



## RESEARCH ARTICLE

# INFLUENCE OF FOLIAR APPLICATION OF ZINC AND BORON ON FLOWERING AND FRUITING OF MANDARIN (*CITRUS RETICULATA BLANCO*) AT MYAGDI, NEPAL

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## ABSTRACT

A study was conducted during the spring season of 2022 to find out the effect of foliar application of micronutrients (Zinc and Boron) in flowering and fruit setting of mandarin (*Citrus reticulata blanco*) in Myagdi, Nepal. The experiment was laid out in a factor-randomized complete block design (RCBD) with five treatments and four replications. The treatments consist of foliar application of sole and combined application of Zinc and Boron namely: control (water spray), 0.2% Zn, 0.1% B, 0.15% Zn + 0.05% B, and 0.1% Zn + 0.1% B. Twenty mandarin trees of the same age and height from an orchard were chosen from the north-facing slope. The spray solution was formulated using standard procedures. The foliar application of the micronutrients was done twice, the first application was done days before flowering, and the second application was done after 2 days of full flowering. The data analysis was done using MS Excel and R-stat. Treatments had significant variations in total flowers and hermaphrodite flowers per branch, fruit diameter, fruit set, and fruit drop. Thus, our study showed that foliar spray of Zinc 0.1% + Boron 0.1% was the best for the production of more hermaphrodite flowers, for a higher fruit set percentage, and for a higher fruit retention percentage in Mandarin.

## KEYWORDS

Zinc, Boron, Flowering, Mandarin

## 1. INTRODUCTION

Citrus has an important rank among the fruit trees worldwide due to its economical, nutritional, medical, and esthetic as well as ecological importance. Citrus fruits are grown in more than 140 countries around the world. Citrus, particularly the mandarin orange is the most important and highly commercial fruit crop in the mid-hills of Nepal. In Nepal, the climatic condition of mid-hills having an altitude of 800 to 1400 m from east to west of the country is considered favorable for all types of citrus fruit cultivation. According to (Kaini, 2013), mandarin (*Citrus reticulata*), sweet orange especially junar (*Citrus sinensis*), lime (*Citrus aurantifolia*), lemon (*Citrus lemon*), hill lemon (*Citrus pseudolemon*) possesses commercial potential in Nepal. The total area, production area, production, and productivity of Mandarin Orange are 6591.18 ha, 4550.32 ha, 156179.68 mt, and 10.73 MT/ha respectively (Ministry of Agriculture and Livestock Development, 2077; 2078). The total area, production area, production, and productivity of mandarin in the Myagdi district are 463 ha, 203ha, and 9.28 MT/ha respectively (Ministry of Agriculture and Livestock Development, 2077; 2078). A variety of biotic (rootstock, cultivar, insect pest, and disease management) and abiotic (climate, soil, nutrition, and irrigation management) factors influence the productivity of Citrus trees (Davies and Albrigo, 1994). However, the availability of sufficient micronutrients is the most important factor in producing high-quality fruits (Babu and Yadav, 2005). Research by Razzaq et al. (2013) demonstrated that the application of zinc sulfate via foliar spraying led to significant improvements in various aspects of citrus tree health and fruit quality. This included increased tree height, crown width, stem girth, fruit diameter, fruit weight, ascorbic acid content, and total phenolic compounds. Additionally, zinc sulfate application effectively controlled pre-harvest fruit drop and boosted the overall yield of fruit per tree at harvest. Another study by Khan et al. (2015) found that combining zinc

