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Efficacy of Foliar Application of Micronutrients and BA Concentrations on Flowering and Vase Life of Zinnia Plant (Zinnia elegans)

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Abstract

This study was carried out in the lath house of the Horticulture Department Nursery, College of Agriculture Engineering Sciences, Duhok University. Kurdistan region, Iraq, for the period from 5th 2024 to study the effect of different levels of Zn (0, 0.50 and 0.75) and different concentration of BA (0. 50, and 100) mgl^{-1} on some flowering and vase life of two cultivars of Zinnia plant. The results were as follows: The best results (fewest days) for the number of days from planting to bud emergence, and anthesis were obtained on Zinnia Lavanda (54.957 and 85.185) respectively. Also, these treatments were significantly superior in the other characteristics like flower stem length (cm), flower stem diameter (cm) and vase life (days) for Zinnia Lavanda cultivar reached (3.815 cm 8.169 cm 10.710 day) respectively. While the flower dry weight 1.429g and vase life 11.009 day was significantly increased when plant spraying with 0.75 % Zn compared with other treatments. The responses of the Zinnia plants to micro elements under study, significantly increased number of flowers per plant 4.389, flower stem diameter 0.437 cm, flower fresh weight 9.510 g and vase life 11.148 for the Zinnia Lavanda when spraying with 0.75% Zn compared to the control. While the maximum result about the flower stem length 87.310 cm, flower diameter 8.319 cm and flower dry weight 1.674 g for Zinnia rosso scarlatta when spraying with 0.75% Zn. Also, the best result of Zinnia Lavanda for number of flowers per plant, flower stem diameter, flower fresh weight and vase life (4.333, 0.405 cm, 10.462 g and 11.111 days) was obtained when the plant sprays with BA at (100 and 50) mgl^{-1} respectively compared with control and Zinnia rosso scarlatta. Maximum fresh flower weight (13.030 g) was recorded for plants grown in BA at 50 mgl-1+ 0.50% Zn treatment for the Zinnia Lavanda cultivar follow by 12.217g fresh flower weight for the same cultivar when spraying only 100 mgl-1 BA. Maximum dry flower weight (2.317 g) was recorded for Zinnia rosso scarlatta cultivar in control treatment. Maximum vase life (12.333 days) was recorded for Zinnia Lavanda cultivar in 0.75% Zn combined with 50 mgl-1 BA treatment.

Key words: Zinnia cultivar, Micronutrients, BA concentration and Foliar Application.

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INTRODUCTION

Zinnia elegans, a member of the Asteraceae family, is native to Mexico. The leaves have fewer stems and are opposite. The flowers may have a single row of petals, or they can be colored red, lilac, and purple and take the shape of a dome. Most of the plants are grown from seeds. Zinnia is used as a cut flower, bedding, or pot plant. Its long longevity, extensive marketing as a cut flower, and availability in a variety of forms and colors are all factors contributing to its commercial importance (**Dole, 1999**). The zinnia is a natural flower of the Americas that originated in Mexico and Central America. Zinnias grow well in Pakistan as summer flowers, with blooming appearing from May to October. The timely sowing of seeds, the healthful development and growth of plants, and the blooming traits of different cultivars are all essential for the reliable production of high-quality flowers (**Dorgham, 2019**).

Zinnias are summer flowers that bloom from May to October. A plant's ability to continuously produce high-quality flowers is dependent on several factors, including timely seed sowing, plant development and growth, and the way certain growth inhibitors impact a plant's ability to produce flowers. Chemicals used to treat plants may be applied on the foliage, which might stunt their development. It also depends on the type of species and cultivar (**Pobudkiewicz, 2008**). BA belongs to the group of cytokinin and is an aromatic compound that stimulates plants to produce lateral branching providing a bushy appearance to the plant. Due to its antagonistic effect to auxin BA counter the epical dominance while reducing height of plant (**Pobudkiewicz, 2008**). Applying BA directly may cause stimulation of growth and cell division in dormant buds while improving the plant (**Taiz and Zeiger, 2010**). Research analysis showed that zinnia plants treated with 100mg.L^{-1} and pinched at 6 leaves stage recorded maximum days to flowering, flower persistency and flowers $plant^{-1}$ and stem thickness. While in case of untreated and un-pinched plants maximum flower diameter, fresh and dry flower weight, and height of plant were reported. Hence, it is concluded from the research study that BA application 100 mg. L^{-1}reduced height of plant, enhanced number of flowers per plant and lateral branching in zinnia plants. Moreover, the plants pinched at the stage of 6 leaves performed well in height reduction and flower quality enhancement. **El-Nashar and Hassan (2020).**

