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EFFECTS OF DIFFERENT NPK FERTILIZERS ON THE GROWTH AND DEVELOPMENT OF ZINNIA (*ZINNIA ELEGANS* (JASQ.))

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Summary: This research was conducted in order to determine optimal combination of NPK fertilizer to obtain high yield, good quality of flowers and high decorativeness. The experiment was set at the research field Rimski Šančevi, Faculty of Agriculture, Novi Sad in 2014 year. The seedlings were produced in the greenhouse and the young plants were implemented in the open field. The experiment included three treatments with 30 replicate plants per treatment. Four treatments were applied: 'Ferticare' 14-11-25 with microelements (S, Mg, Fe, Mn, B, Cu, Zn, Mo, Co), 'Kristalon Special'TM 18 + 18 + 18 (+ 3Mg), 'Kristalon Brown'TM 3 + 11 + 38 (+4 Mg) and control. Fertilizers were applied over the soil in certain concentrations. During the plant development following characteristics of zinnia have been monitored: plant height (cm), number of lateral shoots, number of leaves per plant, leaf length (cm), number of flowers per plant and dry and fresh root weight (g). It was observed that plants treated with fertilizer 'Ferticare' showed highest number of lateral shoots, highest foliar weight and a maximum root system weight. Plants treated with 'Kristalon Special' had the largest number of flowers per plant. Plants treated with 'Kristalon Brown' achieved greatest values of plant height. Fertilizer 'Ferticare' showed the best effects on plant decorativeness.

Key words: NPK fertilizers, *Zinnia elegans*, growth and development

INTRODUCTION

Zinnia is an annual flowering species originating from Central America (Mexico). It belongs to the family *Compositae*. There are about 20 species of zinnia but the most popular is *Zinnia elegans* (Jasq.). Zinnia has solitary flower heads (Javid et al, 2005). Flower of zinnia consists of ray and disc flowers. Ray flowers are white, cream, pink, red, and purple, yellow, apricot, orange, salmon, and bronze, while disc flowers are yellow, brown or black. The height of zinnia is 15 to 90 cm. Tall varieties are used in borders, beds and for cut flowers, whilst dwarf varieties are used in containers and window planters. Zinnia does not tolerate frost; hence it is a summer crop which flowers from May to October, in the conditions of Serbia.

Good quality of plants and high yield of large flowers can be achieved by proper combinations of NPK fertilizers. Nitrogen, phosphorus and potassium are important elements for the better plant growth and development as well as achievement of highly decorative plants. Jana and Pal (1991) stated that certain combinations of NPK fertilizers showed a positive impact in zinnia traits. Which combinations will be used primarily depends on the

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purpose of production. Each mineral element affects the particular characteristics of plants and finding the right combination of fertilizers provides high quality of plants.

The aim of this study was to find the optimal combination of nitrogen, phosphorus and potassium in NPK fertilizers that will give the most positive impact on growth and development of zinnia.

MATERIALS AND METHODS

Sowing seeds was carried out on March 20th, in 2014. year in containers of ϕ 5 cm. All standard nursing measures were applied during the production of seedlings. The plants began to sprout after 10 days from sowing. After 3-4 weeks after sowing, when the plants had two true leaves, they were transplanted into pots of ϕ 12 cm, after which first treatment with fertilizer was applied.

Treatments included: T1 - plants treated with 'Ferticare' 14-11-25 fertilizer with micro elements, T2-plants treated with 'Kristalon SpecialTM' 18 + 18 + 18 (+ 3Mg) fertilizer, T3-plants treated with 'Kristalon BrownTM' 3 + 11 + 38 (4 + Mg) fertilizer and C-control treatment. Fertilization was applied over the soil six times during the production in prescribed concentrations every 10 days. Plants were grown in open field where they have been marked and continuously observed through their growth and development. From the moment of transplantation until the end of the experiment plant height, leaf length, number of leaves, the number of lateral shoots and the number of flowers per plant were measured every 10 days. At the end of the production cycle root dry and fresh weights were measured.

