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EFFECT OF DIFFERENT LEVELS OF NITROGEN AND POTASSIUM UNDER VARIOUS SPACINGS ON GROWTH AND QUALITY OF ANNUAL CHRYSANTHEMUM

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ABSTRACT

The present investigation entitled “Effect of different levels of nitrogen and potassium under various spacings on growth and quality of annual chrysanthemum” was carried out during the *Rabi* season of 2024–2025 at the Post Graduate Institute for Horticultural Sciences, Sri Konda Laxman Telangana Horticultural University, Mulugu, Siddipet, with the objective of evaluating the effects of varying nitrogen and potassium levels and plant spacing on vegetative growth and flower quality in annual chrysanthemum. Among the nitrogen and potassium treatments, the highest level (L_4 : 70 g N + 70 g K) resulted in superior growth parameters, achieving plant height of 45.38 cm; plant spread (north–south) of 39.57 cm; plant spread (east–west) of 31.66 cm; branches per plant of 36.64 and stem diameter of 0.90 cm. Among spacing treatments, the widest spacing (S_3 : 60 × 60 cm) resulted in maximum plant spread (N–S: 36.01 cm; E–W: 28.86 cm), number of branches (32.51) and stem diameter (0.83/ cm), while the closest spacing (S_1 : 45 × 45 cm) produced the greatest plant height (42.19/ cm). In terms of treatment combinations, T_8 (L_3S_2 : 50 g N + 50 g K with 45 × 60 cm spacing) exhibited superior vegetative growth with maximum plant spread (N–S: 40.13 cm; E–W: 32.60 cm), number of branches (40.81), and stem diameter (0.91 cm), whereas T_{10} (L_4S_1 : 70 g N + 70 g K with 45 × 60 cm spacing) recorded the tallest plant height (47.07 cm). Flower quality parameters were also influenced significantly; L_4 (70 g N + 70 g K) produced the largest flower diameter (5.67 cm) and longest flower longevity (6.94 days), S_3 (60 × 60 cm) resulted in maximum flower diameter (5.25 cm) and longevity (5.78 days) and among treatment combinations, T_8 (L_3S_2) achieved the greatest flower longevity (7.10 days), indicating that 50 g N + 50 g K per plant combined with 45 × 60 cm spacing optimizes both vegetative growth and flower quality in annual chrysanthemum under *Rabi* season conditions.

Key words : Chrysanthemum, Nitrogen levels, Potassium levels, Plant spacing, Growth parameters, Flower quality, Yield, *Rabi* season.

Introduction

The Annual Chrysanthemum (*Glebionis coronaria* L.) is a fragrant, herbaceous annual plant native to the Mediterranean and parts of Europe, known for its ornamental appeal, it features bright yellow and white blossoms and is increasingly cultivated in India for loose flower production and garland making. It also grows in

regions of East Asia and some parts of North America. This branching plant typically reaches a height of 61 to 90 cm and has finely divided leaves. It flowers, either single or double, come in shades of yellow, cream and white, often with a cream-white center, and measures about 2.5 to 3.8 cm in diameter (Vishnu, 1967). It is a rapid-growing annual that blooms in winter (Nagdeve *et al.*, 2021). In India, the garland Chrysanthemum is

recognized by different regional names: it is called “Bijli” in Nagpur (Meshram *et al.*, 2008), “Baboona” in Haryana (Mishra *et al.*, 2002), “Guldhak” in Punjab, “Market” in Delhi and “Gendi” in Uttar Pradesh (Arora, 1990).

Studies indicate that the growth and quality of *Chrysanthemum morifolium* are greatly influenced by nitrogen, phosphorus, potassium, and organic fertilizers. Nitrogen is vital for biomass production and enzyme synthesis in leaves (Liu *et al.*, 2010), with consistent uptake from planting to flowering, then decreasing (Yoon *et al.*, 2000). While phosphorus needs are lower than nitrogen (Li *et al.*, 2009), potassium is required in high amounts and enhances growth (Vanek *et al.*, 2012). Fertilizer is the primary nitrogen source for plant growth (Konnerup and Brix, 2010). A combination of high nitrogen with suitable phosphorus and potassium boosts early vegetative growth (Denisen, 1982). As a heavy feeder, chrysanthemum requires ample N, P, and K from the beginning for optimal development.