Flowers are the vibrant element in decorative flowering plants, and they look awesome where we live (**Tariq et al., 2012**). Growers are not successful in producing the best quality production due to the reason of very insufficient knowledge and technical skills regarding proper concentrations of different micronutrients. For the successful production of excellent cut rose flowers (**Khoshgoftarmanesh *et al.*, 2008**). When nutrient shortage cannot be corrected through soil application then foliar nutrition is an alternate method to correct those problems (**Halder *et al.*, 2007; Sarkar *et al.*, 2007; Cakmak, 2008**). Application of fertilizers through foliar spray may be helpful in these conditions to keep away from the soil fixation of some micronutrients (**El-Naggar, 2009**). Micronutrients such as Fe, Mn, B, Cu and Zn are necessary in much lesser amount and essential for plant intensification than those of the primary nutrients (**Brady and Ray, 2000**). Zinc is essential for internode elongation and hormone production in plants. These are essential because of their immense connotation and involvement to enzyme system in metabolism (**Massoud *et al.*, 2005**).

Foliar application of micronutrients may be six to 20 times more efficient than soil application in increasing crop production and other growth parameters (**Leiw, 1988**). Due to the important value of zinnia in world global cut flower, a field experiment was envisaged to evaluate the impact of foliar application of micronutrients regarding growth, flower production and early blossoming of zinnia plant. **Kashyap and Tikey, (2022)** applied of micronutrient $ZnSO_4$ (0.4 mgl^{-1}) with foliar spray was initiate to be most successful for superior performance of different parameters such as days taken to 50% sprouting, days to open first flower, flower diameter, vase life, and number of flowers. Zinc are important micronutrients needed for better flower production. Role of Zinc is well established in the formation of auxin and RNA. It regulates the metabolic process and enhances plant growth (**Sarwar *et al.*, 2012**) and flower production. Zinc is an important micronutrient which is necessary for sugar regulation and various enzymatic activities related to plant growth (**Khosa *et al.*, 2011**). Flower diameter and flower quality increased with an increasing fertilization level and began to turn down when fertilization level exceed beyond the above given levels of macro and micronutrients. It took 85.55 days in Zn (5000±200mg/100ml) treatment as compared to control reached 105.55 and in case of micronutrients it took 81.88 days in flower emergence as compared to control gave 100.88 (**Khosa *et al.*, 2011**)

MATERIALS AND METHOD

The study was carried out in the lath house of the Department of Horticulture, College of Agriculture Engineering Sciences, University of Duhok, Kurdistan region, Iraq, for the period from April 20st, 2024. The different materials, which include BA (0, 50 and 100 mgl^{-1}) with $ZnSO_4$ (0, 0.50 and 0.75) % used alone and their interaction on two cultivars of zinnia plant (Lavanda and rosso scarlatta). So, the experiment includes (3×3×2×3×4= 216) plant. The seeds of Zinnia were imported (*Zinnia elegans*) cultivars, from the Pagano Costantino company in Italy. through Kurdistan offices, which is one of the agricultural offices in Duhok, and the seeds were planted in peatmoss at the first time after germination the seedling transferred to a growing medium containing (river soil and peatmoss at 2:1 v/v) in 24 cm pots. The pots were placed in a lath house with an average day/night temperature of 25 C°/18 C°. The plants at four-leaf stage were sprayed individually with different concentrations of this BA and Zn which are used foliar application by sprays on plant on three times and 15 days between the spray. **Flowering characters**: Number of days from planting to flower bud emergence, Number of days from planting to anthesis, Number of flower $plant^{-1}$, Flower diameter (cm), Flower stem length (cm), Flower stem diameter (cm), Flower fresh weight (g), Flower dry weight (g) and Vase life (days).

STATISTICAL ANALYSIS

The experiment was carried out using a completely randomized design. Each treatment comprised three replicates and four plants for each replication. Collected data were subjected to analysis of variance (ANOVA) and the mean values were assessed by Duncan Test at $P \leq 0.05$ using program (**SAS**).

