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Effect of Nano NPK Fertilizers and 2,4 Dichlorophenoxy Acetic Acid on Growth and Development of Buxus microphylla 'Golden Dream' plant

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Abstract:

Buxus microphylla 'Golden Dream' is widely cultivated for its compact growth habit, glossy foliage, and golden-yellow new growth, making it a popular choice for landscaping and horticulture. A pot experiment was conducted during the 2021 and 2022 seasons in a heated plastic house belonging to the Nursery of Duhok University, located on the Zanko campus. The aim of this study was to investigate the effect of foliar application of Nano NPK fertilizer at concentrations of 0, 2, and 4 g l^{-1} and 2,4-D at concentrations of 0, 100, and 200 mg l^{-1} on the growth and development of Buxus plants. The results showed that the application of these two factors had a significant impact on most of the vegetative growth parameters, including plant height, longest branch length, growth index, number of branches and leaves per plant, leaf area, and root dry weight. The highest recorded values were obtained in plants treated with Nano NPK fertilizer at a concentration of 4 g l^{-1}, which had a plant height of 40.67 cm, longest branch length of 36.00 cm, growth index of 2747.4 cm^3, number of branches of 6.56 branch $plant^{-1}$, number of leaves of 115.22 leaf $plant^{-1}$, leaf area of 1126.3 cm^2, and vegetative and root dry weight of 14.72-5.38 g. However, plants sprayed with high concentrations of 2,4-D at 200 mg l^{-1} achieved the highest values for plant height 36 cm, growth index 2684.2 cm^3, number of branches 5.78 branch $plant^{-1}$, number of leaves 87.44 leaf $plant^{-1}$, leaf area 869.6 cm^2, and vegetative and root dry weight 13.31-5.78 g. Furthermore, the best interaction between the two factors was observed when high levels of nano NPK fertilizer 4 g l^{-1} were combined with 2,4-D at a concentration of 100 mg l^{-1}, which led to increased vegetative parameters. These findings suggest that this combination could be a promising treatment for enhancing the growth and development of Buxus plants in horticultural applications.

Keywords: *Buxus plant , Nano fertilizer, 2,4 dichlorophenoxy acetic acid.*

Introduction

Buxus microphylla 'Golden Dream' is a cultivar of the small-leaved boxwood a species of evergreen shrub or small tree in the family Buxaceae. Native to Southeast Asia, this plant is widely cultivated for its ornamental value, particularly for its compact growth habit, glossy foliage, and golden-yellow new growth. The plant is highly valued in landscaping and horticulture due to its ability to thrive in a range of environments **(Di Domenico *et al.*, 2012)**. *Buxus microphylla* is considered an important plant in many regions due to its aesthetic value, ability to provide shade, and potential medicinal properties. The leaves of the plant have been used in traditional medicine for various purposes, including treating skin conditions and digestive problems. The plant's essential oil has also been shown to have antioxidant and antimicrobial properties **(Rao *et al.*, 2015)**.

Nano-fertilizers are a new type of fertilizer that has gained popularity in recent years due to their potential to improve crop yields and reduce environmental pollution. Nano-fertilizers are characterized by their small particle size, typically ranging from 1-100 nanometers, which allows for increased surface area and improved nutrient uptake by plants. The use of nano-fertilizers has been shown to increase plant growth, improve nutrient utilization efficiency, and reduce the risk of environmental pollution **(Kumar *et al.*, 2018; & Shilpa *et al.*, 2022).** Spraying rosemary (*Rosmarinus officinalis* L.) plants with nano NPK fertilizers at a concentration of 6 g l^{-1} increased the plant height, number of branches, and certain chemical parameters, including total chlorophyll content and volatile oil percentage, as well as the production of volatile oil per plant **(Ali & Al-atrakchii, 2022)**. **Ahmed *et al.* (2023)** also reported that sprayed nano NPK fertilizers on two Red Cabbage hybrids cultivar led to increases in all vegetative and yield parameters.

