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# Effect of gibberellic acid and potassium nitrate on seed germination of the resurrection plants *Ramonda serbica* and *Ramonda nathaliae*

Bekim Gashi<sup>1,2\*</sup>, Kasamedin Abdullai<sup>1</sup>, Valbona Mata<sup>2</sup> and Efigjeni Kongjika<sup>3</sup>

<sup>1</sup>Department of Biology, Faculty of Mathematics and Natural Sciences, University of Pristina, Republic of Kosovo.

<sup>2</sup>Department of Biotechnology, Faculty of Natural Sciences, University of Tirana, Albania.

<sup>3</sup>Section of Natural and Technical Sciences, Academy of Sciences of Albania.

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*Ramonda serbica* and *Ramonda nathaliae* are rare resurrection plants, endemic and relict species from Balkan Peninsula. The effect of gibberellic acid (GA<sub>3</sub>) and potassium nitrate (KNO<sub>3</sub>) were conducted to determine the seed germination response for these two species. An experiment was conducted with four replications and three treatments including: different concentrations of GA<sub>3</sub> (0, 250, 500 and 1000 part per million (ppm)) and KNO<sub>3</sub> (0, 0.1, 0.2 and 0.3% v/v) and their combination. Final germination percentage (FGP), mean germination time (MGT), germination rate index (GRI) and corrected germination rate index (CGRI) were measured. The highest FGP, GRI and CGRI of *R. serbica* were recorded in seeds treated with 1000 ppm GA<sub>3</sub> + 0.3% KNO<sub>3</sub>, while MGT in seeds control. The highest FGP and GRI of *R. nathaliae* were recorded in the seeds treated with 500 ppm GA<sub>3</sub>, while CGRI in seeds treated with 500 ppm GA<sub>3</sub> + 0.2% KNO<sub>3</sub>. The seeds of *R. nathaliae* treated with different concentration of KNO<sub>3</sub> had significantly higher germination compared to the control seeds, while the seeds of *R. serbica* did not have an effect on seed germination. The GA<sub>3</sub> and KNO<sub>3</sub> treatments of *Ramondas* seeds are suitable for the higher percentage of germinations.

**Key words:** *Ramonda serbica*, *Ramonda nathaliae*, seed germination, GA<sub>3</sub>, KNO<sub>3</sub>.

## INTRODUCTION

*Ramonda serbica* and *Ramonda nathaliae* (Gesneriaceae) belongs to a small group of rare resurrection plants of the Northern hemisphere, which originate from the Balkan Peninsula as an endemic and relict species of the Tertiary period. The distribution of *R. serbica* extends in these countries of Balkan Peninsula: Albania, Kosovo, Montenegro, Serbia, FYR Macedonia, Bulgaria and Greece, whereas, *R. nathaliae* is sited only

in FYR Macedonia, Serbia and Greece area. Their current distribution is restricted to the northern rocky slopes of gorges and canyons, mainly on foothills, reaching sometimes the alpine belts (Kosanin, 1921; Meyer, 1970). They all prefer limestone rocks, while *R. nathaliae* also settles on ophiolitic bedrock (Kosanin, 1921).

The ability of these *Ramonda* plants to live on harsh environmental conditions up till now have been researched on different aspects of morphological, physiological and biochemical as well as the propagation through *in vitro* cultivation. These researches has conveyed data to generate the cell membrane (Quartacci et al., 2002), antioxidative capacity (Sgherri et al., 2004; Jovanovic et al., 2011), photosynthetic activity (Augusti et al., 2001), CO<sub>2</sub> fixation and chlorophyll *a* fluorescence (Degl'Innocenti et al., 2008), genome size variation and polyploidy (Siljak-Yakovlev et al., 2008), osmotic

\*Corresponding author. E-mail: [bekim.gashi@uni-pr.edu](mailto:bekim.gashi@uni-pr.edu). Tel: +381(0)38 249 872/ 249 873/ 249 874, +38649600850. Fax: +381 38 226 104.

**Abbreviations:** GA<sub>3</sub>, Gibberellic acid; KNO<sub>3</sub>, potassium nitrate; PPM, part per million; FGP, final germination percentage; MGT, mean germination time; GRI, germination rate index; CGRI, corrected germination rate index.

adjustment (Zivkovic et al., 2005) and *in vitro* cultivation from seeds of *Ramonda* plants (Kongjika et al., 2002; Dontcheva et al., 2009; Gashi et al., 2011).