(Zn) and boron (B) applications during the fruit setting stage enhanced nutrient uptake, reduced fruit drop, and increased the yield of 'Kinnow' mandarins with improved fruit quality. Zinc plays a crucial role in plant physiology. It aids in auxin content regulation, acts as a catalyst in oxidation-reduction processes, and participates in enzymatic reactions, such as carbohydrate transformation and cellulose formation (Bhalerao et al., 2014). Furthermore, zinc supplementation, whether through foliar or soil application, enhances chlorophyll and carotenoid biosynthesis, improving photosynthesis, and preventing interveinal chlorosis (Zhao et al., 2012). However, care must be taken not to exceed recommended zinc concentrations to avoid potential toxicity (Fu et al., 2016). Boron is a vital micronutrient essential for the growth and development of numerous crops, influencing critical physiological processes throughout the plant's life cycle (Hansch and Mendel, 2009). It plays pivotal roles in cell division, respiration, nucleic acid, and protein metabolism, as well as the synthesis of important compounds like indole-3-acetic acid (IAA) and phenolics. Additionally, boron is crucial for sugar translocation, cell wall growth, and maintaining cell membrane integrity (Bhalerao et al., 2014). The application of foliar boron has proven effective in reducing fruit drop, enhancing carbohydrate translocation, improving pollen viability, and aiding in fertilization (Ahmad et al., 2012). Combining boron with zinc through foliar spraying has demonstrated significant benefits, such as increased fruit size and elevated vitamin C content in sweet oranges (M. Tariq et al., 2007). For optimal results, different crops require specific timing of boron application. Pre-bloom foliar sprays are preferable for pome fruits, while other fruits benefit from both pre-bloom and post-bloom applications. Boron's phloem mobility means that a single application at flowering suffices for some crops like apples, whereas immobile crops like mango necessitate both pre-bloom and post-bloom sprays. Noticeable changes in development, flowering, fruit set, yield, and quality of Citrus species have been observed after applying these nutrients

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through foliar spray (Babu & Yadav, 2005). The absorption of the nutritional elements by leaves is usually more rapid and efficient than the absorption by roots especially when the soil conditions are not suitable for absorbing the elements such as PH, the presence of calcium carbonate, and the loss during the washing. Some of the foliar application advantages are the increase in the plant utilization of the sprayed nutritional elements, less fertilizers consumption, soil problems and rapid treatment of the nutritional element deficiency, especially the micro ones, and the easiness of applying it on the vegetative. Since plant nutrients are easily absorbed through the leaf surface, foliar application of nutrients often results in a faster response than soil application (Obreza, Boman, Zekri, and Futch)

## 2. RESEARCH DESIGN AND METHODOLOGY

### 2.1 Experimental Site

The research was conducted in Raghuganga-3 of Myagdi, Nepal. The site is at an altitude of 1300 meters above sea level.

### 2.2 Experimental Material

For conducting this study, 8-year-old trees of the same height from the northern-facing orchard were selected. The orchard was maintained at a 6\*6 plant-plant distance. The soil of the orchard was clayey loam.

### 2.3 Experimental Design and Treatment Details

The experiment was laid out in Randomized Complete Block Design (RCBD) with 5 treatments and each treatment was replicated 4 times. Altogether 20 plants were involved and each tree was considered for one treatment. There were five treatments constituting of spray of Zinc and Boron at various concentrations and their combinations which were as follows; T1: Control, T2:0.2% Zn, T3:0.1% B, T4:0.15% Zn + 0.05% B, T5:0.1% Zn+ 0.1% B

### 2.4 Source and Preparation Of Micronutrients

Excellent double chelate double action Zinc was used as a source of Zinc which contained 10% Zinc while Agri-borax, which contained 10.5% Boron, was used as the source of Boron.

Zinc in liquid form as double chelate double-action containing 10% Zinc and Boron in the form of borax containing 10.5% Boron will be used for the spray. 0.2% zinc spray was prepared by dissolving 20 ml of double chelate double-action Zinc solution in one liter of water, while 0.1% boron solution was prepared by dissolving 9.52 grams of borax on 1 liter of water. Treatments were prepared by using an insole or in combination through the mixing of separately prepared zinc and boron sprays. In the case of control, ordinary tap water was sprayed.

### 2.5 Method and Time of Application

The foliar spray was done in such a way that every leaf of the trees was

damped with the required solutions until runoff. Spraying was done with the help of 2 in 1 motorized sprayer. Foliar application of micronutrients was done twice. The first application was before flowering on the 12<sup>th</sup> of Falgun in the morning and the second spray was done on the 30<sup>th</sup> of Chaitra, 2 days after full flowering.

### 2.6 Parameters Recorded

A total of five branches were tagged and the total number of flowers was manually counted by using the ladder. The average total number of flowers per branch will be calculated. The total number of hermaphrodite flowers on the tagged branches will be counted manually and the average number of hermaphrodite flowers per branch will be calculated.