However, 2,4-D is a synthetic auxin herbicide commonly used in agriculture to control broadleaf weeds. It has also been shown to have potential applications in horticulture as a plant growth regulator. Research has demonstrated that 2,4-D can promote root growth, increase biomass production, and enhance seed germination in various plant species **(Al-Huqail *et al.*, 2017)**. As an auxin-like herbicide, 2,4-D is selective and specifically designed to control broad-leaf weeds (dicotyledons) in cereal crop fields. At low concentrations, 2,4-D exhibits growth-promoting properties, whereas at high concentrations it inhibits plant growth. In fact, it was reported to be the first herbicide to improve crop growth and yield at sub-toxic levels **(Ries,**

1976). Growth regulators like 2,4-D influence plant growth and development at very low concentrations, but can inhibit it at higher concentrations **(Jules et *al.*, 1981)**. Studies have shown that spraying Radish (*Raphanus sativus* L.) plants with 2,4-D at concentrations of 2 and 4 ppm resulted in significant increases in vegetative growth, including leaf length, plant height, number of leaves per plant, fresh and dry weight of roots **(Ashraf et *al.*, 2016)**.

The aim of this study is to investigate the effects of nano-fertilizers and 2,4-dichlorophenoxy acetic acid and the intraction between them on the growth and development of *Buxus microphylla* 'Golden Dream' plants.

Materials and Methods

Pots experiments were conducted in a heated plastic house belonging to the Nursery of Duhok University, located on the Zanko campus, during the 2021 and 2022 seasons to investigate the effect of either Nano NPK fertilizer (0, 2, 4 g l^{-1}) and 2,4-D (0, 100, 200 mg l^{-1}) on the growth and development of Buxus plants. Plastic pots with a diameter of 17 cm were used for cultivation, which were filled with a medium containing a mixture of sand and compost in a 1:1 ratio by volume. The application of Nano NPK fertilizer (0, 2, 4 g l^{-1}) and 2,4-D (0, 100, 200 mg l^{-1}) was carried out twice as foliar sprays, with one week between each application. The first spray with nano-fertilizer was applied after 20 days of transplanting, while the second spray was applied one month after the first one. The control plants were sprayed with distilled water only. The pots were arranged in a Randomized Complete Block Design (RCBD) with nine treatments and three replicates (each replicate containing three plants). The following data were recorded: plant height (cm), longest branch length (cm), growth index (cm^3), number of branches per plant, number of leaves per plant, leaf area (cm^3), and vegetative and root dry weights (g).

Results

The result in **Table (1)** showed that the spryed different concentration of Nano NPK fertilizer and 2,4-D had significantly stimulatory effect on vegetative growth parameters of Buxus plant in the term of plant height, longest branch, growth index and number of branches per plant compared with untreated plants. The spryed plant with 4 g l^{-1} of Nano NPK fertilizers caused a significantly increased in plant height which reached to 40.67cm, longest branch to 36.00 cm, growth index to 2747.4 cm^3 and branch number to 6.56 branch $plant^{-1}$, compared with control.

However, increase 2,4-D concrentrations to 200 mg l^{-1} spryed on Buxus plant caused a significantly increased plant height which reached to 36.00 cm, growth index to 2684.2 cm^3, and branch number to 5.78 branch $plant^{-1}$ number of leaves 87.44 leaf $plant^{-1}$, leaf area 869.6 cm^2, and vegetative and root dry weight 13.31-5.78 g compared with control. Whereas, the longest branch significantly increased reached to 30.56 cm when plants spryed with 100 mg l^{-1} respectivly compared with control.

The intraction between concetraion nano NPK fertilizers and 2,4 D affected significantly incresed vegitatve characteristic, the plant highest significantly increased reached to 44.67 cm, for plant spryed with 4 g nano fertilizer intracted with 200 mg l^{-1} 2,4 D respectivly compared with control reached to 23.00 cm. Waile, the longest branch and branch number significantly increased to 7.33 cm and 40.67 branch $plant^{-1}$ for plant spryed with 4 g l^{-1} nano NPK fertilizers intracted with 100 m l^{-1} 2,4 D respectively compared with control.

Table (1): Effect of Nano-fertilizer and 2,4-D on some characteristics of *Buxus microphylla* Golden dream plant