The data collected were statistically analyzed by STATISTICA 12.(Dell, USA) which included average values, coefficients of variability (%) and correlations between measured parameters.

RESULTS

Maximum average plant height (50.61 cm) was obtained in the T3 treatment, while the minimum average height was obtained in control plants (31.96 cm) (Tab. 1). Although the nitrogen and phosphorus are extremely important for the growth of plants because of their role in the metabolism, in this case, the potassium proved to be favorable for achievement of certain plant height.

Table 1: Effect of NPK fertilizer on the growth and development of zinnia (*Zinnia elegans*)

\bar{X} Treatmans	Plant hight (cm)	Number of lateral shoots	Number of leaves	Leaf lenght (cm)	Number of flower	Fresh root weight (g)	Dry root weight (g)
T1	41.67 ^b	10.33 ^d	72.5 ^d	3.01 ^b	4.33 ^c	10.27 ^c	3.33 ^c
T2	43.73 ^c	10.13 ^c	69.23 ^c	2.78 ^a	4.70 ^d	6.80 ^a	2.48 ^a
T3	50.61 ^d	10.00 ^b	68.33 ^b	3.11 ^c	3.43 ^b	6.83 ^b	2.75 ^b
K	31.96 ^a	8.30 ^a	61.65 ^a	3.20 ^d	3.25 ^a	16.20 ^d	6.63 ^d
S.E.	2.01	0.24	1.19	0.05	0.18	1.15	0.50
CV%	16.60	8.74	6.06	5.41	16.18	39.95	45.76
SD	6.96	0.84	4.12	0.16	0.63	4.00	1.74

Values between treatments, followed by same letters do not differ significantly at 0.05 probability level.

The greatest numbers of lateral shoots were in the first treatment – T1 (10.33) and the lowest in control (8.3).

The maximum average number of leaves per plant was achieved in the first treatment - T1 (72.5 leaves), while the minimum average number of leaves was obtained in the control plants (61.65 leaves).

The maximum average leaf length (3.11 cm) was obtained by the third treatment (T3), while the minimum average leaf length (2.78 cm) was obtained in the second treatment (T2) (Fig. 2). Fertilizer 'Kristalon Brown' proved to be the right formulation for achievement of certain characteristics like plant height and improved leaf traits. 'Kristalon Special' showed moderately good results which is in accordance with El-Aziz (2007) who showed that use of 'Kristalon' 19-19-19 in lower concentrations, positively influenced leaf area in croton (*Codiaeum variegatum*).

The maximum average number of flowers per plant occurred in second treatment (T2) (4.7) while the minimum average number of flowers per plant was observed in the control (3.25).

The maximum average root weight was achieved in control plants (6.63 g), while among fertilizers T1 gave the best results (3.33 g). The lowest average root weight occurred in treatment T2 (2.48 g). Increased above-ground plant volume (high number of shoots and leaves) influenced by application of fertilizers decreased root system development.

Correlation analysis shown in table 2., indicated significantly high correlation between the number of lateral shoots and number of leaves ($r=0,96$), number of flower and leaf length ($r=0,94$) and dry and fresh root weight ($r=0,98$).

Table 2. Correlations of zinnia (*Zinnia elegans*) morphological characteristics

Variable	Leaf length	Number of leaves	Number of lateral shoots	Number of flower	Fresh root weight	Dry root weight
Plant height	0,34	0,64	0,79*	0,23	0,63	0,59
Leaf length		0,59	0,66	0,94*	0,66	0,71
Number of leaves			0,96*	0,72*	0,71	0,61
Number of lateral shoots				0,70*	0,57	0,55
Number of flower					0,53	0,64
Fresh root weight						0,98*

