

Table 4 Comparison of the differences in vase life of fresh cut zinnias between harvest one and harvest two

Dependent variable	df	Mean Square	F Value	P Value
Minimum days	1	14.40	3.283	0.078
Maximum days	1	1.225	0.142	0.709
Average days	1	1.806	0.379	0.542

4 Discussion

Overall, it was found that the use of flower food extended the vase life of *zinnia elegans* regardless of if the stems were trimmed or not. Trimming the stems of zinnias that were placed in the floral preservative solution was found to extend the vase life the longest. Past studies have found that floral food prolongs the vase life of various fresh cut flowers (Asrar, 2012; Nguyen and Lim, 2021; Zeng et al., 2023). Findings from this study indicated there were significant differences between zinnias that were trimmed and placed into tap water in the first harvest when compared to all other treatment groups within the first harvest, however this was not consistent with findings from the second harvest or when the flowers from both harvests were looked at collectively. Though it was not found to be significantly different, when the zinnias were looked at collectively, overall, the zinnias that were placed in tap water and had their stems cut had the shortest vase life when compared to all other groups. These findings support past research completed by (Kalinowski et al., 2022) which stated that leaving the stems in tap water untrimmed will slightly lengthen the vase life of *Zinnia elegans*. This would indicate that should floral food not be available for use, then the proper recommendation for *Zinnia elegans* is to leave the stems untrimmed in tap water. The shortened vase life that was observed when cutting stems placed in tap water could be a result of a wound-induced xylem occlusion, which occurs in some flowers species due to a stress response when their stems are cut (Manzoor et al., 2024).

No significant differences were found in the vase life of the zinnia between the two separate harvests. Previous research has found that earlier harvests of zinnias had longer vase lives than those bloom that were harvested later in the growing season (Kalinowski et al., 2022). Only two harvests taken two weeks apart were used in this study. Results investigating vase life between harvests from this study could have potentially changed if additional harvests of zinnia been investigated or more time had passed between harvests. Additional harvests over an extended time period should be investigated in similar future research studies.

Retail florists, specialty cut flower farmers, educators, and home gardeners can all benefit from this research. Proper post-harvest techniques are critical to implement immediately upon cutting the blooms from the mother plant. From a cut flower farmer perspective, it is important to properly hydrate the stems and know how to care for the zinnias before sending them out to buyers, markets, or selling them. Farmers may also benefit from sharing the proper care techniques with the buyers to ensure longevity of vase life in the retail setting. Home gardeners and consumers of fresh cut zinnias could potentially benefit the most from this knowledge, as flower preservatives for fresh cut flowers are not commonly purchased by the general population. Publishing updated tips on keeping zinnias looking fresh for the longest amount of time that are written for and accessible to the general public should be considered. Extension services that offer classes on cut flower cultivation and floral design is another way to share the proper post-harvest protocol for zinnia when handling them in the absence of floral preservatives with the public.

5 Conclusions

Findings from this study indicated that the use of floral preservatives in combination with trimming the ends of the stems significantly increases the vase life of *zinnia*. Additionally, differences were observed in the vase life of zinnias placed in tap water based on whether their stems were trimmed or not, with trimmed stems exhibiting the shortest overall vase life compared to all other treatment groups. These findings suggest that, in situations where floral preservative solutions are unavailable, the recommended postharvest handling practice for *Zinnia elegans* may be to leave stems untrimmed to maximize vase life. Results may not apply to other flower species, as *Zinnia elegans* may respond differently to treatments than other cut flowers. Also, the study focused only on postharvest