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Response of China aster (*Callistephus chinensis* L.) to foliar nutrition in relation to flowering

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Abstract
The investigation on effect of foliar nutrition on China aster was conducted at College of Horticulture, under Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli Dist. Ratnagiri, Maharashtra. The experiment was laid out in randomized block design with three replications and nine treatments *viz*, T_1 - 0:52:34 - 1%, T_2 - 0:52:34 - 2%, T_3 - Ca $(NO_3)_2$ -1%, T_4 - Ca $(NO_3)_2$ -2%, T_5 - 0:52:34 + Ca $(NO_3)_2$ - 1%, T_6 - 0:52:34 + Ca $(NO_3)_2$ - 2%, T_7 - 19:19:19 - 1%, T_8 - 19:19:19 - 2% and T_9 - Control. It was observed that the significantly minimum days to first flower bud emergence (75.87), days to opening of flower from bud emergence (9.29 days), days to 50% flowering (88.62 days), was recorded in treatment T_6 [0:52:34 + Ca $(NO_3)_2$ – 2%].

Keywords: China aster, flowering, flower bud emergence, days to 50% flowering foliar nutrition

Introduction
China aster (*Callistephus chinensis* L.) is a member of Asteraceae family, native of Northern China (Navalinskien *et al*., 2005) [4]. It is one of the most important commercial annual flower crops grown in most parts of the world. Among annual flowers, it ranks third next to chrysanthemum and marigold. China Aster being well adapted to diversified soil and climatic condition, it is now days successfully grown in various agro-climatic zones of India.

The economic yield is largely affected when plants don't gate proper nutrition. Plant nutrition has a pronounced effect on the vegetative growth and yield of flowers. Plants absorb nutrients through the roots and through the foliage. Many plant nutrients are needed in such great quantities that it is impractical to supply them through the foliage. However, when soil conditions are unfavourable, when micronutrients are needed, or when spraying for insects and disease, it may be desirable to make foliar applications of the plant nutrients.

When plant nutrients are applied to the foliage of the plant, smaller quantities of the fertilizer material are required than when applying to the soil. The danger of fixation or leaching is also reduced when nutrients are applied to the foliage of the plant. Nutrients applied to the foliage are generally absorbed more rapidly than when applied to the soil. Foliar application provides a means of quickly correcting plant nutrient deficiencies, when identified on the plant. It often provides a convenient method of applying fertilizer materials, especially those required in very small amounts and the highly soluble materials.

As China aster is a flower crop, it is necessary to boost up its production potential and among several horticultural foliar nutrition is one of the approaches. Apart from this, regulation of flowering is an important practice. With this view, the present investigation was undertaken to assess the effect of foliar nutrition on flowering induction and flowering span in China aster.

Materials and Methods
The present investigation was conducted in the *rabi-summer* of 2022–2023, at Nursery No. 4, College of Horticulture, under Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli Dist. Ratnagiri, Maharashtra. The experiment was laid out in randomized block design with three replications and nine treatments *viz*, T_1 - 0:52:34 - 1%, T_2 - 0:52:34 - 2%, T_3 - Ca $(NO_3)_2$ -1%, T_4 - Ca $(NO_3)_2$ -2%, T_5 - 0:52:34 + Ca $(NO_3)_2$ - 1%, T_6 - 0:52:34 + Ca $(NO_3)_2$ - 2%, T_7 - 19:19:19 - 1%, T_8 - 19:19:19 - 2% and T_9 - Control. The planting of seedlings of China aster was done at spacing of 30 cm X 30 cm. The recommended intercultural operations were followed for crop management.

The water-soluble fertilizers were first applied at 30 days after transplanting as per treatment with the help of knapsack sprayer and the whole plant was sprayed completely with the different fertilizer during morning time and two more sprays of same treatments were given at 30 days interval. The observations on flower bud initiation, days required for initiation of flowering, days to 50% flowering, duration of flowering and number of picking were recorded. The data were statistically analysed by adopting the methods suggested by Panse and Sukhatme (1995) [5].

Results and Discussion

The induction of flowering and flowering duration of the flower crop especially in China aster is governed by several factors. The application of foliar nutrients promotes the growth of the crop which eventually manipulates the flowering.

