RESEARCH ARTICLE
Published December 2024
https://doi.org/ 10.21070/nabatia.v12i2.1641

Enhancing Gardenia Leaf Nutrients via Shading, Vermicompost, and Chelated Iron

Zainab Kamal Mustafa Nuftji[1], Alaa Hussien A.-Q. AL- Bakkar[2]

[1]Horticultural and land scape, College of Agricultural, Univ of Iraq / Kirkuk, Iraq
[2]Medicinal and industrial plants, College of Agricultural, Univ of Iraq / Kirkuk, Iraq
*Corresponding Author: akgh21m012@uokirkuk.edu.iq

Abstract. This study aimed to investigate the impact of shading, vermicompost, and chelated iron on the leaf content of certain elements in Gardenia jasminoides plants. Conducted at a private nursery in Erbil during the 2022 agricultural season, the experiment utilized gardenia plants propagated by cuttings and grafted onto one-year-old rootstocks. Over five months (April to October 2022), the effects of two shading levels (0% and 75% direct sunlight), vermicompost application at two levels, and chelated iron application at three levels (0, 0.1, and 0.2 g.L-1) were assessed. Results indicated that 75% shading significantly increased leaf nitrogen (1.72%) and iron content (73.94 mg.kg-1). Vermicompost at 25% significantly enhanced leaf nitrogen (1.75%), phosphorus (0.248%), potassium (1.36%), and iron (67.95 mg.kg-1). Chelated iron at 0.2 g.L-1 markedly improved leaf nitrogen (1.78%), phosphorus (0.256%), potassium (1.28%), and iron (78.45 mg.kg-1). The study utilized one-year-old uniform seedlings, grown in 15-liter pots with river loam soil, and standard care practices were followed. Data analysis was performed using ANOVA and Duncan's Multiple Range Test at a 0.05 significance level. The findings suggest that specific shading, organic fertilizer, and chelated iron treatments can significantly enhance the nutrient content of gardenia leaves, potentially improving plant health and growth.
Keyword : Gardenia jasminoides; Shading and Vermicompost Effects; Chelated Iron

INTRODUCTION

Gardenia, also known as gardenia or gardenia jasminoides [1], is a genus of flowering plants in the coffee family, Rubiaceae, order Gentianales [2]. This genus was named by the Swedish botanist Carl Linnaeus and the British naturalist and merchant John Ellis [3] in honor of the Scottish-born American naturalist Dr. Alexander Garden (1730-1791). Recent years have witnessed an increase in temperatures and light intensity and a decrease in humidity, negatively impacting plant growth and leading to plant death. Exposure to high light intensity levels reduces the rate of photosynthesis. To mitigate this, shading is used to reduce sunlight intensity and lower temperatures [4]. Adding fertilizers to gardenia plants enhances growth, and soil fertilization is a crucial factor in increasing vegetative and floral growth in gardenia. Vermicompost is a decomposition process involving the joint action of earthworms and microorganisms in digesting and breaking down materials, making them easily absorbable by plants. This type of fertilizer is rich in nutrients, vitamins, growth hormones, and enzymes such as protease, amylase, lipase, chitinase, and microflora, which continue to break down organic materials even after being excreted by the worms [5]. Iron is an essential element that contributes to oxidation and reduction processes and helps build chlorophyll molecules, although it is not a component of chlorophyll itself. Iron plays a crucial role in forming enzymes responsible for chlorophyll synthesis and is involved in the composition of many respiratory enzymes, such as catalase, peroxidase, and cytochrome oxidase, and in the HEME pigment necessary for the final stages of respiration [6].

MATERIALS AND METHODS

One-year-old seedlings were obtained at the beginning of the experiment from gardenia plants on 26-3-2022 from Mohammed Nursery in Kirkuk province. The plants were grafted and propagated vegetatively by cuttings and were uniform in size and height, free from diseases and insect infestations. The plants were 54.75 ± 1 cm in height, had a stem diameter of 10.66 ± 1 cm, and had 125.52 ± 1 leaves per plant. The plants were grown in pots with a capacity of 15 liters using a river loam soil mixture. Standard care practices were applied as needed. The data were statistically analyzed using the ANOVA table and the statistical analysis program (SAS) (V9.0, 2001). Means were compared using Duncan’s Multiple Range Test at a significance level of 0.05 [7].