RESULTS

Effect of cultivars

Our results showed that the difference between two cultivars (Zinnia Lavanda and Zinnia rosso scarlatta) significantly affected the plant growth parameters (Table 1). The best results (fewest days) for the number of days from planting to bud emergence, and anthesis were obtained on Zinnia Lavanda (54.957 and 85.185) respectively. Also, the number of flowers 3.815, flower stem diameter 0.390 cm, flower fresh weight 8.169 g and vase life 10.710 day for the Zinnia Lavanda cultivar. While Zinnia rosso scarlatta cultivar the highest flower stem length 85.789 cm, flower diameter 7.978 cm and flower dry weight 1.541 g.

Table (1): Effect of foliar application of Zn and BA on different characteristic of two cultivars of zinnia plants

Cultivar	day number from planting to flowers Bud emergence	day number from between planting to anthesis	Number of flowers per plant	flower stem length (cm)	flower diameter (cm)	flower stem diameter (cm)	flower fresh weight (g)	flower dry weight (g)	vase life
Zinnia Lavandav	54.957[a]	85.185[a]	3.815[a]	82.548[a]	6.985[b]	0.390[a]	8.169[a]	1.331[a]	10.710[a]
Zinnia rosso scarlatta	57.148[a]	87.960[a]	3.746[a]	85.789[a]	7.978[a]	0.387[a]	6.709[a]	1.541[a]	9.836[b]

Effect of BA concentration on different characteristics of two cultivars of zinnia plants

Table 2 indicated that Zinnia cultivars flowering significantly delayed with BA sprayingat different concentrations. The highest values (fewest days) for the number of days from planting to bud emergence, and anthesis were obtained on Zinnia Lavanda (50.537 and 82.574) days when the plant spraying with BA at 100 mgl^{-1} respectively compared with control and Zinnia rosso scarlatta cultivar. Also, the best result of Zinnia Lavanda for number of flowers per plant, flower stem diameter, flower fresh weight and vase life (4.333, 0.405 cm, 10.462 g and 11.111 days) was obtained when the plant sprays with BA at (100 and 50) mgl^{-1} respectively compared with control and Zinnia rosso scarlatta. While the highest value for flower stem length, flower dry weight and flower diameter reached (89.347 cm, 2.027 cm and 8.104 g) obtained when the Zinnia rosso scarlatta sprays with BA at (50 and 100) mgl^{-1} respectively compared with control.

Table (2): Effect of foliar application of BA concentration on different characteristic of two cultivars of zinnia plants

Cultivar	BA mgl^{-1}	day number from planting to flowers Bud emergence	day number from between planting to anthesis	Number of flowers per plant	flower stem length (cm)	flower diameter (cm)	flower stem diameter (cm)	flower fresh weight (g)	flower dry weight (g)	vase life
Zinnia Lavanda	0	61.426[a]	88.852[ab]	3.519[bc]	80.789[ab]	6.394[b]	0.362[a]	6.117[b]	1.284[b]	10.130[abc]
	50	52.907[cd]	84.130[ab]	3.593[bc]	87.020[ab]	7.243[ab]	0.403[a]	10.462[a]	1.448[b]	11.111[a]
	100	50.537[d]	82.574[b]	4.333[ab]	79.836[b]	7.319[ab]	0.405 [a]	7.929[ab]	1.261[b]	10.889[ab]
Zinnia rosso scarlatta	0	59.926[ab]	91.815[a]	3.037[c]	81.896[ab]	7.941[a]	0.386[a]	7.349[ab]	1.206[b]	10.667[ab]
	50	54.704[c]	87.481[ab]	3.648[bc]	89.347[a]	7.891[a]	0.399[a]	7.406[ab]	2.027[a]	9.611[bc]
	100	56.815[bc]	84.583[ab]	4.407[a]	86.124[ab]	8.104a	0.375[a]	5.374[b]	1.391[b]	9.231[c]

Effect of Zinc level on different characteristics of two cultivars of zinnia plants

The data in Table (3) indicated that significant effect had been obtained as a result of micro elements spraying. The highest values (fewest days) for the number of days from planting to bud emergence, and anthesis were obtained on Zinnia Lavanda (51.074 and 82.324) days respectively compared with control. The responses of the Zinnia plants to micro elements under study, significantly increased number of flowers per plant 4.389, flower stem diameter 0.437 cm, flower fresh weight 9.510 g and vase life 11.148 for the Zinnia Lavanda when spraying with 0.75% Zn compared to the control. While the maximum result about the flower stem length 87.310 cm, flower diameter 8.319 cm and flower dry weight 1.674 g for Zinnia rosso scarlatta when spraying with 0.75% Zn.