Among various crop management practices, planting density is crucial for regulating growth and quality in Annual Chrysanthemums. It affects plant development and flower attributes by altering the microclimate (Shagufta, 2023). This study focuses on evaluating the impact of different planting densities on growth and quality parameters to determine the optimal spacing for superior flower production.

Materials and Methods

The experimental site is located at the Post Graduate Institute for Horticultural Sciences, Sri Konda Laxman Telangana Horticultural University, Mulugu, Siddipet. The experimental site falls under a semi-arid tropical climate with an average rainfall of 615.6 mm, located at an altitude of 543.3 m above mean sea level on 78.62° East longitude and 17.72° North latitude. The experiment was laid out in Factorial Randomized Block Design with two factors in which the first factor consists of five levels of nitrogen and potassium viz., L_1 - 0 levels of Nitrogen and Potassium, L_2 - 30 g of nitrogen and 30 g of potassium, L_3 - 50 g of nitrogen and 50 g of potassium, L_4 - 70 g of nitrogen and 70 g of potassium, L_5 - 90 g of nitrogen and 90 g of potassium and the second factor consisting of three spacings viz., S_1 - 45 × 45 cm, S_2 - 45 × 60 cm, S_3 - 60 × 60 cm with three replications. The number of treatment combinations- 15, number of plots – 45, number of plants per plot varies with spacing, S_1 - 25 plants, S_2 - 20 plants, S_3 - 16 plants. 75% of nitrogen and potassium are applied as basal dose and remaining 25% is applied 30 days after applying the first dose. Phosphorous (40 g) is applied completely as basal dose. The above doses are applied

per 4 m² (plot size 2 m × 2 m) area. Local variety annual chrysanthemum seeds were sown in portrays, after 30 days, healthy seedlings were transplanted into the main field. From each treatment and replication, five plants were randomly selected for recording observations. Data collected included plant height, plant spread (E-W and N-S), number of branches, stem diameter, flower diameter, flower longevity. The data, averaged over three replications, were analyzed using ANOVA (Panse and Sukhatme, 1985) and statistical significance was assessed using SEm and CD at the 5% level.

Results and Discussion

Growth parameters

Plant height (cm)

All treatments of levels of nitrogen and potassium had significant influence on plant height. The highest plant height (45.38 cm) was observed in L_4 (70 g of nitrogen and 70 g of potassium), on par with L_3 (50 g of nitrogen and 50 g of potassium) at 45.18 cm and the lowest (34.71 cm) was recorded in L_1 (0 levels of nitrogen and potassium). Likewise, spacing treatments also indicated significant impact on plant height. The tallest plants were recorded in the S_1 treatment (45 × 45 cm) with a height of 42.19 cm, on par with S_2 (45 × 45 cm) at 41.40 cm. The shortest plants were observed in S_3 (60 × 60 cm), with a height of 38.57 cm. Significant interaction effect was observed between different levels of nitrogen, potassium and spacing methods in plant height. The tallest plants were observed in the L_4S_1 treatment (70 g of nitrogen and 70 g of potassium with 45 × 45 cm spacing, reaching 47.07 cm on par with L_3S_2 treatment combination (50 g of nitrogen and 50 g of potassium with 45 × 60 cm spacing) at 46.13 cm. The shortest (30.67 cm) plant height was recorded in L_1S_3 (0 levels of nitrogen and potassium with 60 × 60 cm spacing) treatment combination.

Plant spread N-S (cm)

Significant differences were observed in plant spread along the north-south (N-S) axis depending on the levels of nitrogen and potassium. The greatest plant spread (39.57 cm) was observed in treatment of 70 g of nitrogen and 70 g of potassium (L_4), on par with 50 g of nitrogen and 50 g of potassium (L_3) at 39.43 cm, while the smallest spread (24.41 cm) occurred with 0 levels of nitrogen and potassium (L_1). The results showed that plant spacing had a significant impact on plant spread (N-S). The greatest plant spread was recorded in the S_3 treatment (60 × 60 cm) with a spread of 36.01 cm, on par with S_2 (45 × 60 cm) at 34.19 cm. The shortest spread was

Table 1 : Effect of different levels of nitrogen and potassium under various spacings on plant height (cm) and plant spread (N-S) (cm) in annual chrysanthemum.