Nevertheless, up to now there is only a few data from previous studies on seeds germination of *R. serbica* and *R. nathaliae*. Till date, study on *Ramonda* species on seeds has not been found in literature. Our current study indicates an increase on the percentage of seeds germination for these species.

Gibberellins and potassium nitrate ( $\text{KNO}_3$ ) were used for breaking seed dormancy and promoting seed germination. Gibberellins is most directly implicated in the control and promotion of germination. A biochemical reaction known to be enhanced by GA is the synthesis of hydrolases (especially  $\alpha$  amylase) in the endosperm of cereal grains. Its breakdown is generally assumed to be an essential process of germination (Kolumbina et al., 2006). GA stimulates seed germination via amylase synthesis (Finch-Savage and Leubner, 2006).  $\text{KNO}_3$  is the most widely used chemical for promoting germination. Solutions of 0.1 to 0.2%  $\text{KNO}_3$  are common in routine germination testing and are recommended by the Association of Official Seed Analysts and the International Seed Testing Association for germination tests of many species (Copeland and Mc Donald, 1995; Basra, 1994). Nitrate (such as  $\text{KNO}_3$ ) clearly stimulates the germination of dormant seeds (Alboresi et al., 2005). The effect of  $\text{KNO}_3$  was discovered when it was proven that Knop's solution encourages germination of some plant species.

These species belong to the group of "resurrection plants" and need to be preserved as ornamental plants by cultivation. The propagation of European Gesneriad species from natural seeds is very slow and difficult. Therefore, the objective of this study was to determine the effect of different concentration of  $\text{GA}_3$  and  $\text{KNO}_3$  treatments on seed germination and devise an effective method for improving seed germination of *R. serbica* and *R. nathaliae*.

## MATERIALS AND METHODS

This research was conducted during 2011 in the Department of Biology, University of Pristina, Republic of Kosovo and Department of Biotechnology, University of Tirana, Albania. The study was carried out with *R. serbica* seeds collected from native populations in the gorge of Matos, Sharri Mountains (Kosovo) at an altitude of 910 m, and with *R. nathaliae* seeds collected from gorge of River Vardar near village Radusha (FYR Macedonia) at an altitude of 405 m.

### Seed treatments

For the two *Ramonda* plants, all the seeds were disinfected with ethanol 70% for three minutes and rinsed three times with distilled and sterilized water, before treatments. After the disinfection, the seeds were divided into four treatment groups: (1) seeds of the first group were soaked on  $\text{H}_2\text{O}$ -distilled water (control); 2) seeds of the

second group were treated with 0.1, 0.2 and 0.3% (v/v) potassium nitrate ( $\text{KNO}_3$ ) for 24 h; 3) likewise, similar to the previous treatment, the seeds of the third group were put into flasks containing 250, 500 and 1000 ppm gibberellic acid ( $\text{GA}_3$ ) for 24 h; and 4) seeds of the fourth group were soaked in aqueous solutions supplemented with 250 ppm  $\text{GA}_3$  + 0.1%  $\text{KNO}_3$ , 250 ppm  $\text{GA}_3$  + 0.2%  $\text{KNO}_3$ , 250 ppm  $\text{GA}_3$  + 0.3%  $\text{KNO}_3$ , 500 ppm  $\text{GA}_3$  + 0.1%  $\text{KNO}_3$ , 500 ppm  $\text{GA}_3$  + 0.2%  $\text{KNO}_3$ , 500 ppm  $\text{GA}_3$  + 0.3%  $\text{KNO}_3$ , 1000 ppm  $\text{GA}_3$  + 0.1%  $\text{KNO}_3$ , 1000 ppm  $\text{GA}_3$  + 0.2%  $\text{KNO}_3$ , 1000 ppm  $\text{GA}_3$  + 0.3%  $\text{KNO}_3$ , for 24 h in  $\text{GA}_3$  and 24 h in  $\text{KNO}_3$ , respectively. For the all seeds groups, the experiment was conducted with four replicates of 100 seeds which were germinated on top of double layered papers (ISTA, 1996) with 5 ml of water in 10 cm Petri dishes. These Petri dishes were placed in sealed plastic bags to avoid moisture loss. Seeds were allowed to germinate at  $24 \pm 1^\circ\text{C}$  and at light regime 16 h light (day)/8 h darkness (night).