Table (3): Effect of foliar application of Zn % on different characteristic of two cultivars of zinnia plants

Cultivar	Zn%	day number from planting to flowers Bud emergence	day number from between planting to anthesis	Number of flowers per plant	flower stem length (cm)	flower diameter (cm)	flower stem diameter (cm)	flower fresh weight (g)	flower dry weight (g)	vase life
Zinnia Lavanda	**0.00**	58.500[b]	85.981[ab]	3.222[b]	84.090[a]	7.180[ab]	0.325[b]	6.917[a]	1.401[a]	10.444[ab]
	0.50	53.167[cd]	84.074[b]	3.833[ab]	83.135[a]	6.993[ab]	0.407[a]	8.081[a]	1.349[a]	10.537[ab]
	0.75	53.204[cd]	85.500[ab]	4.389[a]	80.420[a]	6.783[b]	0.437[a]	9.510[a]	1.243[a]	11.148[a]
Zinnia rosso scarlatta	**0.00**	63.944[a]	93.111[a]	3.056[b]	84.157[a]	7.681[ab]	0.397[ab]	6.317[a]	1.614[a]	9.000[c]
	0.50	51.074[d]	82.324[b]	3.796[ab]	85.900[a]	7.935[ab]	0.366[ab]	6.671[a]	1.335[a]	9.639[bc]
	0.75	56.426[bc]	88.444[ab]	4.352[a]	87.310[a]	8.319[a]	0.397[ab]	7.141[a]	1.674[a]	10.870[ab]

Effect of BA concentration and Zn% on different characteristics of two cultivars of zinnia plants

Concerning the combination of the three factors BA concentration and Zn% on different characteristics of two cultivars of zinnia plants it was demonstrated that the Zinnia rosso scarlatta cultivar under spraying in 50 mgl^{-1}BA and 0.50 % Zn, which recorded 46.833 follow by Zinnia Lavanda and rosso scarlatta cultivar grown under spraying 100mgl^{-1}BA combine with 0.50 % Zn, which recorded 47.333 and 47.611 days, respectively, had fewer days to flower bud emergence. Also, the fewer day number from planting to anthesis for Zinnia rosso scarlatta cultivar under spraying in 50 mgl^{-1}BA and 0.75 % Zn, was recorded 72.167 days. Maximum flowers plant^{-1} 5.333 were obtained at 100 mg L^{-1}BA combined with Zn 0.75% for Zinnia Lavanda. Maximum flower stem length 93.367cm was obtained at 50 mg L^{-1}BA combined with Zn 0.50 % for the Zinnia rosso scarlatta cultivars. The flower diameter in plants without sprayed BA and Zn was the highest 9.322 cm, which was statistically similar with the flower diameter of plants treated with 0.75% Zn combined with 50 mg L^{-1}BA 8.722 cm flower diameter both of this length for Zinnia rosso scarlatta cultivar. The flower stem diameter in plants sprayed with 0.75% Zn was the highest length reached 0.518cm, which was statistically similar with the flower stem diameter of plants treated with 0.75% Zn combined with 50 mg L^{-1}BA 0.455 cm flower stem diameter both of this length for Zinnia Lavanda cultivar. Maximum fresh flower weight (13.030 g) was recorded for plants grown in BA at 50 mgl^{-1}+ 0.50% Zn treatment for the Zinnia Lavanda cultivar follow by 12.217g fresh flower weight for the same cultivar when spraying only 100 mgl^{-1} BA. Maximum dry flower weight (2.317 g) was recorded for Zinnia rosso scarlatta cultivar in control treatment, follow by the Zinnia Lavanda cultivar 1.947 g dry flower weight when spraying only 0.75% Zn. Maximum vase life (12.333 days) was recorded for Zinnia Lavanda cultivar in 0.75% Zn combined with 50 mgl^{-1} BA treatment.