Levels of N & K	Plant height (cm)				Plant spread (N-S) (cm)			
	Spacings (S)				Spacings (S)			
	S ₁	S ₂	S ₃	Mean(L)	S ₁	S ₂	S ₃	Mean(L)
L ₁	32.57	35.2	26.67	31.48 ^C	23.33	23.63	26.27	24.41 ^D
L ₂	37.5	36.93	36.73	37.06 ^B	34.33	36.53	39.67	36.85 ^B
L ₃	40.73	42.13	40.67	41.18 ^A	38.27	40.13	39.9	39.43 ^A
L ₄	43.07	41.87	39.2	41.38 ^A	39.17	39.73	39.83	39.57 ^A
L ₅	39.87	30.87	29.6	33.44 ^{BC}	27.2	30.93	34.4	30.84 ^C
Mean (S)	38.75 ^a	37.40 ^a	34.57 ^b		32.46 ^c	34.19 ^b	36.01 ^a	
Factors	SE(m) ±		CD @ 5%	CV%	SE(m) ±	CD @ 5%		CV%
L	0.95		2.75	6.97	0.54	1.56		4.70
S	0.73		2.13		0.42	1.21		
L x S	1.64		4.77		0.93	2.71		

Levels of N & K (L)L₁–0 levels of nitrogen and potassiumL₂–30 g of nitrogen and 30 g of potassiumL₃– 50 g of nitrogen and 50 g of potassiumL₄– 70 g of nitrogen and 70 g of potassiumL₅– 90 g of nitrogen and 90 g of potassium**Spacings (S)**S₁– 45 x 45 cmS₂– 45 x 60 cmS₃– 60 x 60 cm

observed in S₁ (45 x 45 cm), with a spread of 32.46 cm. The interaction between different levels of nitrogen, potassium and spacing methods resulted in notable differences in plant spread (N-S). The highest spread was observed in the L₃S₂ treatment combination (50 g of nitrogen and 50 g of potassium with 45 x 60 cm spacing), reaching 40.13 cm on par with L₃S₃ treatment (70 g of nitrogen and 70 g of potassium with 60 x 60 cm spacing) at 39.9 cm. The shortest plant spread was recorded in L₁S₁ (0 levels of nitrogen and potassium with 45 x 45 cm spacing) at 23.33 cm.

Plant spread (E-W) (cm)

There was a significant difference in plant spread along the east-west (E-W) axis depending on the levels of nitrogen and potassium. The greatest plant spread (31.66 cm) was observed in treatment of 70 g of nitrogen and 70 g of potassium (L₄), on par with 50 g of nitrogen and 50 g of potassium (L₃) at 31.53 cm, while the smallest spread (18.64 cm) occurred with 0 levels of nitrogen and potassium (L₁). The results indicated that plant spacing had a significant impact on plant spread (E-W). The greatest plant spread was recorded in the S₃ treatment (60 x 60 cm) with a spread of 28.86 cm, on par with S₂ (45 x 60 cm) at 32.75 cm. The shortest spread was observed in S₁ (45 x 45 cm), with a spread of 26.49 cm. The interaction between different levels of nitrogen,

potassium and spacing methods resulted in notable differences in plant spread (E-W). The highest spread was observed in the L₃S₂ treatment (50 g of nitrogen and 50 g of potassium with 45 x 60 cm spacing), reaching 32.6 cm on par with L₄S₃ treatment (70 g of nitrogen and 70 g of potassium with 60 x 60 cm spacing) at 32.1 cm. The shortest plant spread was recorded in L₁S₁ (0 levels of nitrogen and potassium with 45 x 45 cm spacing) at 14.87 cm.

Number of branches per plant

There was a significant difference in number of branches per plant depending on the levels of nitrogen and potassium. The highest number of branches (36.64) was observed in treatment of 70 g of nitrogen and 70 g of potassium (L₄), on par with 50 g of nitrogen and 50 g of potassium (L₃) at 36.03, while the lowest number of branches is (18.28) occurred with 0 levels of nitrogen and potassium (L₁). The results indicated that plant spacing had a significant impact on number of branches. The highest number of branches was recorded in the S₃ treatment (60 x 60 cm) with 32.51 branches, on par with S₂ (45 x 60 cm) with 29.61 branches. The shortest number of branches was observed in S₁ (45 x 45 cm), with 23.21 branches. The interaction between different levels of nitrogen, potassium and spacing methods resulted in notable differences in number of branches per plant. The

Table 2 : Effect of different levels of nitrogen and potassium under various spacings on plant spread (E-W) (cm) and number of branches in annual chrysanthemum.

