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Daffodil, flowering, nickel, tolerance,  
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### Tolerance of Daffodil (*Narcissus poeticus* L. c.v. "Ice Folies") to Nickel Contaminated Media

#### Abstract

The objective of this study was to determine the tolerance of daffodil (*Narcissus poeticus* L. c.v. "Ice Folies") as a hyperaccumulator plant to nickel contaminated media. This research was carried out in a completely randomized plot experimental design with three replications in green house conditions. Four doses of nickel (control, 25 mg kg<sup>-1</sup>, 50 mg kg<sup>-1</sup>, 75 mg kg<sup>-1</sup>) were applied to each growing media having 500 g soil:sand mixture in 2:1 ratio. The distillate water was used in irrigation and Hoagland solution was applied for fertilization. At the end of the experiment, effects of nickel applications on leaf length, plant length, flower length (P<0.01) and flower diameter, stem diameter (P<0.05) were found significant, except leaf number and leaf length. The lowest first flowering time, full flowering time and first floret withering time were obtained in control and 75 mg kg<sup>-1</sup> nickel application. The highest leaf length (341.60 mm), plant length (418.24 mm), flower length (70.74 mm) and stem diameter (7.63 mm) were obtained in 75 mg kg<sup>-1</sup> nickel application. The highest flower diameter was found as 78.35 mm in 25 mg kg<sup>-1</sup> nickel application. Generally, while the nickel doses increased flowering time, leaf length, plant length, flower length and flower diameter increased.

## INTRODUCTION

In an environmental research, any metal that causes ecological problem which cannot be biologically degraded should be considered as a heavy metal (Padmavathiamma and Loretta, 2007). Soil pollution caused by metals is different from air or water pollution, because heavy metal persists in soil much longer periods of time than in other compartment of the biosphere (Lasat, 2002). Many researchers reported that the hyper accumulation of heavy metals in some plants has been recorded (Barman et al., 2000). Phytoremediation seems to be cheap and environmentally option for amelioration the hazardous toxic metals (Huang et al., 1997; Wu et al., 2009). According to many researchers (Barman et al., 2001; Espinoza-Quiñones et al., 2005), the hyperaccumulation of heavy metals is depends plant species, soil condition (pH, organic matter content, cation exchange capacity etc.) and types of heavy metal. The metals bioaccumulation potential of various species was investigated by many scientists in different parts of the world. Metal specific some species are not suitable for commercial applications because of their small biomass, small growth habit and require careful management for accumulate multiple metals (Dan et al., 2000). Thus,

using ornamental plants for remediation of contaminated environment has a great importance and realistic purpose. On the other hand the using of ornamental plants by remediation aim have advantage because they can beautify environment at the same time. It is known that some ornamental plants are hyperaccumulator plants and they are used for phytoremediation (Özay and Mammadov, 2013). Heavy metal (Cr, Fe, Ni, Mn, Cu, Pb) contents have been determined in different plant parts such as root and leaf / stem of ornamental plants such as *Aptenia cordifolia*, *Carpobrotus edulis*, and *Bryophyllum tubiflorum* (Köseoğlu, 2007). The highest Ni (6.36 ppm) and Pb (3.76 ppm) contents were determined in leaves of *Pyracantha coccinea* M. Roem. in a campus landscape by the lake in Van (Turkey) (Gülser et al., 2011). Sönmez and Çığ (2019) reported that *Hyacinthus* cadmium contents accumulate in more bulbs than leaves. Some plants such as *Thlaspi*, *Urtica*, *Chenopodium*, *Polygonum sachalase* and *Alyssum* have the ability to accumulate cadmium, copper, lead, nickel and zinc in their bodies, and therefore, cultivation of these plants is considered an indirect method for cleaning contaminated soils (Mulligan et al., 2001).

In this study, tolerance of *Narcissus*, is an ornamental plant belong on Amaryllidaceae family, to nickel contaminated media was investigated and determined its utility for phytoremediation.

## MATERIALS and METHODS

This study was carried out is completely randomized plot experimental design with three replications in greenhouse. Each replication was formed with five pots. *Narcissus* “Ice Folies” was used as plant variety. *Narcissus* bulbs were planted each pots including 500 g soil:sand mixture in 2:1 ratio.