A. Measured Parameters:

Estimation of nitrogen percentage N%

The nitrogen percentage in the dried samples was determined using the Kjeldahl method with a Kjeldahl-micro apparatus, following the method described by [8] , [9] in the botany laboratory of the College of Agriculture - University of Kirkuk.

Estimation of Phosphorus Percentage (P%)

Phosphorus percentage was estimated using the molybdate ammonium method and ascorbic acid, and read with a spectrophotometer [10].

Estimation of Potassium Percentage (K%)

Potassium percentage was determined using a Photometer Flame instrument, type Elico CL 378, in the laboratories of the College of Agriculture at the University of Kirkuk.

Estimation of Iron Percentage (Fe, mg/kg)

Iron was quantified using atomic absorption spectrophotometry.

RESULTS AND DISCUSSION

The results in Table (1) indicate significant differences with 75% shading (plants covered with Saran or green net), where nitrogen content reached 1.72%. Also noted is an increase in nitrogen content when plants were irrigated with chelated iron at a concentration of 0.2 g/L, reaching 1.78%. This increase in leaf iron content is partially attributed to its presence in leaf plastids in the form of Phytoferritin, indicating nutritional balance in the plant and increased nutrient uptake.

Additionally, the addition of organic fertilizer at a concentration of 25% led to a significant increase in plant nitrogen content (1.75%), compared to the control treatment. Nitrogen is considered most important as it forms proteins and nucleic acids and promotes plant growth [11], [12]. Increased nitrogen concentration in leaves leads to an increase in cell number and size, along with enhanced leaf production [13].

Table 1. The effect of shading, organic fertilizer (vermicompost), and iron chelate on the nitrogen content (%) of Gardenia jasminoides leaves

.

Shade (%)	Organic Fertilizer (%)	Chelated Iron (g/L) 0	0.1	0.2	Shading Rate
0	0	1.28 f	1.50 e	1.68 bcd	
	25	1.59 ed	1.69 bcd	1.83 ab	0.239 a
75	0	1.56 ed	1.66 cd	1.80 abc	
	25	1.68 bcd	1.77 abc	1.91 a	0.243 a
Iron Chelated Rate		1.54 c	1.54 c	256 a	
Organic Fertilizer Rate		0		25	
		1.56 b		1.75 a	
Bilateral Shading Interaction (%) + Organic Fertilizer (%)			0	25	
		0	1.49 c	1.70 b	
		75	1.64 b	1.80 a	
Bilateral Shading Interaction (%) + Iron (g/L)			0	0.1	0.2
		0	1.43 d	1.59 c	1.75 a
		75	1.65 bc	1.71 ab	1.81 a
Bivariate interaction of organic fertilizer (%) + iron (g/L)			0	0.1	0.2
		0	1.42 d	1.58 c	1.69 b
		25	1.66 bc	1.73 b	1.87 a

Organic fertilizers have a significant impact on increasing leaf content of major elements and increasing carbohydrate levels necessary for completing vegetative growth and metabolic activities, consistent with [14]. Results in Table (3) show an increase in leaf potassium content with 75% shading, reaching 1.35%. Significant differences were observed with 25% fertilization, where it reached 1.40%, surpassing the control treatment. Organic fertilizers contain potassium, which increases leaf element content, activates enzymes, synthesizes proteins and energy compounds necessary for vital activities in plants, and aids in chlorophyll production [8], [15].