### Germination tests

The germination percentage is an estimate of the viability of seeds. Germinated seeds were counted every 48 h for 29 days. According to Sharma and Sharma (2010), seeds were considered germinated upon emergence of radicles ( $\geq 2$  mm). The following germination parameters were recorded:

1) FGP is:  $\text{FGP} = (\text{number of germinated seeds} / \text{number of total seeds}) \times 100$ .

2) MGT was calculated according to the following equation (Moradi et al., 2008).

$$\text{MGT} = \sum Dn / \sum n$$

Where, n is the number of seeds which were germinated on day D, and D is the number of days counted from the beginning of germination.

$$3) \text{GRI} = [(G1/1) + (G2/2) + (Gx/X)]$$

Where, G is the germination on each alternate day after placement 1, 2 and x is the corresponding day of germination (Esechie, 1994)

$$4) \text{CGRI} = (\text{GRI} / \text{FGP}) \times 100$$

Where, FGP is the final germination percentage.

### Statistical analysis

The statistical design was a completely randomized design. Four replications and 100 seeds per replicate were used. The mean and one-way ANOVA were calculated using SPSS software. The means were compared using Duncan's multiple range tests at 5% level of probability and least significant difference (LSD) test with the statistical significance set at P 0.01 and P 0.05 levels.

## RESULTS AND DISCUSSION

The results of the analysis of variance of mean square for the germination parameters of *R. serbica* and *R. nathaliae* are shown in Table 1. The highly significant differences of the double interaction effects on traits (Gibberellin +  $\text{KNO}_3$ ) of FGP, MGT, GRI and CGRI were

**Table 1.** Analysis of variance of gibberellic acid and potassium nitrate effects on seed germination properties for *R. serbica* and *R. nathaliae*.

SOV	df	Mean Square			
		FGP	MGT	GRI	CGRI
<b><i>R. serbica</i></b>					
Gibberellin	3	2527.838**	0.609*	309.129**	15.205*
KNO <sub>3</sub>	3	1.198 <sup>NS</sup>	0.399 <sup>NS</sup>	0.118 <sup>NS</sup>	5.527 <sup>NS</sup>
Gibberellin * KNO <sub>3</sub>	9	1821.001**	2.080**	275.549**	21.321**
<b><i>R. nathaliae</i></b>					
Gibberellin	3	363.888**	15.457**	262.930**	270.130**
KNO <sub>3</sub>	3	656.178**	11.852**	99.772*	191.172**
Gibberellin * KNO <sub>3</sub>	9	145.870**	7.072**	133.862*	127.556**

NS,\*\* and \* are respectively non significant and significant at the P 0.01 and 0.05 levels. FGP, Final germination percentage; MGT, mean germination time; GRI, germination rate index; CGRI, corrected germination rate index.

**Table 2.** Mean of FGP, MGT, GRI and CGRI for seeds of *R. serbica* under various levels of GA<sub>3</sub> (in ppm) and KNO<sub>3</sub> (in %).