Fruit diameter was calculated by using a digital vernier caliper at 10-day intervals. 5 sample fruits were measured randomly per tagged branch in a tree. As a result, 25 sample fruits were measured per tree

The fruit set on the tagged branches was manually counted. The number of flowers per branch was also counted. Then, the fruit set per branch was expressed in the form of a percentage.

$$\text{Fruit Set \%} = \frac{\text{total number of developing fruit set per branch}}{\text{total number of flowers per branch}} * 100$$

Fruit drop was calculated and expressed in percentage.

Fruit drop percentage (%) =

$$\frac{\text{Total number of fruitlets} - \text{number of fruits retained in branch on reading day}}{\text{Total number of fruitlets}} * 100$$

### 2.7 Statistical Analysis

Data were collected at 10-day intervals. Recorded data was tabulated treatment-wise under four replications. The data entry was accomplished using the software Ms-Excel. Data were subjected to one Analysis of Variance (ANOVA) to test the significance of treatments. Mean Comparison was done by Duncan's Multiple Range Test (DMRT) at a 5% level of significance.

## 3. RESULTS AND DISCUSSION

### 3.1 Total Flowers and Hermaphrodite Flowers Per Branch

The foliar application of Boron and Zinc produced significantly higher total flowers and hermaphrodite flowers per branch (Table 2). The 0.1% Zn + 0.1% B spray resulted in the highest total flowers per branch (326.75) and hermaphrodite flowers per branch (310.75) which were significantly higher than 0.2% Zn and Control, while other treatments produced statistically similar numbers of total flowers and hermaphrodite flowers per branch in Mandarin. These results correlate with the results of (Supriya, 1993) on Assam lemon where he observed an increase in the percentage of flowers number on the tree when using foliar spraying with Zn in the form of chelate and sulfate.

**Table 1:** Effect of Foliar Application of Zinc And Boron And Their Combinations in The Flowering of Mandarin (*Citrus Reticulata*) at Myagdi, Nepal, 2022

Treatment	Total Flowers per branch	Hermaphrodite flowers per branch
Control	87.5 <sup>c</sup>	68.25 <sup>c</sup>
0.2% Zinc	252 <sup>b</sup>	234.5 <sup>b</sup>
0.1% Boron	308.75 <sup>a</sup>	288.5 <sup>a</sup>
0.15% Zinc +0.05% Boron	313.5 <sup>a</sup>	298.5 <sup>a</sup>
0.1% Zinc + 0.1% Boron	326.75 <sup>a</sup>	310.75 <sup>a</sup>
LSD (0.05)	51.28***	53.41***
SE <sub>mean</sub> (±)	7.44	7.75
CV, %	12.92	14.44

Note: \*, \*\*, and \*\*\* denote significance at p=0.05, p=0.01, and p=0.001 respectively, CV = Coefficient of Variation, SEM (+/-) = Standard Error of Mean, LSD = Least Significant Difference, Treatment means within a column followed by the different letter(s) were significantly different at p=0.05 level by Duncan Multiple Range Test

### 3.2 Fruit Diameter

Significant variation was observed in the fruit diameter of Mandarin among different treatments on different days after foliar spraying of treatment combinations (Table: 3). At DAS30, DAS40, and DAS50, the foliar application of 0.1% Zinc + 0.1% Boron resulted in highest fruit diameter (3.60mm) which was statistically similar to those observed in trees sprayed with 0.15% Zinc + 0.05% Boron (3.50mm) and 0.1% Boron (3.51mm). At DAS 60, the highest fruit diameter(13.12mm) was recorded in trees that were foliar sprayed with 0.1% Zinc+0.1% Boron, which was

statistically similar to the diameter of fruits (13.02mm) in trees sprayed with 0.15% Zinc +0.05% Boron. However, at 70DAS, the diameter of fruit in trees sprayed with 0.1% Boron was recorded to be the highest (18.80mm) which was statistically similar to those observed in trees sprayed with 0.15% Zinc + 0.05% Boron (18.79mm) and 0.1% Zinc +0.1% Boron(18.08mm). At every recorded data i.e., DAS 30, DAS40, DAS50, DAS60, DAS70, the fruit diameter was found to be the lowest in trees with control treatment. Additionally, trees sprayed with 0.2% Zinc bore the fruits with a diameter that was statistically higher than the control but statistically lower than the other treatments, Zinc and boron have

significant effects on fruit diameter and length (Mohammad et al., 2018). Application of Zn + B in sweet oranges resulted in maximum fruit size (Tariq et al., 2007). It may be due to Zn role in the biosynthesis of

chlorophyll and carotenoids enhancing the photosynthesis process (Mousavi, 2011). B role in translocation of carbohydrates, cell wall development, and RNA synthesis (Bhalerao et al., 2014)