Levels of N & K	Plant spread (E-W) (cm)				Number of branches			
	Spacings (S)				Spacings (S)			
	S ₁	S ₂	S ₃	Mean(L)	S ₁	S ₂	S ₃	Mean(L)
L ₁	14.87	18.33	22.67	18.62 ^D	13.20	16.32	25.32	18.28 ^C
L ₂	27.93	28.53	29.3	28.59 ^C	14.88	30.12	30.12	25.04 ^B
L ₃	30.3	32.6	31.7	31.53 ^B	30.36	40.81	36.93	36.03 ^A
L ₄	31.4	31.47	32.1	31.66 ^A	33.24	36.20	40.49	36.64 ^A
L ₅	27.93	28.33	28.53	28.27 ^C	24.36	24.60	29.67	26.21 ^B
Mean (S)	26.49 ^b	27.85 ^{ab}	28.86 ^a		23.21 ^c	29.61 ^b	32.51 ^a	
Factors	SE(m) ±		CD @ 5%	CV%	SE(m) ±	CD @ 5%		CV%
L	0.50		1.47	5.47	0.42	1.24		4.48
S	0.39		1.14		0.33	0.96		
L x S	0.87		2.55		0.74	2.14		

Levels of N & K (L)L₁–0 levels of nitrogen and potassiumL₂–30 g of nitrogen and 30 g of potassiumL₃– 50 g of nitrogen and 50 g of potassiumL₄– 70 g of nitrogen and 70 g of potassiumL₅– 90 g of nitrogen and 90 g of potassium**Spacings (S)**S₁– 45 x 45 cmS₂– 45 x 60 cmS₃– 60 x 60 cm

highest number of branches was observed in the L₃S₂ treatment (50 g of nitrogen and 50 g of potassium with 45 x 60 cm spacing), reaching 40.81 branches on par with L₄S₃ treatment (70 g of nitrogen and 70 g of potassium with 60 x 60 cm spacing) with 40.49 branches. The shortest number of branches was recorded in L₁S₁ (0 levels of nitrogen and potassium with 45 x 45 cm spacing) at 13.20 branches

Stem diameter (cm)

There was a notable deviation in stem diameter depending on the levels of nitrogen and potassium. The highest stem diameter (0.90 cm) was observed in treatment of 70 g of nitrogen and 70 g of potassium (L₄), on par with 50 g of nitrogen and 50 g of potassium (L₃) at 0.87 cm, while the smallest spread (0.69 cm) occurred with 0 levels of nitrogen and potassium (L₁). The present investigation revealed that plant spacing had a significant impact on stem diameter. The maximum stem diameter was recorded in the S₃ treatment (60 x 60 cm) with a stem diameter of 0.83 cm, on par with S₂ (45 x 60 cm) at 0.80 cm. The minimum stem diameter was observed in S₁ (45 x 45 cm), with a diameter of 0.71 cm. The interaction between different levels of nitrogen, potassium and spacing methods resulted in notable differences in stem diameter. The highest stem diameter was observed in the L₃S₂ treatment (50 g of nitrogen and 50 g of

potassium with 45 x 60 cm spacing), reaching 0.91 cm on par with L₄S₂ treatment combination (70 g of nitrogen and 70 g of potassium with 45 x 60 cm spacing) and L₄S₃ (70 g of nitrogen and 70 g of potassium with 60 x 60 cm spacing) treatments at 0.9 cm. The shortest stem diameter was recorded in L₅S₁ (90 g of nitrogen and 90 g of potassium with 45 x 45 cm spacing) at 0.55 cm.