The data on days required for flower bud initiation after transplanting was presented in Table 1 revealed that the significantly least days to initiation of flowering bud (75.87 days) was recorded in treatment T_6 [0:52:34 + Ca $(NO_3)_2$ - 2%]. It was at par with treatments T_4 and T_1. The delayed flower bud initiation (80.16 DAT) was observed in treatment T_8 (19:19:19 - 2%) which was at par with control (T_9) while rest of the treatments were at par among themselves.

In the present investigation, it is observed that the phosphorus and potassium available in the form of 0:52:34 together with Ca $(NO_3)_2$ led to restrained growth in China aster and encouraged the plant to early flower.

The data on days required for initiation of flowering after transplanting was presented in Table 2 perused that the foliar nutrition treatments showed the significant effect on period to flower initiation. The significantly least days for initiation of flower from bud stage (9.29 days) was taken in the treatment T_6 (0:52:34 + Ca $(NO_3)_{2\ -}$ 2%) which is significantly superior over rest of the treatments. It was followed by T_4, T_1, T_7 and T_2 treatments (99.76, 10.12 and 10.67 and 10.82 days, respectively). In control treatment (T_8), the flower initiation was observed at 12.17 days after bud initiation. The extended period of flower initiation (12.59 days after bud stage) was recorded in treatment T_8 (19:19:19 - 2%).

The similar trend was observed as in bud initiation. The monopotassium phosphate application in combination with other nutrient Calcium Nitrate T_6 (0:52:34 + Ca $(NO_3)_2$ - 2%) produced beneficial effects on flowering attributes of China aster flower i.e. on days to initiation of bud. The overall performance of application of Monopotassium phosphate + Calcium Nitrate together @ 2% was found superior and it was closely followed with the sole application of T_4, T_1 and T_7.

Mono potassium phosphate (MKP), KH_2PO_4 in combination was found to be very effective as a P and K source for China aster. Both phosphorus and potassium play crucial roles in plant metabolism. Utilizing an ideal concentration of mono potassium phosphate (MKP) has the potential to enhance the efficient absorption of phosphorus (P) and potassium (K) nutrients, thereby improving essential physiological processes crucial for the growth and development of flowers. This suggests that fertilizing with the optimal MKP concentration can lead to increased growth, flower production, and uptake of nutrients. (Ma *et al*., 2021) [2]. Potassium is vital because it helps the body uptake magnesium, which is essential for the development of flowers. Increased flowering intensity by MKP might be due to the presence of K in it, that stimulates photosynthesis and transports photo assimilates, which is important for the formation of flowers (Swietlik, 2003) [7]. Positive role of K in floret development. The role of K in the greatly improved biometric characteristics. These results are comparable with the findings of Mohammed and Abood (2020) [3] in gerbera, Seyedi *et al*. (2013) [6], Watane *et al*. (2022) [8].

The data regarding days required for 50% flowering in China aster crop is presented in Table 2 and from the data, it is cleared that the significantly minimum number of days required for 50% flowering (88.62 days after transplanting) were taken in T_6 (0:52:34 + Ca $(NO_3)_{2\ -}$ 2%) and was at par with the treatment T_4 (89.11 days) and T_1 (89.54 days) treatments. The maximum days for 50% flowering (92.15 days after transplanting) was recorded in treatment T_8 (19:19:19 - 2%) and it was on par with T_9 and T_2 treatments. Early 50% flowering was found in the plants treated with 0:52:34 + Ca $(NO_3)_2$ - 2% treatment as compared to control and other treatments. This might be due to role of P and K and Ca in confining the vegetative growth and to tempt to plants in reproductive phase.

The data on flowering duration as influenced by the foliar nutrition treatments are presented in the Table 2. The significantly longest flowering duration 26.42 days was observed in the treatment T_6 (0:52:34 + Ca $(NO_3)_2$ - 2%) which was statistically at par with the treatment T_4 (Ca $(NO_3)_2$ - 2%) having period of flowering duration (26.11 days). The shortest flowering duration (22.64 days) was observed in the treatment T_8 (19:19:19 - 2%) whereas in control flowering duration in control (T_7) was 23.47 days.

Advanced bud formation and onset of flowering in 0:52:34 + Ca $(NO_3)_2$ - 2% treated plants were attributed to enhanced flowering duration. The prolong duration of flowering in most of the foliar nutrition treatments might be attributed to supportive nutrition through foliar feeding which lead to enhance life span of the crop.