Treatment	FGP	MGT	GRI	CGRI
Control (H <sub>2</sub> O)	9.26 <sup>g</sup>	17.14 <sup>h</sup>	2.79 <sup>h</sup>	30.24 <sup>i</sup>
KNO <sub>3</sub> (0.1)	10.37 <sup>g</sup>	16.78 <sup>fg</sup>	3.25 <sup>h</sup>	31.54 <sup>gh</sup>
KNO <sub>3</sub> (0.2)	9.63 <sup>g</sup>	16.59 <sup>fg</sup>	3.12 <sup>h</sup>	32.37 <sup>fgh</sup>
KNO <sub>3</sub> (0.3)	8.89 <sup>g</sup>	16.27 <sup>ef</sup>	2.96 <sup>h</sup>	33.46 <sup>efg</sup>
GA <sub>3</sub> (250)	58.15 <sup>f</sup>	16.48 <sup>fg</sup>	18.36 <sup>g</sup>	31.58 <sup>gh</sup>
GA <sub>3</sub> (500)	68.40 <sup>e</sup>	16.15 <sup>def</sup>	23.90 <sup>f</sup>	34.99 <sup>c-f</sup>
GA <sub>3</sub> (1000)	71.85 <sup>d<sub>e</sub></sup>	16.23 <sup>ef</sup>	24.64 <sup>f</sup>	34.33 <sup>c-g</sup>
GA <sub>3</sub> (250) + KNO <sub>3</sub> (0.1)	75.93 <sup>cd</sup>	15.60 <sup>cde</sup>	25.90 <sup>f</sup>	34.11 <sup>d-g</sup>
GA <sub>3</sub> (250) + KNO <sub>3</sub> (0.2)	82.15 <sup>bc</sup>	15.18 <sup>c</sup>	30.10 <sup>de</sup>	36.85 <sup>a-d</sup>
GA <sub>3</sub> (250) + KNO <sub>3</sub> (0.3)	85.93 <sup>ab</sup>	14.79 <sup>abc</sup>	31.48 <sup>cd</sup>	36.65 <sup>a-e</sup>
GA <sub>3</sub> (500) + KNO <sub>3</sub> (0.1)	75.70 <sup>cd</sup>	14.99 <sup>bc</sup>	28.44 <sup>e</sup>	37.58 <sup>abc</sup>
GA <sub>3</sub> (500) + KNO <sub>3</sub> (0.2)	91.81 <sup>a</sup>	15.26 <sup>c</sup>	33.74 <sup>bc</sup>	36.76 <sup>a-d</sup>
GA <sub>3</sub> (500) + KNO <sub>3</sub> (0.3)	89.26 <sup>ab</sup>	14.17 <sup>a</sup>	34.71 <sup>ab</sup>	38.90 <sup>ab</sup>
GA <sub>3</sub> (1000) + KNO <sub>3</sub> (0.1)	87.37 <sup>fg</sup>	15.39 <sup>cd</sup>	31.53 <sup>cd</sup>	36.14 <sup>b-e</sup>
GA <sub>3</sub> (1000) + KNO <sub>3</sub> (0.2)	82.22 <sup>bc</sup>	15.01 <sup>bc</sup>	30.79 <sup>de</sup>	37.32 <sup>a-d</sup>
GA <sub>3</sub> (1000) + KNO <sub>3</sub> (0.3)	92.26 <sup>a</sup>	14.22 <sup>ab</sup>	36.70 <sup>a</sup>	39.82 <sup>a</sup>

Mean in each column followed by same letters are not significantly different at the P 0.05 level using Duncan test. FGP, Final germination percentage; MGT, mean germination time; GRI, germination rate index; CGRI, corrected germination rate index.

ascertained for *R. serbica* and single effect (Gibberellin) for *R. nathaliae*.

### Final germination percentage

Based on the results (Table 2) for FGP, significant difference was ascertained for *R. serbica* between seeds treated with a different gibberellic acid concentration (250, 500 and 1000 ppm GA<sub>3</sub>) and with combination of different concentration of potassium nitrate (0.1, 0.2 and 0.3% KNO<sub>3</sub>) and untreated seeds (control). The highest germination percentage was detected in the seeds treated with 1000 ppm GA<sub>3</sub> + 0.3% KNO<sub>3</sub> (92.26%) and

500 ppm GA<sub>3</sub> + 0.2% KNO<sub>3</sub> (91.81%), compared to the control seeds (9.26%). Our results is in agreement with the results of Shanmugavalli et al. (2007), who treated seeds of sorghum with GA<sub>3</sub> (100 ppm) in combination with 0.5, 1, and 1.5% KNO<sub>3</sub> and obtained a germination percentage of 94%. Additionally, Amri, (2011) treated seeds of *Terminalia sericea* with GA<sub>3</sub> (400 ppm) and confirmed a higher percentage of germination (67%) compared with the control. In our experiment, the seeds of *R. serbica* treated with different concentration of KNO<sub>3</sub> (0.2 and 0.3%) did not show significant results for FGP, and on the contrary, treatment with 0.3% KNO<sub>3</sub> inhibited the seeds germination (Table 2).

Similar results were reported from other authors, such

**Table 3.** Mean of FGP, MGT, GRI and CGRI for seeds of *R. nathaliae* under various levels of GA<sub>3</sub> (in ppm) and KNO<sub>3</sub> (in %).