Table 2. The effect of shading, organic fertilizer (vermicompost), and chelated iron onleaf phosphorus content (%) in Gardenia Jasminoid

Shade (%)	Organic Fertilizer (%)	Chelated Iron (g/L) 0	0.1	0.2	Shading Rate
0	**0**	0.220 c	0.229 c	0.252 ab	0.239 a
	25	0.224 c	0.252 ab	0.260 a	
75	**0**	0.220 c	0.231 bc	0.256 a	0.243 a
	25	0.237 abc	0.258 a	0.260 a	
Iron Chelated Rate		0.227 c	0.242 b	256 a	
Organic Fertilizer Rate		0		25	
		0.233 b		0.248 a	
Bilateral Shading Interaction (%) + Organic Fertilizer (%)		0		25	
	0	0.233 b		0.246 ab	
	75	0.234 b		0.251 a	
Bilateral Shading Interaction (%) + Iron (g/L)		0	0.1	0.2	
	0	0.222 c	0.240 ab	0.256 a	
	75	0.228 bc	0.244 a	0.255 a	
Bivariate interaction of organic fertilizer (%) + iron (g/L)		0	0.1	0.2	
	0	0.220 b	0.230 b	0.251 a	
	25	0.230 b	0.255 a	0.260 a	

*The different letters within the same column indicate significant differences (A < 0.05) among the factors

A noticeable increase was observed when iron was added to the soil, resulting in increased leaf iron content. This is because iron is present in leaf plastids in the form of Phytoferritin. "The results of tables (1-2-3-4) have indicated that an increase in iron concentrations led to an increase in the leaf content of major elements. This is because iron possesses a small surface area with high absorptive capacity, resulting in an enhancement of photosynthetic activity and uptake of nutrients from the soil [16]. Additionally, it enhances the plant's ability to produce a strong root system capable of absorbing nutrients from the soil to sustain plant life [17].

Table 3. The effect of shading, organic fertilizer (vermicompost), and chelated iron on the leaf potassium content (%) in Gardenia Jasminoides plant.
*The different letters within the same column indicate significant differences (A < 0.05)

Shade (%)	Organic Fertilizer (%)	Chelated Iron (g/L) 0	0.1	0.2	Shading Rate
0	**0**	0.80 c	1.13 abc	1.05 bc	1.13 b
	25	1.11 ab	1.30 ab	1.38 abc	
75	**0**	0.83 c	1.25 abc	1.37 abc	1.35 a
	25	1.49 ab	1.48 ab	1.67 a	
Iron Chelated Rate		1.05 b	1.29 ab	1.38 a	
Organic Fertilizer Rate		0		25	
		1.08 b		1.40 a	
Bilateral Shading Interaction (%) + Organic Fertilizer (%)		0		25	
	0	0.99 b		1.26 ab	
	75	1.16 b		1.45 a	
Bilateral Shading Interaction (%) + Iron (g/L)		0	0.1	0.2	
	0	0.96 b	1.21 ab	1.21 ab	
	75	1.15 ab	1.37 a	1.54 a	
Bivariate interaction of organic fertilizer (%) + iron (g/L)		0	0.1	0.2	
	0	0.81 b	1.19 a	1.23 a	
	25	1.30 a	1.39 a	1.53 a	

among the factors

Table 4. The effect of shading, organic fertilizer (Vermicompost), and chelated iron on the leaf iron content (in mL/kg) in Gardenia Jasminoides plant

*The different letters within the same column indicate significant differences (A < 0.05) among the factors

Shade (%)	**Organic Fertilizer (%)**	**Chelated Iron (g/L) 0**	**0.1**	**0.2**	**Shading Rate**
0	**0**	56.45 bc	58.45 bc	65.85 ab	60.81 b
	25	48.82 c	62.71 abc	72.58 abc	
75	**0**	59.42 bc	71.20 abc	82.35 ab	73.94 a
	25	74.92 ab	72.28 abc	85.97 a	
Iron Chelated Rate		57.52 b	66.15 b	78.45 a	
Organic Fertilizer Rate		0		25	
		66.79 a		67.95 a	
Bilateral Shading Interaction (%) + Organic Fertilizer (%)			0	25	
		0	60.25 b	61.36 ab	
		75	73.34 ab	74.54 a	
Bilateral Shading Interaction (%) + Iron (g/L)			0	0.1	0.2
		0	52.63 c	60.57 bc	69.21 bc
		75	62.40 bc	71.74 b	87.68 a
Bivariate interaction of organic fertilizer (%) + iron (g/L)			0	0.1	0.2
		0	57.93 b	64.82 ab	77.62 a
		25	57.10 b	67.49 ab	79.27 a

REFERENCES

[1] Al-Shaikh, Adnan Awad, "Rooting of Gardenia Jasmenoides Gardenia Treated with Naphthalene Acetic Acid (NAA) Oxin", *Damascus Journal of Agricultural Sciences*, 2(2), pp. 87-104, 2004.