**Table 2:** Effect of Foliar Application of Zinc and Boron and Their Combinations in Fruit Diameter of Mandarin (*Citrus Reticulata*) at Myagdi, Nepal, 2022

Treatment	Fruit Diameter(mm) at				
	DAS30	DAS40	DAS50	DAS60	DAS70
Control	2.92 <sup>c</sup>	4.09 <sup>c</sup>	6.88 <sup>c</sup>	8.86 <sup>d</sup>	14.13 <sup>c</sup>
0.2% Zinc	3.27 <sup>b</sup>	4.72 <sup>b</sup>	7.58 <sup>b</sup>	11.37 <sup>c</sup>	16.56 <sup>b</sup>
0.1% Boron	3.51 <sup>a</sup>	5.22 <sup>a</sup>	8.36 <sup>a</sup>	12.13 <sup>b</sup>	18.80 <sup>a</sup>
0.15% Zinc +0.05% Boron	3.50 <sup>a</sup>	5.50 <sup>a</sup>	8.58 <sup>a</sup>	13.02 <sup>a</sup>	18.79 <sup>a</sup>
0.1% Zinc + 0.1% Boron	3.60 <sup>a</sup>	5.68 <sup>a</sup>	8.39 <sup>a</sup>	13.12 <sup>a</sup>	18.08 <sup>a</sup>
LSD (0.05)	0.12 <sup>***</sup>	0.49 <sup>***</sup>	0.28 <sup>***</sup>	0.73 <sup>***</sup>	0.86 <sup>**</sup>
SE <sub>mean</sub> (±)	0.02	0.07	0.04	0.03	0.13
CV, %	2.53	6.33	2.27	4.06	3.24

Note: \*, \*\*, and \*\*\* denote significance at p=0.05, p=0.01, and p=0.001 respectively, CV = Coefficient of Variation, SEM (+/-) = Standard Error of Mean, LSD = Least Significant Difference, Treatment means within a column followed by the different letter(s) were significantly different at p=0.05 level by Duncan Multiple Range Test, DAS=Days after spray

### 3.3 Fruit Set

Foliar application of Zinc and Boron was found to significantly affect the fruit set at 40 and 50 days after spray (Table: 4). At 40 DAS, the highest percentage of fruit set (83.25%) was observed for treatment 0.1% Boron which was statistically similar to the fruit set percentages observed in trees with treatments 0.15% Zinc +0.05% Boron (77.75%) and 0.1% Zinc + 0.1% Boron (75.75%). Similarly, at 60 DAS, trees sprayed with 0.1% Boron recorded the highest fruit set percentage (73.40%) that was statistically similar to trees sprayed with 0.15% Zinc +0.05% Boron

(60.81%) and 0.1% Zinc + 0.1% Boron (62.40%) (Table: 4). The lowest fruit set percentage, however, was observed in control with 41.95 % at 40 DAS and 33.55% at 60 DAS respectively. Higher fruit set in response to higher micronutrient concentrations is likely owing to increased translocation of hormones, dietary components, and other elements that stimulate fruit development to the ovary tissue. Likely, better photosynthesis, decreased fruit drop, and improved fruit size and quality characters are linked to micro-elements: Boron's role in pollination and zinc's position as a growth promoter, both contributing to reduced fruit drop and improved fruit set.

**Table 3:** Effect of Foliar Application of Zinc and Boron and Their Combinations in Fruit Set at Different Days from The First Spray of Mandarin (*Citrus Reticulata*) at Myagdi, Nepal

Treatments	Percentage of Fruit Set at	
	DAS40	DAS60
Control	41.95 <sup>b</sup>	33.55 <sup>c</sup>
0.2% Zinc	53.65 <sup>b</sup>	52.85 <sup>b</sup>
0.1% Boron	83.25 <sup>a</sup>	73.40 <sup>a</sup>
0.15% Zinc +0.05% Boron	77.75 <sup>a</sup>	60.81 <sup>ab</sup>
0.1% Zinc + 0.1% Boron	75.75 <sup>a</sup>	62.40 <sup>ab</sup>
LSD (0.05)	14.66 <sup>***</sup>	18.83 <sup>**</sup>
SE <sub>mean</sub> (±)	2.13	2.73
CV, %	14.32	21.59

