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Short Communication

Effect of different levels of gibberellic acid on seed sprouting of some species of Salvia genus grown in Iran

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The harmful effects of chemicals and the side effects of chemical drugs on human health have widely focused global attention on herbal drugs and medicinal plants. The increasing use of medicinal plants in the world is more than enough to show the significance of cultivating and producing such plants. Seeds of most medicinal plants have very long dormancy periods, so shortening the dormancy period and increasing sprouting rates through laboratory methods, may be effective in the proliferation of medicinal plants. Salvia L. is a member of the family *Lamiaceae* with more than 900 species all over the world. One of the most important physiological roles of gibberellic acid concerns its effects on seed sprouting. So, an experiment was run in the form of completely random blocks in 3 iterations to study the effects of different levels of gibberellic acid on seed sprouting of 5 different species of Salvia. Four sprouting treatments were applied to seeds of each species and the sprouting process was studied inside incubators at a temperature of 22°C. Experiment data were analyzed by SPSS 16 software. Results indicated that gibberellic acid treatment resulted in a significant ($p<0.01$) increase of sprouting percentage in *Khardar Salvia*, *Ghoochani Salvia*, *Arghavani Salvia*, *Tamashaei Salvia*, and *Jonoobi Salvia*. These results may be used as a good strategy for shortening dormancy periods and increasing sprouting rates of such seeds.

Key words: *Salvia* L., seed, sprouting, gibberellic acid, Lamiaceae, Iran.

INTRODUCTION

The harmful effects of chemicals and the side effects of chemical drugs on human health have widely focused global attention on herbal drugs and medicinal plants. The increasing use of medicinal plants in the world is more than enough to show the significance of cultivating and producing such plants. Seeds of most medicinal plants have diverse dormancy properties to be capable of adapting different climatic conditions. Thus providing suitable conditions for sprouting of medicinal plant seeds is a necessary (Amu Aghaei, 2005; Cao et al., 2011; Sharma et al., 2011; Ebadi and Hisoriev, 2011). Giberrellic acid is today known as a very efficient stimulating factor for breaking dormancy and increasing sprouting in many agronomic and horticultural crops (Faghihi and Radan, 2011). *Salvia* L. is a member of the family Lamiaceae with more than 900 species all over the world (Mozaffarian, 1998). Many good properties have been attributed to Salvia such as anti-seizure and anti-coughing (Zargari, 1991; Amu Aghaei, 2005; Arteka, 2000; Bewley and Black, 1982; Dunand, 1992; Faghihi and Radan, 2011; Heartman, 1999). Due to positive effects of gibberellic acid on seed sprouting properties, this study was run to find the effects of this compound on sprouting properties of Salvia and finding the best concentration of the acid to be used for sprouting of the plant.

MATERIALS AND METHODS

Seeds of five species of Salvia were collected from slopes of

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Table 1. Analysis of variance of gibberellic acid effects on *Salvia spinosa* sprouting.

Source of change	Degree of freedom	Mean squares
Gibberellic acid	3	34.45 **
Error	8	3.56
Total	11	-

** Significant at (p<0.01).

Table 2. Average sprouting percent due to gibberellic acid in *Salvia spinosa*.

Gibberellic acid concentration (particles/million)	Sprouting percent
50	29.4^{A}
100	35.1^{B}
150	40.4^{C}
200	48.9^{D}

Table 3. Analysis of variance of gibberellic acid effects on *Salvia chloroleuca* sprouting.

Source of change	Degree of freedom	Mean squares
Gibberellic acid	3	36.35**
Error	8	3.87
Total	11	-

** Significant at (p<0.01).

Table 4. Average sprouting percent due to gibberellic acid in *Salvia chloroleuca*.

Gibberellic acid concentration (particles/million)	Sprouting percent
50	31.2^{A}
100	36.8^{B}
150	41.9^{C}
200	49.7^{D}

Table 5. Analysis of variance of gibberellic acid effects on *Salvia multicaulis* sprouting.