Treatment		Characteristics			
		Plant height (cm)	**longest branch (cm)**	**growth index cm^3**	**Number of branch / plant**
Nano NPK g l^{-1}	0	25.00 ^{c}	22.00 ^{c}	1708.4 ^{b}	4.44 ^{b}
	2	33.11 ^{b}	26.33 ^{b}	2370.9 ^{ab}	4.33 ^{b}
	4	40.67 ^{a}	36.00 ^{a}	2747.4 ^{a}	6.56 ^{a}
2,4,D mg l^{-1}	0	28.00 ^{b}	24.22 ^{b}	1799.4 ^{b}	4.44 ^{b}
	100	34.78 ^{a}	30.56 ^{a}	2343.1 ^{ab}	5.11 ^{ab}
	200	36.00 ^{a}	29.56 ^{a}	2684.2 ^{a}	5.78 a
Nano NPK g l^{-1} × 2,4,D mg l^{-1}	0×0	23.00 ^{c}	20.00 ^{e}	1882.8 ^{cd}	4.67 ^{bc}
	0×100	24.33 ^{c}	21.00 ^{e}	1910.2 ^{cd}	4.67 ^{bc}
	0×200	27.67 ^{bc}	25.00 $^{c-e}$	1332.3 ^{d}	4.00 ^{cd}
	2×0	28.00 ^{bc}	22.00 ^{de}	1417.4 ^{d}	2.67 ^{d}
	2×100	35.67 ^{b}	30.00 ^{bc}	1729.8 ^{d}	3.33 ^{cd}
	2×200	35.67 ^{b}	27.00 $^{b-d}$	3965.5 ^{a}	7.00 ^{a}
	4×0	33.00 ^{b}	30.67 ^{b}	2098.0 ^{cd}	6.00 ^{ab}
	4×100	44.33 ^{a}	40.67 ^{a}	3389.4 ^{ab}	7.33 ^{a}
	4×200	44.67 ^{a}	36.67 ^{a}	2754.7 ^{bc}	6.33 ^{a}

Means with same letter for each factor and interactions are not significantly different at 5% level based on DMRT.

Whereas, the growth index caused a significantly increased which reached to 3965.5 cm^3 for the interaction between 2 g l^{-1} Nano NPK fertilizers and 200 mg l^{-1} 2,4 D respectively compared with control which reached to 1882.8 cm^{-3} .

The results in **Table (2)** showed that sprayed Nano NPK fertilizers on Buxus plants with a concentration of 4 g l^{-1} caused a significant increase in number of leaves which reached 115.22 leaf $plant^{-1}$, leaves asrea to 1126.3 cm^2, and vegetative and root dry weight to 14.72-5.38 g respectively compared with control. On the other hand, increasing 2,4 D concentrations 400 mg l^{-1} spryed on plants significantly increased in number of leaves which reached 87.44 leaf $plant^{-1}$, leaves asrea to 869.6 cm^2, and vegetative and root dry weight to 13.31 - 5.23 g compared with control.

Table (2): Effect of Nano-fertilizer and 2,4-D on some characteristics of *Buxus microphylla* Golden dream plant

Treatment		Characteristics			
		number of leaves leaf $plant^{-1}$	leaves area cm^2	vegetative root weight g	roots dry weight g
Nano NPK g l^{-1}	0	60.44 ^{c}	501.1 ^{b}	8.54 ^{b}	3.24 ^{b}
	2	76.11 ^{b}	650.1 ^{b}	10.31 ^{b}	4.77 ^{a}
	4	115.22 ^{a}	1126.3 ^{a}	14.72 ^{a}	5.38 ^{a}
2,4,D mg l^{-1}	0	77.56 ^{b}	650.8 ^{a}	8.87 ^{b}	3.72 ^{b}
	100	86.78 ^{a}	757.2 ^{a}	11.39 ^{ab}	4.43 ab
	200	87.44 ^{a}	869.6 ^{a}	13.31 ^{a}	5.23 ^{a}
Nano NPK g l^{-1} × 2,4,D mg l^{-1}	0×0	57.00 ^{d}	492.4 ^{bc}	5.37 ^{d}	2.56 ^{c}
	0×100	61.33 ^{d}	431.0 ^{c}	10.39 ^{bc}	2.79 ^{c}
	0×200	63.00 ^{d}	580.0 ^{bc}	9.88 $^{b-d}$	4.36 ^{bc}
	2×0	60.00 ^{d}	507.0 ^{bc}	8.78 ^{cd}	4.38 ^{bc}
	2×100	64.67 ^{d}	578.3 ^{bc}	7.90 ^{cd}	4.99 ^{ab}
	2×200	103.67 ^{c}	865.0 $^{a-c}$	14.26 ^{ab}	4.93 ^{ab}
	4×0	115.67 ^{b}	953.0 ^{ab}	12.45 $^{a-c}$	4.21 ^{bc}
	4×100	134.33 ^{a}	1262.3 ^{a}	15.89 ^{a}	5.52 ^{ab}
	4×200	95.67 ^{c}	1163.7 ^{a}	15.80 ^{a}	6.42 ^{a}

Means with same letter for each factor and interactions are not significantly different at 5% level based on DMRT.