Moderate increments of nitrogen and potassium up to optimal levels L₄ (70 g of nitrogen and 70 g of potassium) markedly enhance key growth parameters in chrysanthemum, including plant height, canopy spread, branch number, and stem diameter, owing to their vital roles in plant metabolism and development. Conversely, excessive application (L₅ - 90 g of nitrogen and 90 g of potassium) adversely affects growth by causing nutrient imbalances that impair the uptake of other essential nutrients, resulting in hidden deficiencies and plant stress. Regarding spacing, closer planting at S₁ (45 × 45 cm) encourages increased plant height through shade avoidance mechanisms, while wider spacing at S₃ (60 × 60 cm) fosters greater plant spread, branch development, and stem thickness by reducing competition and improving resource availability.

The combination of 50 g nitrogen and 50 g potassium with 45 × 60 cm spacing provides an optimal balance of nutrient supply and plant density, supporting vigorous

Table 3 : Effect of different levels of nitrogen and potassium under various spacings on stem diameter (cm) and flower diameter (cm) in annual chrysanthemum.

Levels of N & K	Stem diameter				Flower diameter			
	Spacings (S)				Spacings (S)			
	S ₁	S ₂	S ₃	Mean (L)	S ₁	S ₂	S ₃	Mean (L)
L ₁	0.56	0.75	0.76	0.69 ^B	2.63	3.46	4.88	3.67 ^C
L ₂	0.74	0.76	0.77	0.75 ^B	4.73	5.20	5.26	5.07 ^{AB}
L ₃	0.84	0.91	0.87	0.87 ^A	5.26	6.23	5.26	5.59 ^A
L ₄	0.89	0.9	0.9	0.90 ^A	5.66	5.66	5.69	5.67 ^A
L ₅	0.55	0.71	0.84	0.70 ^B	3.83	4.13	5.13	4.37 ^{BC}
Mean (S)	0.71 ^b	0.80 ^a	0.83 ^a		4.42 ^b	4.94 ^{ab}	5.25 ^a	
Factors	SE(m) ±		CD @ 5%	CV%	SE(m) ±	CD @ 5%		CV%
L	0.02		0.07	9.88	0.29	0.85		18.08
S	0.02		0.06		0.22	0.66		
L x S	0.04		0.13		0.5	NS		

growth while minimizing nutrient excess and competition. This arrangement enhances resource use efficiency, promoting healthy development with reduced nutrient deficiencies and stress. In contrast, 70 g each of nitrogen and potassium at closer 45 × 45 cm spacing increases plant height due to intensified shade avoidance and higher nutrient availability that stimulate stem elongation. However, moderate fertilization with wider spacing favors greater plant spread, branching and stem thickness by reducing competition and enabling balanced lateral growth. These results highlight the need to integrate nutrient management and spacing to optimize chrysanthemum growth.

Similar results were found by Singh *et al.* (2017), Joshi *et al.* (2006), Mahananda *et al.* (2015), Rolaniya *et al.* (2015), Rajan *et al.* (2019), Vimal *et al.* (2022), Dali *et al.* (2019), Meena (2017).

Quality parameters

Flower diameter (cm)

Significant differences were observed in flower diameter depending on the levels of nitrogen and potassium. The maximum flower diameter (5.67 cm) was observed in treatment of L₄ (70 g of nitrogen and 70 g of potassium) on par with L₃ (50 g of nitrogen and 50 g of potassium) at 5.59 cm on par with L₂ (30 g of nitrogen and 30 g of potassium) with 5.07 cm, while the minimum flower diameter (3.67 cm) occurred with 0 levels of nitrogen and potassium (L₁). All the plant spacing treatments had a significant impact on flower diameter. The highest flower diameter (5.25 cm) was recorded in the S₃ treatment (60 x 60 cm), on par with S₂ (45 x 60

cm) with 4.94 cm. The smallest flower diameter was observed in S₁ (45 x 45 cm), with 4.42 cm. All treatment combinations of different levels of nitrogen, potassium and spacing methods resulted in notable differences in flower diameter. The highest flower diameter was observed in the L₃S₂ treatment combination (50 g of nitrogen and 50 g of potassium with 45 x 60 cm spacing), with 6.23 cm, on par to L₄S₃ treatment (70 g of nitrogen and potassium with 60 x 60 cm spacing) with 5.69 cm. The smallest flower diameter was recorded in L₁S₁ (0 levels of nitrogen and potassium with 45 x 45 cm spacing) with 2.63 cm.