Note: \*, \*\*, and \*\*\* denote significance at p=0.05, p=0.01, and p=0.001 respectively, CV = Coefficient of Variation, SEM (+/-) = Standard Error of Mean, LSD = Least Significant Difference, Treatment means within a column followed by the different letter(s) were significantly different at p=0.05 level by Duncan Multiple Range Test

### 3.4 Fruit Drop

The foliar application of Zinc and Boron resulted in significantly lower fruit drop in Mandarin (Table: 5). The lowest fruit drop was observed in trees sprayed with 0.1% Zinc and 0.1% Boron, which was statistically similar to the fruit drop percentage recorded in 0.1% Boron (38.58%) and 0.15% Zinc + 0.05% Boron (41.60%). In contrast to this, the highest fruit drop was observed in Control (76.93%). The favorable reaction of zinc and boron in the fruit setting of mandarin trees might explain the least fruit drop in 0.1% Zinc +0.1% Boron. Zinc increases IAA production, which boosts endogenous auxin levels in the abscission zone, preventing fruit loss (Nijjar, 1985). Because boron plays a vital role in the transfer of carbohydrate and auxin production to sink, and increased pollen viability and fertilization, the fruit loss was reduced by foliar application of boron (Bhalerao et al., 2014).

**Table 4:** Effect of Foliar Application of Zinc and Boron and Their Combinations in Fruit Drop of Mandarin (*Citrus Reticulata*) at Myagdi, Nepal.

Treatment	Percentage of Fruit drop
Control	76.93 <sup>a</sup>
0.2% Zinc	49.63 <sup>b</sup>
0.1% Boron	38.58 <sup>c</sup>
0.15% Zinc +0.05% Boron	41.60 <sup>bc</sup>
0.1% Zinc + 0.1% Boron	37.35 <sup>c</sup>
LSD (0.05)	10.17 <sup>***</sup>
SE <sub>mean</sub> (±)	1.48
CV, %	13.52

Note: \*, \*\*, and \*\*\* denote significance at p=0.05, p=0.01, and p=0.001 respectively, CV = Coefficient of Variation, SEM (+/-) = Standard Error of Mean, LSD = Least Significant Difference, Treatment means within a column followed by the different letter(s) were significantly different at p=0.05 level by Duncan Multiple Range Test

#### 4. CONCLUSION

A study was conducted to evaluate the influence of zinc and boron on the flowering and fruiting of mandarin orange in the citrus zone of Myagdi district. The research was accomplished at Raghuganga rural municipality of Myagdi district in June 2021.

The major findings of the research were as follows:

- The total flowers and hermaphrodite flowers per branch were 257.70 and 240.10 respectively in the trees where 0.1% Zn + 0.1% B was applied which was the best result. Similarly, the lowest total flowers and hermaphrodite flowers per branch *i.e.* 151.75 and 137.75 respectively were recorded in trees with control treatment.
- The maximum percentage of fruit set occurred in the treatment 0.1% B at 40DAS, and 60DAS (Days after spraying) *i.e.*, 83.25% and 73.40% respectively whereas, the minimum percentage of fruit set was recorded in the control treatment at 40DAS and 70DAS *i.e.*, 41.95% and 33.55% respectively.
- Fruit drop occurred very high (76.93%) in the control treatment as compared to 0.1% Zn + 0.1%B *i.e.*, lowest (37.35%).

Based on the above findings, we can conclude that a Foliar spray of Zinc 0.1% + Boron 0.1% was found to be the best for the production of more hermaphrodite flowers, higher fruit set percentage, and higher fruit retention percentage in mandarin.

#### AUTHOR'S CONTRIBUTION

Govinda Lamichhane planned the research, did experiments, collected, data, and prepared the manuscript. Safal Adhikari and Pankaj Karki Dholi analyzed the data, critically revised it, and did the finalization of the manuscript.

#### CONFLICT OF INTEREST

The authors declare that there is no conflict of interest with the present publication.

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#### REFERENCES

Ahmad, S. K., Ullah, W., Ahmad, R., Saleena, B. A., and Rajwana., 2012. Foliar application of boron and zinc influence in tree growth and fruit yield in citrus reticulata. *Journal of Agriculture Science*, Pp. 113-119.