Treatment	FGP	MGT	GRI	CGRI
Control (H <sub>2</sub> O)	27.66 <sup>e</sup>	15.30 <sup>c</sup>	11.13 <sup>e</sup>	40.80 <sup>d</sup>
KNO <sub>3</sub> (0.1)	40.00 <sup>bc</sup>	12.80 <sup>b</sup>	20.86 <sup>cd</sup>	51.80 <sup>c</sup>
KNO <sub>3</sub> (0.2)	43.66 <sup>ab</sup>	11.34 <sup>a</sup>	24.85 <sup>bc</sup>	57.10 <sup>abc</sup>
KNO <sub>3</sub> (0.3)	31.66 <sup>cd</sup>	10.89 <sup>a</sup>	18.52 <sup>d</sup>	58.30 <sup>ab</sup>
GA <sub>3</sub> (250)	48.33 <sup>ab</sup>	11.14 <sup>a</sup>	27.59 <sup>ab</sup>	57.13 <sup>abc</sup>
GA <sub>3</sub> (500)	52.33 <sup>a</sup>	10.18 <sup>a</sup>	32.83 <sup>a</sup>	62.85 <sup>ab</sup>
GA <sub>3</sub> (1000)	47.00 <sup>ab</sup>	11.30 <sup>a</sup>	26.77 <sup>abc</sup>	57.14 <sup>abc</sup>
GA <sub>3</sub> (250) + KNO <sub>3</sub> (0.1)	45.66 <sup>ab</sup>	11.08 <sup>a</sup>	26.82 <sup>abc</sup>	58.67 <sup>ab</sup>
GA <sub>3</sub> (250) + KNO <sub>3</sub> (0.2)	48.00 <sup>ab</sup>	10.34 <sup>a</sup>	29.74 <sup>ab</sup>	61.91 <sup>ab</sup>
GA <sub>3</sub> (250) + KNO <sub>3</sub> (0.3)	47.33 <sup>ab</sup>	10.35 <sup>a</sup>	29.10 <sup>ab</sup>	61.45 <sup>ab</sup>
GA <sub>3</sub> (500) + KNO <sub>3</sub> (0.1)	49.33 <sup>ab</sup>	10.02 <sup>a</sup>	30.87 <sup>ab</sup>	62.88 <sup>ab</sup>
GA <sub>3</sub> (500) + KNO <sub>3</sub> (0.2)	50.66 <sup>a</sup>	10.20 <sup>a</sup>	32.05 <sup>a</sup>	63.39 <sup>a</sup>
GA <sub>3</sub> (500) + KNO <sub>3</sub> (0.3)	51.66 <sup>a</sup>	10.68 <sup>a</sup>	30.92 <sup>ab</sup>	59.80 <sup>ab</sup>
GA <sub>3</sub> (1000) + KNO <sub>3</sub> (0.1)	51.00 <sup>a</sup>	11.17 <sup>a</sup>	29.65 <sup>ab</sup>	58.12 <sup>ab</sup>
GA <sub>3</sub> (1000) + KNO <sub>3</sub> (0.2)	48.66 <sup>ab</sup>	11.47 <sup>a</sup>	27.45 <sup>ab</sup>	56.35 <sup>bc</sup>
GA <sub>3</sub> (1000) + KNO <sub>3</sub> (0.3)	45.00 <sup>ab</sup>	10.73 <sup>a</sup>	26.65 <sup>abc</sup>	59.11 <sup>ab</sup>

Mean in each column followed by same letters are not significantly different at the P 0.05 level using Duncan test. FGP, Final germination percentage; MGT, mean germination time; GRI, germination rate index; CGRI, corrected germination rate index.

as Rouhi et al. (2010) for *Tulipa kaufmanniana* seeds treated with 0.1, 0.2 and 0.3% KNO<sub>3</sub> and ascertained that there was no stimulation of the germination. Moreover, the effect of pre-treatment with solutions of potassium nitrate (KNO<sub>3</sub>) on seed germination *Terminalia sericea* was not significant (Amri, 2011). On the other hand, Yücel and Yilmaz (2009) confirmed the inhibiting effect of germination on seeds of *Salvia cyanescens* treated with different concentrations of KNO<sub>3</sub>. Ali et al. (2010) showed that the using 0.1 and 0.2% KNO<sub>3</sub> did not have a huge effect on germination of *Plantago ovata*. Similar results were also reported in *Panicum maximum* by Previero et al. (1996) and Usberti et al. (2000) in many plant species.

