Effect of Benzyladenine Foliar Sprays on Offsets Production and Root Growth of *Aloe Barbadensis* Miller.

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Abstract: Aloe vera (*Aloe barbadensis*) is one of the most important medicinal plants and used world wide in drug and cosmetic industry. In order to determine the effect of different BA levels on offset production and root growth of Aloe vera, an experiment was conducted; the experimental design was RCBD with four replications placed in greenhouse condition. Treatments were included four different BA levels (0, 500, 1000, 1500 mg.L^{-1}). At the end of growth period, some characteristics such as offset number, offset leaf number, offset height; number of flowering stems, root length, root volume and root fresh and dry weight were measured. Resulted showed that Increasing hormone concentration cause increase offset number and decreased the root growth, so that the highest offset number was at 1500 mg.L^{-1} which was 95.36% more than our control treatment. Thus BA spraying can be used as an appropriate way to increase offset production in Aloe vera, which has low offset production rate.

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1. Introduction

Aloe vera (*Aloe barbadensis*) which belongs to Liliaceae family is a perennial plant with rosette growth pattern compatible with subtropical regions. This species is native to southern and eastern Africa, but is commercially cultivated in different region in America, European and Asia (Reynolds, 2004; Hasanuzzaman et al., 2008). In recent years, aloe vera gel extracts are widely used in cosmetics industry due to physiological and biological properties and also efficiency in healing wounds caused by burns and skin incision, and also because of anti inflammatory, antifungal, antibacterial antiviral and other medicinal properties (Ramachandra and Srinivasa Rao, 2008). Aloe plants are propagated by two methods: sexual and vegetative. In *Aloe barbadensis* species, the most common species in gel production, there is high rate of male sterility which results in cross-pollination; therefore propagation via seed leads to genetic segregation in daughter plants (Natali et al., 1990; Keijzer and Cresti, 1987). For commercial production and increasing leaves yield by increasing area of cultivated land, we have need methods to minimize plantlet production period. Main vegetative propagation method of Aloe plants is by using offsets. Offsets are produced from the end of short stolon and can be used as a propagule in perennial plants propagation (Carey, 2008). Although the offset production rate in Aloe vera plants is high, it is not enough for commercial production, and slow rate of offset production is a serious obstacle in developing its cultivation. Therefore, offset production should somehow be increased. Due to these reasons, using agronomy practices seems to be necessary in order to produce maximum plants number in minimum time. Cytokinin is widely used in ornamental plants production. It is one of the most important plant hormones which regulates plant growth and development and has an important role in promoting cell division with similar functions to kinetin such as differentiation, leaf development and increased nutrients mobility in plants (Duan et al., 2006; Shudo, 1994). Previous study results show that plant growth regulators such as cytokinins could improve shoot growth (Carey, 2008). Spraying cytokinins on *Hemerocallis citrine* shows that this group of plant growth regulators can increase offset production via affecting cell division, offsets size and growth by stimulating lateral buds growth (Amling et al., 2007).

Few studies have been conducted on evaluating the effect of cytokinins on root system of Liliaceae family. Cytokinin is a plant hormone synthesized in root and considering plant type and hormone concentration it has irritating or inhibiting effects on root development. High cytokinins concentration prevents roots growth, but lower concentrations result in improved root development and growth (Zhang and Hasenstein, 1999). Cytokinin is a hormone which can increase flowering stem production in many plants (Carey et al., 2008). The purpose of this study was to determine different BA foliar Sprays application levels on offset production and root growth in Aloe vera.

2. Materials and Methods

Field trials with Aloe vera (*Aloe barbadenisis*) were conducted at the experimental farm of Faculty of Agriculture, Tarbiat Modares University (TMU) in 2009-2010 growth seasons. This experiment was based on Complete Randomized Block Design (RCBD) with four replications. Treatments were included four levels of benzyl adenine (BA_1: 0, BA_2: 500, BA_3: 1000, BA_4: 1500 mg.L^{-1}). Uniform offsets size of 18-20 cm were completely randomly selected then transferred to greenhouse and were planted in pots with capacity of 20 kg soil. Greenhouse temperature during the experiment was 28ºC and 22ºC during day and night, respectively. Plants, based on field water capacity, were uniformly irrigated.

BA application

The cytokinin stock solution was diluted into 10 L aliquots of 0, 500, 1000, and 1500 ml.L^{-1} BA, each containing 10 ml (0.l'%) Tween-20 surfactant. All mixtures were formulated and sprayed in 17th week after planting. Control plants were sprayed with Distilled water plus 10 ml. L^{-1} Tween 20.

Data collection

After 12 months, four plants for each treatment were randomly selected, and were measured stem diameter, number of flowering stem, offset number, offset leaf number, offset length, offset weight, root length, and roots fresh and dry weight characteristics.

Statistical analysis

Data were statistically analyzed using two way analysis of variance (SAS Institute, 9.1.3). The significance of differences among treatment means were compared by Fisher's least-significant difference test (LSD) at $P < 0.05$. The number of replications (n=4) in the table/figures denotes individual plants from each treatment measured for each parameter.