Source of change	Degree of freedom	Mean squares
Gibberellic acid	3	33.43
Error	8	3.55
Total	11	-

mountains in Lar region (Fars Province) in June 2009. The species included Khardar (*Salvia Spinosa*), Ghoochani (*Salvia chloreleuca*), Arghavani (*Salvia multicaulis*), Tamashaei (*Salvia hydrangea*) and Jonoobi (*Salvia sharifii*).

Table 6. Average sprouting percent due to gibberellic *acid in Salvia multicaulis*.

Gibberellic acid concentration (particles/million)	Sprouting percent
50	31.4^{A}
100	36.9^{B}
150	42.1^{C}
200	49.8^{D}

Table 7. Analysis of variance of gibberellic acid effects on *Salvia hydrangea* sprouting.

Source of change	Degree of freedom	Mean squares
Gibberellic Acid	3	25.75 **
Error	8	2.74
Total	11	-

** Significant at (p<0.01).

Table 8. Average sprouting percent due to gibberellic acid in *Salvia hydrangea*.

Gibberellic acid concentration (particles/million)	Sprouting percent
50	27.4^{A}
100	35.5^{B}
150	42.3^{C}
200	50.4^{D}

Seeds were washed with water for 15 min and soaked in soapy water for 15 min, after which they were then sterilized under laminar hood blowing 70% alcohol (2 to 3 min) and 1% sodium hypochlorite including 2 to 3 drops of water (15 to 20 min). After each stage the seeds were washed with sterilized distilled water. The sterilized seeds were cultured on a petri dish on filter paper at concentrations of 50, 100, 150, and 200 particles in million GA_3. They were then incubated at 22°C for 12 weeks. The experiment was done as a completely random block in 3 iterations. Percentages of seed sprouting were calculated at the end of each week in the whole 3 months, using the following formula:

Sprouting percentage = 100 × (sprouted seeds count / total seeds count)

Statistical analysis of obtained data was done by SPSS (version 16) and mean comparisons were done by FLSD test.

RESULTS AND DISCUSSION

One month after the treatment of seeds with GA_3, their dormancy was broken and they began sprouting. Maximum rate of sprouting was obtained with a gibberellic acid concentration of 200 (Tables 1 to 10). Gibberellic acid hormone breaks the dormancy induced by seed embryo and membranes and eliminates the

Table 9. Analysis of variance of gibberellic acid effects on *Salvia sharifii* sprouting.

Source of change	Degree of freedom	Mean squares
Gibberellic acid	3	43.38 **
Error	8	4.62
Total	11	-

** Significant at ($p<0.01$).

Table 10. Average sprouting percent due to gibberellic acid in *Salvia sharifii*.

Gibberellic acid concentration (particles/million)	Sprouting percent
50	31.3^{A}
100	38.9^{B}
150	47.2^{C}
200	55.6^{D}

inhibiting effects of abscisic acid in direct or indirect manners.

The most important seed inhibitor is abscisic acid, which is reduced to some extend by washing or soaking. Declined levels of abscisic acid tend to increase embryo sensitivity to gibberellic acid when passing from dormancy to non-dormant state in seeds of many species. At the time of sprouting, gibberellic acid causes the production of α-amylase enzyme, which in turn hydrolyzes starch into sugar, which is the vital source of energy for the sprouting process (Kucera et al., 2005; Mozafarian, 1998).

Gibberellic acid interferes in the sprouting process at two different phases. In phase I, it has been suggested that gibberellic acid works on the chromosome replication in the first phase of enzyme production and in the next phase in which it is very critical, gibberellic acid activates the enzymes interfering with nutrient transfer systems. External application of gibberellic acid on the seeds may also result in the breaking of seed sprouting and birth of sprouts.

At the time of sprouting in the seed and through hydrolysis of reserved nutrients, gibberellic acid directly engages in the growth of the sprout (Kepczynski and Groot, 1989; Kucera et al., 2005; Mozafarian, 1998; Varner, 1964; Zargari, 1991).

Conclusion

From the findings of this study, it can be concluded that treatment of seeds of *Salvia* species (*S. Spinosa, S. chloreleuca, S. multicaulis, S. hydrangea and S. sharifii*) with a concentration of 200 particles/million gibberellic acid is a good way of breaking seed dormancy and promoting sprouting properties. Hence, this treatment may be used to increase sprouting speed and rates of seeds.

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