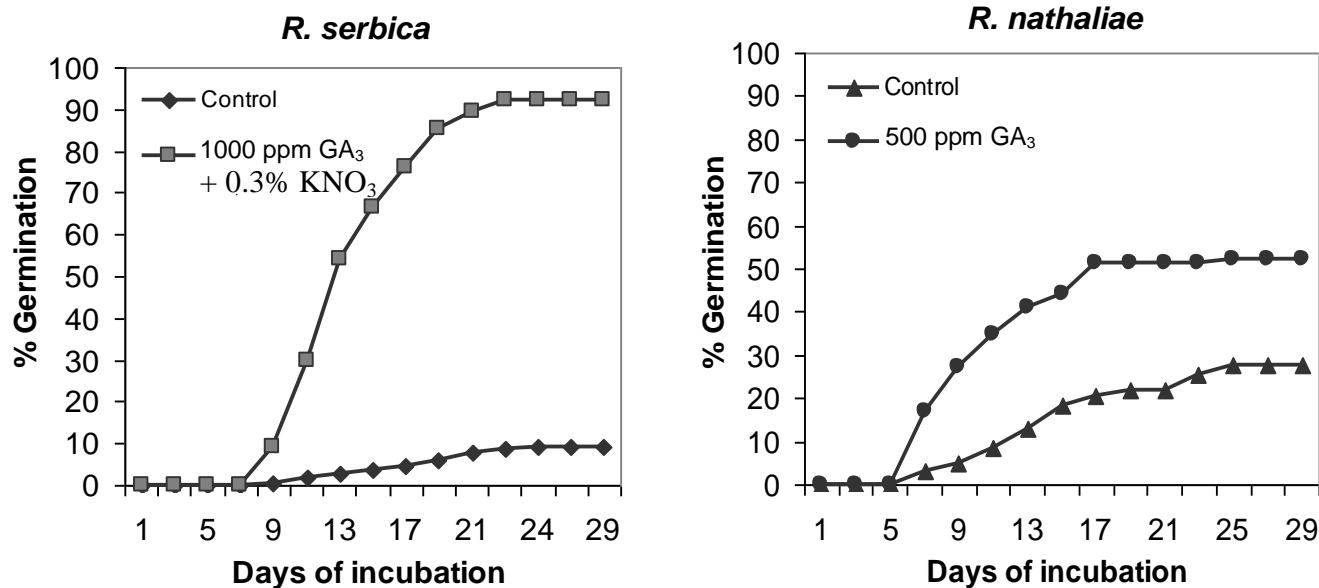
Concerning the FGP at *R. nathaliae* seeds for all treatments, significant difference was detected compared with the control (Table 3). Seeds treated with 500 ppm GA<sub>3</sub> had the highest percentage of germination compared to the control seeds (52.33 and 27.66% respectively). According to Liopa-Tsakalidi and Barouchas (2011), the seeds germination of chervil treated with GA<sub>3</sub> concentrations 200, 500 and 1000 ppm is significantly higher than the corresponding one in H<sub>2</sub>O treatment. In addition, the best germination percentage for the seeds of *Sabal palmetto* is in treatments with 1% KNO<sub>3</sub> and 500 ppm GA<sub>3</sub> respectively (Dewir et al., 2011). Kabar and Baltepe (1990), showed that seeds of barley and lettuce treated with GA<sub>3</sub> recorded higher values of germination seeds. Gashi et al. (2011) confirmed that the seeds germination of *R. nathaliae* in concentration of higher gibberellic acid did not exceed 50%. At the seeds of *R. nathaliae* (Table 3), higher FGP was confirmed with 0.1 and 0.3% KNO<sub>3</sub>, especially with 0.2% KNO<sub>3</sub> compared with the control

seeds (40.00, 31.66, 43.66 and 27.66% respectively). Similar results were obtained in the studies carried out on seeds of sorghum soaked in 0.5 and 1% potassium nitrate (KNO<sub>3</sub>), improved germination up to 44%, but again it was not a complete success (Shanmugavalli et al., 2007).