*Marked values are statistically significant for $p<0.05$

DISCUSSION

Fertilizer 'Kristalon Brown™' show positive effect on plant height. The positive effect of nitrogen, phosphorus and potassium in this formulation on the development of zinnia was noticed by other researchers (Henry, 1982; Javid, 2005; Baloch, 2010). A higher number of lateral shoots implies higher number of leaves, which makes the plant more ample. The positive effect of nitrogen, phosphorus and potassium in these formulations on the development of zinnia was noticed by other researchers (Henry, 1982; Javid, 2005; Baloch, 2010). Fertilizer 'Ferticare' 14-11-25 show best results for average number of leaves. Similar results was published by Pal (2010) with application of different levels of potassium fertilizers in African marigold (*Tagetes erecta*) and Belorkar (1992) who showed that potassium implied better overall growth. Larger number and better quality leaves occurred due to the presence of microelements in the formulation, which was previously reported in research conducted by Khosa (2011) in gerbera (*Gerbera jamesonii* L.). These results showed that the given concentration of the most important microelements in T1 provided the most positive characteristics of zinnia plants. The maximum average number of flowers per plant occurred treatment with 'Kristalon Special™' 18 + 18 + 18 (+ 3Mg) fertilizer. Abbasi (2004) obtained similar results with PK+AgNO₃ fertilizer in a production of zinnia flowers. Optimal dose of NPK fertilizers proved to be the best for maximum production of flowers, because the elements uniformly affected the metabolism of plants (Boodly and Meyer 1965). Maynard (2003) got similar results in his study of the impact of fertilizers on the production of cut flowers of zinnia, with application of NPK fertilizer in the formulation of 10-10-10, where he achieved a high quality and yield of flowers. According to Mark et al. (1998) nitrogen application at a higher rate than optimum reduced the number of flowers per plant in *Alstromeria*. Results indicated the negative impact of nitrogen on flowering, when applied below or above the optimum dose.

CONCLUSION

The results showed positive influence of NPK fertilizers of various formulations on the growth and development of zinnia (*Zinnia elegans* (Jasq.)). The formulation which has proven to be the most is 'Ferticare' 14-11-25 with microelements. This formulation provided the greatest vegetative volume- the largest number of lateral shoots and number of leaves. These plants were more decorative and the first to bloom. 'Fertilizer Kristalon Brown™' 3 + 11 + 38 (4 + Mg) showed moderately good results, while 'Kristalon Special™' 18 + 18 + 18 (+ 3Mg) fertilizer proved to be the least favorable for achieving good quality of zinnia plants.

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UTICAJ RAZLIČITIH NPK ĐUBRIVA NA RAST I RAZVOJ LEPOG GLIŠE
(*ZINNIA ELEGANS* (JASQ.))

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Izvod: Istraživanje je sprovedeno u cilju utvrđivanja optimalne kombinacije NPK đubriva kojom se postiže visok prinost, kvalitetan cvet i visoka dekorativnost lepog gliše. Ogled je postavljen u stakleniku, a rasad je realizovan na otvorenom polju oglednog dobra na Rimskim Šančevima, Poljoprivredni fakultet, Novi Sad u toku 2014. godine. Eksperiment je obuhvatio četiri tretmana sa po 30 biljaka. Primenjena đubriva su: 'Ferticare' 14-11-25 sa mikroelementima (S, Mg, Fe, Mn, B, Cu, Zn, Mo, Co), 'Kristalon Special™' 18 + 18 + 18 (+ 3Mg) i 'Kristalon Brown™' 3 + 11 + 38 (+4 Mg). Primena đubriva u preporučenim koncentracijama vršena je prilikom zalivanja preko supstrata. Tokom vegetacionog perioda praćene su i merene sledeće karakteristike: visina biljke (cm), broj bočnih izdanaka, broj listova po biljci, dužina lista (cm), broj cvetova po biljci i težina svežeg i suvog korena (g). Primećeno je da biljke tretirane đubrivom 'Ferticare' su imale najveći broj bočnih grana, najveći broj listova kao i masu svežeg i suvog korena. Biljke đubrene sa 'Kristalon Special™' imale su najveći broj cvetova po biljci, dok su biljke tretirane 'Kristalon Brown™' imale najveću visinu. Đubrivo 'Ferticare' pokazalo je najbolje efekte na dekorativnost biljaka lepog gliše.

Ključne reči: NPK đubriva, *Zinnia elegans*, rast i razvoj biljaka

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