[2] Al-Shihabi, Mustafa, "Al-Shihabi Glossary of Agricultural Science Terms", *Beirut: Lebanon Library*, 2003.

[3] Wells, D, "100 flowers and how they got their names" *Algonquin Books, Chapel Hill.CHICAGO.USA* , 1997.

[4] Raveh, E.; S .Cohen .; T .Raz ; D .Yakir; A .Grava and E .E .Goldschmidt, "Increased growth of young citrus trees under reduced radiation load in a semi-arid" *journal of Experimental Botany*, 54(381), pp 365–37, 2003.

[5] Barik, T.; J. M. L . Gulati ; L. M . Garnayak ; and D.K, "Bastia, Production of vermicompost from agricultural wastes. – Agric", Reviews, 31(3), 2011.

[6] Al-Nuaimi, Saadullah Najm Abdullah, "Principles of Plant Nutrition, translated by authors Minickel and Kirby", *Dar Al-Kitab for Printing and Publishing, University of Mosul*, Iraq, 1984.

[7] Al-Rawi, Khashaa Mahmoud and Abdul Aziz Khalaf Allah, "Design and Analysis of Agricultural Experiments", *Dar Al-Kitab for Printing and Publishing, Second Edition, University of Mosul, Mosul*, 2000.

[8] Al-Dalawi, Lanja Mohammed Saeed, "The effect of shading, organic fertilizer (Horti Boost 10), and benzyladenine and their interaction on the growth and development of Myrtus communis L", *Master's Thesis. College of Agriculture, University of Kirkuk*, 2022.

[9] Black, C .A, "Methods of soil analysis", *Part 1.Physical properties Amer Soc. Agron. Inc. Publisher, Madison Wisconsin, USA*, 1965.

[10] Sparks, D.L , "Methods of soil analysis" ,*part 3. Chemical method*, 978-0-891, 1996.

[11] Nouri, Mahast Samir, "The effect of planting date, garden orientation, and compound fertilizer (Hortifeeds) on the growth and flowering of carnation (Dianthus chinensis x barbatus)", *Master's Thesis, College of Agriculture, Department of Horticulture and Landscape Engineering, University of Kirkuk*, 2023.

[12] Haque, I. and A.A. Jakhro, "Soil and fertilizer potassium. In "Soil Science" *National Book Foundation, Islamabad, Pakistan*, pp. 261–3, 2001.

[13] Meyer, B.S., D. Banderson, R.H. Bohning and D.G. Fratianne, "Introduction to Plant Physiology", D. Van *Nostrand Companey, New York*, pp. 193–322, 1973.

[14] Al-Abbasi, Haitham Thamer Abdul Jabbar, "The Effect of NPK Compound Fertilizer, Humic Acid, and Gibberellin on the Vegetative and Root Growth and Mineral Content of Eriobotrya japonica Lindl Seedlings", *Master's Thesis, College of Agriculture, University of Mosul*, 8(2), pp. 76-62, 2012.

[15] Kazem, Ahmed Adnan, and Akram Abdul Kazem Hadi, "The Effect of Spraying with Marine Algae Extract and Humic Acid on the Growth Indicators of Diospyrus Kaki L. Seedlings", *Al-Furat Journal of Agricultural Sciences*, 7(1), pp. 10-20, 2015.
[16] Sekhon, B.S., "Nanotechnology in agri-food production: an overview", *Nanotechnology, Science and Applications*, 7: 31-53, 2014.
[17] Roosta, H.R., Jalali, M. and Vakili Shahrbabaki, S.M.V., "Effect of nano Fe-chelate, Fe-EDDHA and FeSo4 on vegetative growth, physiological parameters and some nutrient elements concentrations of four varieties of Lettuce (Lactuca sativa L.) in NFT System", *Journal of Plant Nutrition*, 38(14), pp. 1-20, 2015.

Conflict of Interest Statement*:The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.*