Four doses of nickel (0, 25 mg kg<sup>-1</sup>, 50 mg kg<sup>-1</sup> and 75 mg kg<sup>-1</sup>) were applied each pot. Distile water was used by irrigation aim and ½ Hoagland nutrient solution (Hoagland and Arnon, 1938) was applied two times by

fertilization aim. The experiment was ended after four months.

Phenological observations were made during experimental period. First flowering time, full flowering time, first flower withering time were determined.

On the other hand, the physical parameters were measured in harvested plants and determined leaf number, leaf length, leaf width, plant length, flower length, flower diameter and stem diameter.

Statistical analyses was done using SPSS package program to show difference among the mean values of measured plant growth criteria from the different treatments.

## RESULTS and DISCUSSION

The effects of applications of nickel on plant growth criteria of *Narcissus* were found significant (Table 1).

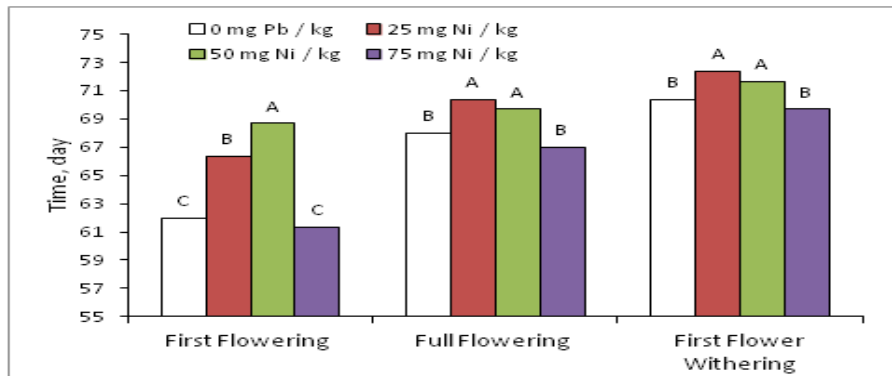
**Table 1.** The effects of different nickel doses on plant growth criteria of *Narcissus*

Applications	First flowering time (days)***	Full flowering time (days)**	First flower withering time (days)**	Leaf number	Leaf length (mm)***	Leaf width (mm)	Plant length (mm)***	Flower length, (mm)***	Flower diameter (mm)*	Stem diameter (mm)*
Control	62.00 C	68.00 B	70.33 B	5.07 A	306.26 B	11.44 AB	364.82 B	51.68 C	63.25 B	6.30 B
25 mg kg <sup>-1</sup> Ni	66.33 B	70.33 A	72.33 A	4.92 AB	294.03 C	11.86 A	313.42 D	58.54 B	78.35 A	6.42 B
50 mg kg <sup>-1</sup> Ni	68.67 A	69.67 A	71.67 A	5.00 A	238.21 D	11.08 B	329.93 C	51.27 C	71.60 AB	6.45 B
75 mg kg <sup>-1</sup> Ni	61.33 C	67.00 B	69.67 B	4.17 B	341.60 A	11.32 AB	418.24 A	70.74 A	60.90 B	7.63 A
	P<0.001	P<0.01	P<0.01	NS	P<0.001	NS	P<0.001	P<0.001	P<0.05	P<0.05

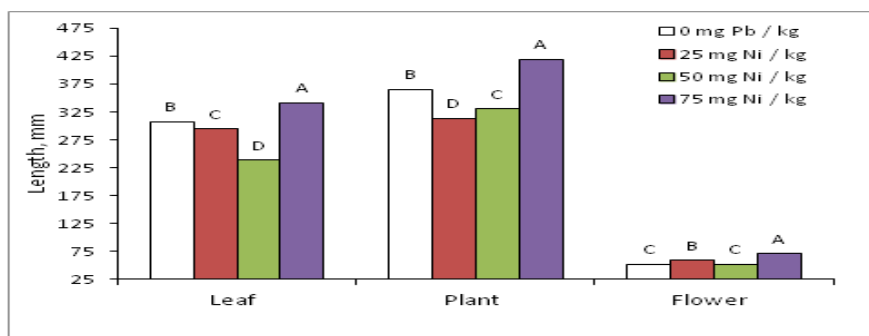
NS: Non significant, \*: Means followed by the same letter indicate no statistical difference at 5%, \*\*: Means followed by the same letter indicate no statistical difference at 1%, \*\*\*: Means followed by the same letter indicate no statistical difference at 0.1%