The data presented in Table 2 shows that the sprays of various foliar nutrients had significant effect on number of pickings. It was in the range of 3.00 to 4.66 pickings. The maximum pickings (4.66) were followed in T_6 (0:52:34 + Ca $(NO_3)_2$ – 2%) treatment which was closely followed by T_4 and T_1 (4.33 and 4.00 pickings, respectively). The least number of pickings (3.00) were done in T_8 (19:19:19 – 2%) and it was on par with T_9 (Control), T_3 and T_2 treatments.

Calcium is an immobile element in plant and therefore application of calcium is more prominent for enhanced productivity. The most effective method of applying calcium is through foliar application, especially when targeted at buds and flowers, where plants can readily absorb and utilize it. Calcium nitrate, known for its high solubility, is a popular choice for immediate and direct foliar supply of both nitrate and calcium. The reinforcement of the flower stalk or pedicel is one of the benefits of calcium, contributing to increased strength.

The initial application of nitrate salts through foliar spraying during the early stages of plant reproductive growth induces various physiological changes. These changes have the potential to impact growth parameters, ultimately resulting in enhanced crop yield. The foliar application of nitrate salts can facilitate the transportation of sucrose through the plant roots, attracting soil microbes. This microbial activity, in turn, fosters improved nutrient uptake by the roots. These results are in close agreement with and findings of Raj and Mallick

(2017) [9] in yellow sarson.

The spray of calcium was found most effective in prolonging the longevity i.e. duration. The increase in calcium concentration increases the days of senescence. Similar findings were also reported by Arjenaki *et al*. (2012) [1] in hybrid rose. The results of the present investigation are in accordance with the findings of Watane *et al*. (2022) [8].

Apart from the Calcium nitrate, Phosphorus and potassium have also role in flowering phenomena. The foliar feeding with P and K might be helpful for accumulation of the food material in plant. It can also be attributed to key roles of P in photosynthesis, transfer of energy and nutrients. Hence, crop response occurs in short time in foliar application compared to soil application.

Table 1: Influence of foliar nutrition on days to initiation of bud, days to initiation of flower in China aster.

Tr. No.	Treatment details	Days to initiation of bud*	Days to initiation of flower**
T_1	0:52:34 - 1%	76.79	10.12
T_2	0:52:34 - 2%	77.96	10.82
T_3	Ca $(NO_3)_2$ -1%	78.67	11.65
T_4	Ca $(NO_3)_2$ - 2%	76.11	9.76
T_5	0:52:34 + Ca $(NO_3)_2$ - 1%	78.34	11.24
T_6	0:52:34 + Ca $(NO_3)_2$ - 2%	75.87	9.29
T_7	19:19:19 - 1%	77.22	10.67
T_8	19:19:19 - 2%	80.16	12.59
T_9	Control	79.05	12.17
S.Em±		0.58	0.13
C. D. at 5%		1.73	0.40

* Days after transplanting

** Days after bud initiation

Table 2: Influence of foliar nutrition on days to 50% flowering, flowering duration and number of picking in flower in China aster.

Tr. No	Treatment details	Days to 50% flowering	Flowering duration (Days)	No. of picking
T_1	0:52:34 – 1%	89.54	25.61	4.00
T_2	0:52:34 – 2%	90.51	24.71	3.33
T_3	Ca $(NO_3)_2$ - 1%	91.39	23.97	3.22
T_4	Ca $(NO_3)_2$ - 2%	89.11	26.11	4.33
T_5	0:52:34 + Ca $(NO_3)_2$ - 1%	91.14	24.82	3.33
T_6	0:52:34 + Ca $(NO_3)_2$ - 2%	88.62	26.42	4.66
T_7	19:19:19 – 1%	90.21	25.48	3.88
T_8	19:19:19 – 2%	92.15	22.64	3.00
T_9	Control	91.73	23.47	3.11
S.Em±		0.41	0.16	0.296
C. D. at 5%		1.22	0.48	0.886

Conclusion

From the present investigation, it is inferred that three sprays of 0:52:34 + Ca $(NO_3)_2$ – 2% treatment exhibited early flowering, long duration of flowering and more number of picking in China aster.

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