The interaction between concentration of Nano NPK fertilizers and 2,4 D caused a significantly increased in the number of leaves reached to 134.33 leaf $plant^{-1}$, leaf area 1262.3

$cm^{3,}$ and vegetative root weight 15.89 g for the interaction between 4 g l^{-1} nano NPK fertilizer and 100 mg l^{-1} 2,4 D, respectively compared with control. However, the root dry weghit significantly increased when plants spryed with 4 g l^{-1} nano fertilizers intracted with 200 mg l^{-1} 2,4 D caused a significantly increase this triat reached to 6.42 g respectively compared with control reached 2.56 g.

Discussion

Nutrition plays a key role in plant growth and development. In the case of medicinal and ornamental plants, nutrients increases will stimulate plants to grow and increase their yield **(Zheljazkov *et al*., 2011).** The increased in all vegetative growth parameter when plants spryed with nano different concentrations of nano NPK fertilizers, this results may be attributed to the role of nitrogen and its availability in the ready form in the form of NO_3 and NH_4, which greatly enhanced plant growth and production through the vital role in the biochemical and physiological functions of the plant (**Jahan *et al.*, 2016)**, In addition to the efficient absorption and permeability of the nano-fertilizer into the plant tissues through the stomata holes, whose ions sizes are smaller than the diameter of the stomata and cell wall holes. In addition, the nanoparticles are characterized by their high specific surface area and energy, which is consistent with what was mentioned **(Jassim., 2018)**. In the present study fertilizing the plants with 4 g l^{-1} of nano NPK fertilizers caused an increase the plant height, this result is in agreement with what was obtained by **Hussein *et al*., (2017)** on *Tagetes erecta* L. plants this result can be explained by the fact that nano fertilizers increase nutrient use efficiency, have a large surface area, and release slowly, which aids in quickly absorbing nutrients and speed of penetration, representation, and movement, leading to increased growth speed and quality (e.g., protein and starch) by promoting photosynthesis **(Sajyan *et al*., 2020)**, besides that nano fertilizers enhance metabolic processes as well as enhance anabolic activities that lead to increased apical growth. This explains the increase in the longitudinal growth of seedlings treated with foliar spraying with nano fertilizer compared to the effect of regular fertilizer **(Shareef *et al.*, 2021)**. Number of branches also increased these results are in support with what was found by **Shehata & Moubarak, (2020)** on *Foeniculum vulgare* L. plants the reasons increase in the number of branches may be due to the impact of nano NPK fertilizers which raises the available nutrient to plants which increase the formation of total chlorophyll content in plant tissues leads to

significantly increase and enhance the efficiency of photosynthesis, which leads to an increase the plant growth parameters such as plant height, number of branches **(Al-Juthery *et al.*, 2018).** In general those increases may be a result of the nano NPK fertilizers and their effect on providing the plant with important nutrients, including nitrogen, which is important in amino acids and protein formation, cell division and elongation, as well as potassium, which is important in the formation of important enzymes for growth, and finally phosphorous, which is important in the formation of energy compounds, thus, increasing roots formation and increasing fresh and dry weight, which is led to increasing plant vegetative growth **(Kazem *et al.*, 2021)**.

However, the plants sprayed with 2,4-D at different concentrations lead to increased all vegetative growth and development plants, this result may be due to the ability of 2,4-D to stimulate plant growth by promoting cell elongation and cell division. As a synthetic auxin, 2,4-D mimics the action of the natural plant hormone auxin, which plays a crucial role in regulating cell elongation and cell division in plants **(Thimann, 1955)**. This result is consistent with previous findings on Radish *Raphanus sativus* L. plants by **(Ashraf *et al.*, 2016)**, and **Bharty *et al.*, (2021)** *Punica granatum* L. plants.

Conclusion

In conclusion, this study demonstrated that foliar application of nano-fertilizer and 2,4-D had a significant impact on the vegetative growth and development of *Buxus microphylla* 'Golden Dream'. The optimal combination of these factors was found to be high levels of nano-fertilizer 4 g l^{-1} combined with 2,4-D at a concentration of 100 mg l^{-1}, which resulted in increased vegetative parameters such as plant height, branch length, growth index, and leaf area. These findings suggest that this combination could be a promising treatment for enhancing the growth and development of Buxus plants in horticultural applications.

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