Flower longevity

There was a significant difference in flower longevity depending on the levels of nitrogen and potassium. The maximum days of flower longevity (6.94 days) was observed in treatment of L₄ (70 g of nitrogen and 70 g of potassium) on par with L₃ (50 g of nitrogen and 50 g of potassium) at 6.59 days, while the minimum days of flower longevity (4.69 days) occurred with L₁ (0 levels of nitrogen and potassium). The results indicated that plant spacing had a significant impact on flower longevity. The highest flower longevity (5.25 cm) was recorded in the S₃ treatment (60 x 60 cm) with 5.78 days, on par to S₂ (45 x 60 cm) at 5.77 days. The smallest flower longevity was observed in S₁ (45 x 45 cm), with 5.35 days. The interaction between different levels of nitrogen, potassium and spacing methods resulted in notable differences in flower longevity. The maximum days of flower longevity was observed in the L₃S₂ treatment combination (50 g of nitrogen and 50 g of potassium with 45 x 60 cm spacing),

Table 4 : Effect of different levels of nitrogen and potassium under various spacings on flower longevity in annual chrysanthemum.

Levels of N & K	Flower longevity on plant (days)			
	Spacings (S)			
	S ₁	S ₂	S ₃	Mean(L)
L ₁	4.6	4.86	4.6	4.69 ^C
L ₂	5.53	5.56	5.46	5.52 ^B
L ₃	5.66	7.06	7.03	6.59 ^A
L ₄	6.9	6.93	7.00	6.94 ^A
L ₅	4.06	4.4	4.8	4.42 ^C
Mean (S)	5.35 ^b	5.77 ^a	5.78 ^a	
Factors	SE(m) ±	CD@5%	CV%	
L	0.10	0.31	5.66	
S	0.08	0.24		
L×S	0.18	0.53		

with 7.10 days, on par with L₃S₃ treatment combination (50 g of nitrogen and 50 g of potassium with 60 x 60 cm spacing) at 7.03 days. The minimum days of flower longevity was recorded in L₅S₁ treatment combination (90 g of nitrogen and 90 g of potassium with 45 x 45 cm spacing) with 4.07 days.

Applying 70 g each of nitrogen and potassium (L₄) significantly increases flower diameter by enhancing photosynthesis, branch and leaf growth, and leaf longevity, leading to larger blooms and longer flower life. Wider spacing (60 × 60 cm) further boosts flower size and longevity by reducing competition and improving air circulation and resource availability. In contrast, a lower dose of 30 g N and K with 45 × 60 cm spacing also improves flower growth but less effectively, resulting in smaller flowers and shorter longevity compared to higher nutrient levels.

Similar findings done by Raviteja (2016), Fayaz *et al.* (2016), Nehra and Singh (2019), Nain *et al.* (2017), Singh *et al.* (2018).

Conclusion

Growth parameters viz., plant height (45.38 cm), plant spread (N-S) (39.57 cm), plant spread (E-W) (31.66 cm) no. of branches per plant (36.64), stem diameter (0.90 cm) was observed maximum in treatment of 70g of nitrogen and 70g of potassium (L₄). Growth parameters viz., plant spread (N-S) (36.01 cm), plant spread (E-W) (28.86 cm), no. of branches per plant (32.51), stem diameter (0.83 cm) was observed maximum in the S₃ treatment (60 x 60 cm). Plant height (39.87 cm) was

observed maximum in S₁ (45 x 45 cm). Growth parameters viz., plant height (47.07 cm) was recorded maximum in L₄S₁ (70g of nitrogen and 70g of potassium with 45x 45 cm), plant spread (N-S) (40.13 cm), plant spread (E-W) (32.6 cm) no. of branches per plant (32.50), stem diameter (0.9 cm) was observed maximum in treatment of L₃S₂ treatment (50g of nitrogen and 50g of potassium with 45 x 60 cm). Quality parameters viz., flower diameter (5.67 cm), flower longevity (6.94) was observed maximum L₄ (70g of nitrogen and 70g of potassium. Quality parameters viz., flower diameter (5.25 cm), flower longevity (5.78) was observed maximum S₃ treatment (60 x 60 cm). Quality parameters viz., flower diameter (6.23 cm), flower longevity (7.10) was observed maximum in the L₃S₂ treatment combination (50g of nitrogen and 50g of potassium with 45 x 60 cm spacing).

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