*R. serbica* seeds treated with different concentration of GA<sub>3</sub> and with combination of KNO<sub>3</sub> had higher FGP compared to *R. nathaliae* seeds (Figure 1), whilst at the untreated seeds (control), the highest FGP was gotten from *R. nathaliae* (9.26 and 27.66% respectively). For the seeds of *R. serbica* treated with 1000 ppm GA<sub>3</sub> + 0.3% KNO<sub>3</sub>, the germination started on the day 9<sup>th</sup> of incubation, while for the control seeds on the day 10<sup>th</sup>. At the *R. nathaliae*, the germination start was the same for treated as well as for the control seeds, the germination started on the day 7<sup>th</sup> (Figure 1). Regarding the first day of seeds germination of *R. serbica*, our results are consistent with the results obtained by Stefanovic et al. (1986), who in seeds of *R. serbica* treated with 100 µg/ml GA<sub>3</sub>, had germination starting after day 9<sup>th</sup> of incubation and the germination percentage reached around 90%.

### Mean germination time

At the *R. serbica* seeds, the best treatment for this trait with the lowest values (14.17) was detected in seeds treatment with 500 ppm GA<sub>3</sub> + 0.3% KNO<sub>3</sub>, whilst for *R. nathaliae* (10.02) in treatment with 500 ppm GA<sub>3</sub> + 0.1% KNO<sub>3</sub> (Tables 1 and 2). MGT between different concentration treatments of GA<sub>3</sub> and KNO<sub>3</sub> and their



**Figure 1.** Minimum and maximum germination percentage at *R. serbica* and *R. nathaliae*, counted 29 days after seeds incubation.

combination in comparison with the control seeds, there was a significant difference for *R. nathaliae*, while for *R. serbica* only between different concentration of  $GA_3$  and combination with  $KNO_3$  compared with the control. Our results for this parameter are consistent with the results obtained by Ganaie et al. (2011) on *Arnebia benthamii* seeds, where the low values of MGT was confirmed at treated seeds with different concentration of  $KNO_3$  and 25 ppm  $GA_3$  in comparison with the control seeds. Similar results were reported in *Descurainia sophia* and *Plantago ovata* treated seeds with prechiling 0.3%  $KNO_3$  which have shown significant differences for MGT in comparison with the control seeds (Ali et al., 2010).

#### Germination rate index and corrected germination index

The highest value of GRI and CGRI in *R. serbica* (36.70 and 39.82 respectively) was at the treatment with 1000 ppm  $GA_3$  + 0.3%  $KNO_3$ . Comparing control and treatments with only  $KNO_3$ , the treated seeds with different concentration of  $GA_3$  and with combination of  $KNO_3$  differed significantly for GRI and CGRI at *R. serbica*.

The application of treatments with different concentration of  $GA_3$  and  $KNO_3$  as well as their combination for *R. nathaliae* seeds had significant differences for GRI and CGRI between controls and treatments. Treatment in the seeds of these species with 500 ppm  $GA_3$  had highest value (32.83) in GRI, while the treatment with 500 ppm  $GA_3$  + 0.2%  $KNO_3$  (63.39) was in CGRI. Dewir et al. (2011) reported the same results for *S. palmetto* seeds treated with 1, 2 and 3%  $KNO_3$  and 100, 250 and 500

ppm  $GA_3$ , significant differences for germination rate index and corrective germination rate index between the treated seeds and those controlled ones was obtained. Zare et al. (2011) confirmed that the *Ferula assa foetida* seeds treated with higher concentration of  $GA_3$  (2000 ppm) had higher germination rate values compared to the lower concentrations. Approximate results were ascertained as well in *Lupinus diffusus* seeds (Dehgan et al., 2003) and *Anthriscus cerefolium* (Liopa-Tsakalidi and Barouchas, 2011).

#### Conclusions

Based on the analysis of the obtained results, we can conclude that the best way to increase percentage germination of *R. nathaliae* is the seeds treatment during the 24 h with 500 or 1000 ppm  $GA_3$  and thus there will be growth in seeds germination percentage.

For the *R. serbica* seeds, the 24 h treatment with 1000 ppm  $GA_3$  in combination with different concentration of  $KNO_3$  is the treatment which increases the seeds germination up to 90% and more.

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