Table (4): Effect of foliar application of BA concentrations and Zn% on different characteristic of two cultivars of zinnia plants

Cultivar		Zn%	day number from planting to flowers Bud emergence	day number from between planting to anthesis	Number of flowers per plant	flower stem length (cm)	flower diameter (cm)	flower stem diameter (cm)	flower fresh weight (g)	flower dry weight (g)	vase life
Zinnia Lavanda	0	0.00	63.167^{abc}	86.333^{a-d}	2.889^{cd}	83.200^{abc}	6.556^{bc}	0.321^{b}	4.767^{d}	1.310^{abc}	9.722^{a-d}
		0.50	60.222^{abc}	84.222^{a-d}	3.778^{a-d}	84.794^{abc}	7.406^{abc}	0.339^{b}	11.547^{abc}	1.592^{abc}	11.222^{abc}
		0.75	52.111^{d-g}	87.389^{a-d}	3.000^{bcd}	84.276^{abc}	7.578^{abc}	0.314^{b}	12.217^{ab}	1.302^{abc}	10.389^{a-d}
	50	0.00	57.833^{cde}	89.722^{abc}	3.667^{a-d}	85.388^{abc}	7.406^{abc}	0.376^{b}	8.077^{a-d}	1.490^{abc}	9.778^{a-d}
		0.50	49.500^{fg}	77.000^{bcd}	3.167^{bcd}	86.701^{abc}	7.100^{abc}	0.414^{ab}	6.810^{bcd}	1.268^{abc}	9.778^{a-d}
		0.75	52.167^{d-g}	85.500^{a-d}	4.667^{ab}	77.317^{abc}	6.472^{bc}	0.432^{ab}	5.863^{bcd}	1.288^{abc}	12.056^{ab}
	100	0.00	63.278^{abc}	90.500^{abc}	4.000^{a-d}	73.778^{c}	7.767^{ab}	0.518^{a}	5.507^{cd}	1.053^{bc}	10.889^{abc}
		0.50	49.000^{g}	91.167^{ab}	3.833^{a-d}	89.565^{abc}	7.450^{abc}	0.455^{ab}	13.030^{a}	1.483^{abc}	12.333^{a}
		0.75	47.333^{g}	74.833^{cd}	5.333^{a}	77.917^{abc}	5.133^{c}	0.339^{b}	5.707^{cd}	1.192^{bc}	10.222^{a-d}
Zinnia rosso scarlatta	0	0.00	59.000^{bcd}	96.333^{a}	2.556^{d}	80.500^{abc}	9.322^{a}	0.390^{ab}	5.850^{cd}	2.317^{a}	10.444^{a-d}
		0.50	66.833^{a}	88.333^{ab}	2.944^{cd}	91.178^{ab}	8.567^{ab}	0.393^{ab}	5.503^{cd}	1.367^{abc}	7.889^{d}
		0.75	66.000^{ab}	94.667^{a}	3.667^{a-d}	80.794^{abc}	7.067^{abc}	0.407^{ab}	7.598^{a-d}	1.340^{abc}	8.667^{cd}
	50	0.00	58.778^{bcd}	90.111^{abc}	2.722^{cd}	75.811^{bc}	6.728^{bc}	0.385^{ab}	8.298^{a-d}	1.817^{abc}	9.778^{a-d}
		0.50	46.833^{g}	81.111^{a-d}	3.667^{a-d}	93.367^{a}	8.078^{ab}	0.371^{b}	7.147^{a-d}	1.303^{abc}	9.722^{a-d}
		0.75	47.611^{g}	72.167^{d}	4.667^{ab}	91.500^{ab}	8.722^{ab}	0.342^{b}	4.693^{d}	0.885^{c}	9.417^{bcd}
	100	0.00	62.000^{abc}	89.000^{abc}	3.833^{a-d}	89.378^{abc}	7.772^{ab}	0.382^{ab}	7.898^{a-d}	1.947^{ab}	11.778^{ab}
		0.50	50.444^{efg}	93.000^{ab}	4.333^{abc}	83.496^{abc}	7.028^{abc}	0.433^{ab}	9.567^{a-d}	1.503^{abc}	11.222^{abc}
		0.75	56.833^{cdef}	83.333^{a-d}	4.889^{a}	89.056^{abc}	8.244^{ab}	0.377^{b}	3.957^{d}	1.393^{abc}	9.611^{bcd}