Effects of nickel applications on leaf length, plant length, flower length ( $P < 0.01$ ) and flower diameter, stem diameter ( $P < 0.05$ ) were found significant, except leaf number and leaf length. The lowest first flowering time, full flowering time and first floret withering time were obtained in control and 75 mg kg<sup>-1</sup> nickel application (Figure 1). The highest leaf length (341.60 mm), plant

length (418.24 mm), flower length (70.74 mm) and stem diameter (7.63 mm) were obtained in 75 mg kg<sup>-1</sup> nickel application (Figure 2). The highest flower diameter was found as 78.35 mm in 25 mg kg<sup>-1</sup> nickel application. Generally, while the nickel doses increased flowering time, leaf length, plant length, flower length and flower diameter increased.



**Figure 1.** The effects of different nickel doses on first and full flowering time, and first flower withering time of *Narcissus* flowers



**Figure 2.** The effects of different nickel doses on leaf, plant and flower length of *Narcissus* plants

Selecting plant species for phytoremediation are one of the important criteria. It was request high growth rate and biomass yield in plants used by remediation aim (US EPA, 2000). Various researchers

reported that biomass production is inhibited in *Glycine max* and *Phaseolus vulgaris* (Kaplan et al., 1990), *Vallisneria spiralis* L. (Vajpayee et al., 2001) by

enhanced  $\text{VOSO}_4$  and Cr toxicity respectively.

On *Helianthus annuus*, *Tagetes erecta* and *Salvia splendens* species, increasing Cd doses (usually except  $10 \text{ mg Cd dm}^{-3}$ ) had a negative effect on plant height and flower widths (Bosiacki, 2008). The effect of increasing nickel concentration in the soil on the total plant length of *Dahlia* (*Georgina wild*) plant was decreasing compared to the control (Shivhare and Sharma, 2012). According to the researchers, shoots of the *Dahlia* are more tolerant than roots of *Dahlia* plant and the biomass and seed germination also affected by the nickel and lead toxicity above the normal concentration. After *Salvia splendens* plants were watered with increasing doses of nickel contaminated water, the entire vegetative (plant height, number of leaves per plant, leaves dry weight per plant, leaves area, number branches per plant, branches dry weight, root length, and root dry weight) and flowering (number of florets per spike, spike length, and flower dry weight) parameters were decreased (El-Shanhorey and Saker, 2018).

In these studies, although Ni and other heavy metal applications have negative effects on the plant, it can be seen that the

following studies have caused an increase in plant growth and flowering parameters.

In the study in which the *Alyssum* plant is a hyperaccumulator for Ni, it was determined that some species are hyperaccumulator plants (Brooks et al., 1979). Schickler and Caspi (1999) stated that the effect of some metals such as nickel on excessive anti-oxidative processes is rare. However, they also stated that low concentrations are useful for plants and high concentrations are effective.

*Althea roseae* and *Calendula officinalis* which are ornamental plants had strong tolerance to Cd contaminated media with high dry biomass production (Liu et al., 2008; Wang, 2005). *Althaea rosea* was also found tolerate to Pb toxicity with grew well (Wang, 2005). According to Özay and Mammadov (2013), although some heavy metals such as Copper (Cu), zinc (Zn), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni) and cobalt (Co) are necessary for plant's growth (Niess, 1999), micronutrients or not, the concentration of heavy metals in the atmosphere, water and soil above a certain level causes serious problems for all living things (Benavides, 2005). When the effect of increasing nickel doses on the life of the flowers of *Dianthus caryophyllus* L. flowers was found to have

a positive effect (Jamali and Rahemi, 2011). *Kocuria rhizophila* bacteria and citric acid applications had an important effect on plant growth, biomass production, chlorophyll content and Ni heavy metal intake of *Consolida ambigua* and *Calendula officinalis* L. It has been revealed that both ornamental plants can be used to reduce soil pollution in plant breeding (Anum et al., 2019).

As seen from previous studies, Ni doses had a decreasing or increasing effect on plant growth and flowering parameters by species. Acceptable Ni concentrations varying according to the type of plant emerged. In this context, the negative effects of Ni applications on the parameters examined in the daffodil plant were not found in our study.

In this study, *Narcissus* "Ice Folies" showed tolerance to nickel toxicity and grew well without toxicity symptoms. As a result, daffodil is promising to be used for phytoremediation.

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