Babu, K. D., and Yadav, D. S., 2005. Foliar spray of micronutrients for yield and quality improvement in Khasi mandarin(Citrus reticulata Blanco). *Indian Journal of Horticulture*, 62(3), Pp. 280-281.

Bhalerao, P. P., Patel, B. N., Patil, S. J., and Gaikwad, S. S., 2014. Effect of foliar application of Ca, Zn, Fe, and B on growth, yield, and quality of

papayas ( *Carica papaya*) cv.Taiwan Red Lady. *Current Horticulture*, Pp. 35-39

Davies, F. S., and Albrigo, L. G., 1994. Environmental constraints on growth, development, and physiology of citrus. *Acribia*, S.A.

Fu, X.-Z., Xing, F., Cao, L., Chun, C.-P., Ling, L.-L., Jiang, C.-L., and Peng, L.-Z., 2016. Effects of Foliar Application of Various Zinc Fertilizers with Organosilicone on Correcting Citrus Zinc Deficiency. *HortScience*, 51(4), Pp. 422–426. <https://doi.org/10.21273/hortsci.51.4.422>

Hansch, R., and Mendel, R. R., 2009, June. Physiological functions of mineral micronutrients (Cu, Zn, Mn, Fe, Ni, Mo, B, Cl). *Current Opinion in Plant Biology*, 12(3), Pp. 259-266. doi:<https://doi.org/10.1016/j.pbi.2009.05.006>

Kaini, B. R., 2013. Package of Practices for Sweet Orange Production and Post Harvest Management. JICA and JCCU.

Khan, A. S., Nasir, M., Malik, A. U., Barsa, S. A., and Jaskani, M. J., 2015. Combined Application of Boron and Zinc Influence the Leaf Mineral Status, Growth, Productivity and Fruit Quality of 'Kinnow' Mandarin (*Citrus nobilis* Lour × *Citrus deliciosa* Tenora). *Journal of Plant Nutrition*, 38(6), Pp. 821-838. doi:<https://doi.org/10.1080/01904167.2015.1009100>

L.Supriya, R. B., 1993. Effect of foliar application of chelated and non-chelated Zinc on growth and yield of Assam lemon. Department of Horticulture, Assam Agriculture University India.

Ministry of Agriculture and Livestock Development. 2077; 2078. Statistical Information on Nepalese Agriculture. Singha Durbar, Kathmandu, Nepal: Government Of Nepal.

Mohammad, N., Malchoul, G., and Bouissa, A. A., 2018. Effect of foliar spraying with B, Zn, and Fe on flowering, fruit set, and physical traits of the lemon fruits (*Citrus Meyer*). *International Journal of Agriculture and Environmental Science*, Pp. 50-57.

Nijjar, G. S., 1985. Nutrition of fruit trees. New Delhi, Country: Mrs. Usha Raji Kumar Kalayani Publishers.

Obreza, T. A., Boman, B. J., Zekri, M., and Futch, S. (n.d.). Methods of fertilizer application. *Nutrition of Florida Citrus Trees*, Pp. 43-47.

Razzaq, K., Khan, A. S., Malik, A. U., Shahid, M., and Ullah, S., 2013. Foliar Application of Zinc Influences the Leaf Mineral Status, Vegetative and Reproductive Growth, Yield and Fruit Quality Of 'Kinnow' Mandarin. *Journal of Plant Nutrient*, 36(10), Pp. 1479-1495. doi:<https://doi.org/10.1080/01904167.2013.785567>

Tariq, M., Sharif, M., Shah, Z., and Khan, R., 2007. Effect of Foliar Application of Micronutrients on the Yield and Quality of Sweet Orange(*Citrus Sinensis* L.). *Pakistan Journal of Biological Sciences*, 10(11), Pp. 1823-1828. doi:10.3923/pjbs.2007.1823.1828

Zhao, H., Wu, L., Chai, T., Zhang, Y., Tan, J., and Ma, S., 2012. The effects of copper, manganese, and zinc on plant growth and elemental accumulation in the manganese-hyperaccumulator *Phytolacca americana*. *Journal of Plant Physiology*, 169(13), Pp. 1243–1252. <https://doi.org/10.1016/j.jplph.2012.04.016>

