ha).

4. Conclusion

The investigation demonstrated that fertiliser management combined with foliar application of benzyl adenine influenced flowering behaviour, cut-flower characteristics, yield and economic returns of statice (Limonium sinuatum L.) under the experimental conditions. Among the fertiliser regimes, the application of 75% recommended dose of fertilisers (RDF) supplemented with humic acid at 5 g m^{-2} resulted in earlier flower spike emergence, first flowering and flower stem harvesting. This treatment also recorded favourable responses in inflorescence length, flower longevity, vase life and cut-flower stem production. Foliar application of benzyl adenine at 100 ppm produced favourable responses in several flowering and postharvest characteristics, although the optimum concentration varied among individual parameters. The combined treatment comprising 75% RDF, 5 g m^{-2} humic acid and 100 ppm benzyl adenine recorded the highest gross income of ₹29,50,560 ha^{-1}, net income of ₹24,55,620.30 ha^{-1} and benefit–cost ratio of 4.96. These findings suggest that the identified treatment combination may provide an economically beneficial fertiliser and growth-regulator management option for statice cultivation under comparable agroclimatic conditions. Further evaluation would help establish the consistency of these responses across different growing conditions.

5. Limitations

The investigation was conducted at a single experimental location under Jammu agroclimatic conditions during 2024–2025. Consequently, the observed treatment responses may vary under different environmental conditions, soil characteristics and cultivation practices. The experiment evaluated one statice cultivar and specified combinations of fertiliser levels, humic acid and benzyl adenine concentrations. Therefore, the findings may not represent the responses of other cultivars or treatment combinations. The economic outcomes were calculated using the cultivation costs and flower prices considered in the study and may vary with changes in input costs and market conditions.

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Declaration of AI Use

The author hereby declares that no generative AI technologies, such as large language models (ChatGPT, COPILOT, etc.), and text-to-image generators have been used during the writing or editing of this manuscript.

Competing Interests

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper. All authors contributed equally in the preparation of the manuscript.

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