Technical Report

Effect of Humic Acid on Germination Indexes and Morphological Characteristics of Isabgol (*Plantago ovata* Forssk), Borage (*Borago officinalis* L.) and Chicory (*Cichorium intybus* L.) in Lab Condition

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Introduction

Iran is a country with different climate conditions and rich plant flora. Besides of a long history in the use and production of medicinal plants, the report of the Iran`s medicinal plant on production and consumption is not suitable. Failure in treating many diseases, namely chronic ones, chemical medicines' side effects and microorganisms' increasing resistance against many medications, particularly antibiotics are reasons for considering herbal medicines. As far as medicinal plants production is concerned, true value is dedicated to the product quality and sustained production, product quantity is in second place of prominence. In such a way that suitable and right application of foods and nutrients during implant, grow, and harvest of medicinal plants not only plays a significant role in increasing the performance but is really influential on the quality and quantity of their ingredients therefore, using a suitable fertilizer is a main factor in successful planting of medicinal plants. In this regard, the application of organic acids to improve the quality and quantity of agricultural products has been widely prevalent. Among these acids, humic acid is one of the most important organic fertilizers which can positively affect plants' growth and increases nitrogen, potassium, calcium, magnesium, and phosphorus absorption by the plant. In spite of numerous studies in case of the effect of humic acid on garden and agricultural plants, very few studies have been carried out regarding the effect of humic acid on medicinal plants, thus the present study aims to investigate the effect of humic acid on germination and morphological characteristics of the medicinal plants' seeds *Plantago ovata* Forssk, *Borago officinalis* L. and *Cichorium intybus* L. in order to determine the best response of these species to the applied concentrations of humic acid.

Materials and Methods

The experimental design was completely randomized with five replicates. The seeds were disinfected by 5% sodium hypochlorite for three minutes, then they were rinsed with distilled water. Twenty-five seeds of the plant were set evenly throughout each petri dish. Humic acid at four levels (0, 5, 15, 30 g L^{-1}) was applied to the seeds in petri dishes. The first counting of the germinated seeds occurred 24 hours after transferring them to the petri dish and the seeds whose radicals were observable, were counted as germinated and brought out of the petri. Germination seeds were counted and recorded daily. On the last counting day (the 6^{th} day), the radicle and pedicle length, dry and fresh weights of seedling were measured. After 6 days, having fixed the number of the germinated seeds and having finished the growth period, the germination indices, including germination rate, germination percentage, germination time, and seed vigor index measured. The seedling vigor index (SVI) and allometric coefficient were determined at the end of growing trial after calculating the pedicle and radicle lengths. In this respect, viability is the final germination percentage. In each petri dish, 10 seedlings were randomly chosen and the radicle and pedicle lengths were calculated by a caliper. Then in order to determine the dry weight, the samples were washed with distilled water and after having removed the radicle and pedicle, they were placed in the oven. Statistical analyses of the experimental data were performed using the SPSS 18.0. The statistical processing was mainly conducted by analysis of variance (ANOVA). Duncan test post hoc analysis was performed to define which specific mean pairs were significantly different.

Results

Results revealed that humic acid had significantly effect on germination rate and seed vigor index of *P. ovata* Forssk ($P<0.05$). The highest and the lowest germination rates, the highest and the lowest seed vigor index were in dose of 30 gLi^{-1} and the control treatment, respectively, whereas humic acid did not affect germination percentage and mean of germination time. Humic acid showed significant

effect on radical length and dry weight ($p<5\%$), length and pedicel dry weight, and allometric coefficient ($p<5\%$). However, seedlings were not different significantly in radical and pedicle fresh weight in response to humic acid. The highest and the lowest radical length, the highest and the lowest radical dry weight, the highest and the lowest pedicel dry weight were measured in dose of 30 g Li^{-1} and the control treatment, respectively. The highest pedicel length was related to dose of 15 g Li^{-1} and the lowest was observed in the control treatment. The highest allometric coefficient was obtained in 30 gLi^{-1} dosage. The same results obtained for *C. intybus* L. and *B. officinalis* L. Results revealed that the effect of humic acid on germination indexes of *C. intybus* L. was significant, except for germination percentage and mean of germination time ($p<1\%$). In addition, results showed that humic acid was effective on morphological indexes of *C. intybus* L., except for radical and pedicel dry weight. Impact of humic acid was effective on germination indexes of *B. officinalis* L. except for germination percentage ($p<1\%$) and was only effective on morphological indexes include: radical fresh weight, seedlings pedicle length and allometric coefficient. The most effect was calculated in 30 g Li^{-1} and the control treatment had the least effect on the plant's properties. In general, results showed that application of humic acid in dose of 30 g Li^{-1} was effective in germination of the plant species and stimulated the plant germination more.