DISCUSSION

Days to first flower harvest Regardless, with the application of different PGR reduce the days to flower harvest (**Ahmad *et al.*, 2013**). Results showed that vase life of flower was increased by the application of different plant growth regulators at same concentration. By the application of cytokinin (1%) longer the vase life of flower in gladiolus (**Pawar et al., 2018**). Flower stem length was significantly enhanced by foliar BA and zinc. Number of flowers and flower stem length increased with increasing BA and zinc levels which activated enzymes and increased vegetative growth and number of branches so therefore more flower stem length was produced with increasing levels of zinc and BA. These results are similar with **Jat *et al*., (2012)** and **Khalifa *et al*., (2011)** who reported that zinc was significantly increased flower stem length.

Its might be due to zinc application increases number of flowers and flower size with increasing zinc rates which activated enzymes and increases vegetative growth and number of branches so therefore more number of flowers and flower size were produced with increasing levels of zinc these results are similar with **Jat *et al*., (2012)** who report that zinc was significantly increases number of flowers. Also, flower vase life was significantly enhanced by foliar zinc this may be due to zinc rates which activated enzymes and increases flower shelf life and reproductive growth so therefore more flower shelf life was produced more with zinc these results are similar with **Jat *et al*., (2012)** who reported that zinc and boron was significantly increases flower shelf life.

The number of flowers is directly related to the number of lateral branches. BA suppresses apical dominance and ultimately enhances the number of lateral shoots that consequently increases the number of flowers

(Ahmad *et al.*, 2007). Cytokinin can affect number of flowers depending upon the concentration used **(Pobudkiewicz, 2008). Hopkins and Huner (2009),** reported that cytokinin are the derivatives of nitrogen-based adenine that are noted for stimulating cell division in tissue culture. BA is one of the aromatic cytokinin that stimulate cell division in lateral buds, which encourage flower buds to sprout. **Abd El-Aal and Mohamed (2017),** reported that Geranium plants when treated with paclobutrazol gave maximum number of flowers as compared to untreated. Foliar application of BA significantly increased number of flowers in every cluster of *Jatropha curcas* as compared to control **(Bang and Xu, 2011)**

Sharaf-Eldien *et al.*, (2017) found a decrease in flower diameter of *Zinnia elegans* after BA treatment because BA increased the number of branches then increased the number of flowers. The present study is in line with the findings of **Srivastava *et al.*, (2002),** who noticed smaller flowers in marigold plants that were left treated and smaller size flowers were also recorded in plants pinched at 20 days after transplanting of carnation **(Dalal *et al.*, 2006).** In case of BA, the current results are in contrast with the findings of **Nishijima *et al.*, (2006)** who investigated that diameter of Petunia flowers were enhanced after the application of cytokinin. While the results are in line with the findings of **Saadawy and AbdelMoniem (2015),** who reported that BA applied at high concentrations resulted in small flowers of *Euphorbia milii*. **Pobudkiewicz (2005)** also observed a decrease in flower size with BA application on carnation 'Snowmass'. **Wu and Chang (2011)** further investigated smaller flowers of Phalaenopsis orchid after the application of higher concentrations of BA, which may be due to nutrient competition for subsequent flower development after improving the flower number
Applying BA to the flowers resulted in a decrease in their fresh weight, which peaked at the highest BA dose. The current results are consistent with those of the study for **Gibson and Whiper (2003)** and **Hojjati et al., (2009),** who observed that when BA was applied to plants, their growth was reduced. They found that plants with more branches produced greater flowers with smaller sizes and lower fresh weights.

Conclusions

The best flowering of zinnia plant was observed in this study when Zn was used for (0, 0.5 and 0.75) % and BA at (0, 50 and 100) mgl^{-1} for the zinnia cultivars like (**Lavanda and rosso scarlatta**), and the result showed a significant increase in most characteristics when compared to other treatments. zinnia production: the best flowering and quality of the cut flowers under spraying 0.50 % Zn and 50 and 100 mgl^{-1} BA

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