3. Results and Discussion

Results showed that BA application has a significant effect on offsets number, weight, height and leaves number (Table 1). Means comparison of treatments showed that higher BA levels result in significance increase on all offsets characteristics. Highest offset number (6.32) offsets leaves number (5.8), offsets weight (38.42) and offsets height (23) was in treatment with 1500 ml.L^{-1} which was 95.36%, 75.51%, 71.89%, 82.74% higher than control treatment, respectively (Figure 1,Table 3). In this experiment, BA increased offsets number that can be attributed to decreased apical dominance by main stem (Duck et al., 2004). Our result was in accordance with those achieved by Carey et al., (2008). Considering the cytokinins effects, it was entirely predictable that spraying BA on plants stimulates cell division and increased cell number (Schmulling, 2002); therefore, application of BA results in higher offsets number, higher offsets leaves number, higher offsets height and weight. These results were in concordance with Carey et al., (2008) on other Liliaceae family plants (Echeveria and Sempervivum). Analysis of variance showed that application of BA had significance effects on roots length, root fresh and dry weight (Table. 2). As indicated in mean comparison Table 3, these traits were simultaneously decreased by increasing BA levels. Foliar application of BA with concentration of 1500 ml.L^{-1} had the shortest root, while the longest root was related to control treatment. Lowest fresh and dry weights was achieved in treatment with 1500 ml.L^{-1} BA; while highest fresh and dry weight was in control treatment (Figure 2). Analysis of variance showed that different BA levels had a significance effect on Aloe vera stem diameter (Table 2). As showed in mean comparison Table 3, foliar application of BA resulted in higher stem diameter which was the highest in treatment with 1000 ml.L^{-1} BA. Response of Aloe vera was the same as polyanthes which showed higher flowering stem diameter by foliar application of BA (Shoor et al., 2005). Stem diameter increasing is a result of BA role in cell division and assimilated transport (Schmulling, 2002; Halmann, 1990). According to the biological effects of cytokinin compounds, the results were entirely predictable that foliar application of BA stimulates cell division and increased cell number and therefore can result in increased offset number, offsets length, offsets weight and stem diameter. These increases were in accordance with those results achieved by (Khalighi et al., 2006). In a study by Garner et al., (1998), results showed that

BA application on hosta plants can increase bud development and propagule production ratio. Baque et al., (2010) showed that application of BA, Tidiazuron, and a combination of these two substances decreased roots fresh and dry weight in *Morinda citriofolia*. Earlier studies on Sedum, a succulent plant, showed that application of BA increased vegetative growth, flowering percentage and prevented root development (Boe et al., 1972). Aloe vera plants grow slowly and offset formation rate is slow in them. Application of BA-type cytokinin hormone increases cell division and lateral bud formation. Foliar application of BA had significantly increased flowering stems number (Table 1), but there was no statistical difference between levels of 500 and 1500 $ml.L^{-1}$. Our results were in agreement with those achieved by Boyle (1992), on Easter cactus in which BA had increased flowering stems number. In another study by Carey (2008), application of BA results in highest flowering stems number in *Echeveria setosa* and *Salvia nemorosa* which was in accordance with our results.

4. Conculation

Based on our results it can be concluded that foliar application of BA with concentration of 1500 $ml.L^{-1}$ can increase offsets number and give rise to higher levels of BA prevents root growth.

Table 1: The analysis of variance for Influence of application BA foliar spray on characterize offset in aloe vera plants

S.O.V	df	Offset				Number of Flower Stalks
		number	weight	Number leaf	height	
BA	3	* *	**	**	**	**
Error	9	0.83	43.77	0.29	4.90	0.09
C.V	--	23.03	25.29	12.41	15.75	17.19

* and** Significant at the 5% and 1% levels of probability, ns: no significant

Table 2: The analysis of variance for Influence of application BA foliar spray on characterize root in aloe vera plants

S.O.V	df	stem Diameter	Root			
			Length	fresh Weight	Volume	dry Weight
BA	3	**	*	**	ns	**
Error	9	9.27	9.15	13.46	22.48	0.21
C.V	---	6.69	13.6	13.55	21.70	12.51

* and** Significant at the 5% and 1% levels of probability, ns: no significant

Table 3: Results of mean comparison the influence of application foliar BA on some characterize in aloe vera plants

Treatment	Offset weight (g)	Number of offset leaf	offset height (cm)	Number of Flower Stalks	Diameter of stem (mm)	Length root (cm)
control	9.41 ± 4.21^{d}	1.68 ± 0.75^{c}	3.97 ± 1.78^{d}	0.55 ± 0.13^{b}	43.82 ± 1.02^{b}	24.8 ± 1.55^{a}
BA 500 $mg.L^{-1}$	24.79 ± 4.45^{c}	4.396 ± 0.70^{b}	11.93 ± 2.15^{c}	2.30 ± 0.21^{a}	43.73 ± 0.85^{b}	24.32 ± 1.41^{a}
BA 1000 $mg.L^{-1}$	32.10 ± 2.87^{b}	5.59 ± 0.24^{a}	17.32 ± 1.11^{b}	2.25 ± 1.9^{a}	48.16 ± 0.75^{a}	21.37 ± 1.28^{c}
BA 1500 $mg.L^{-1}$	38.42 ± 2.88^{a}	5.80 ± 0.19^{a}	23.00 ± 1.93^{a}	1.97 ± 0.06^{a}	46.34 ± 0.79^{a}	18.25 ± 2.17^{c}
LSD at (5%)	4.71	0.38	1.57	0.48	2.16	5.05

Means with different superscripts are significantly different at $P< 0.05$ level of significance using the Fisher's least significant different (LSD).

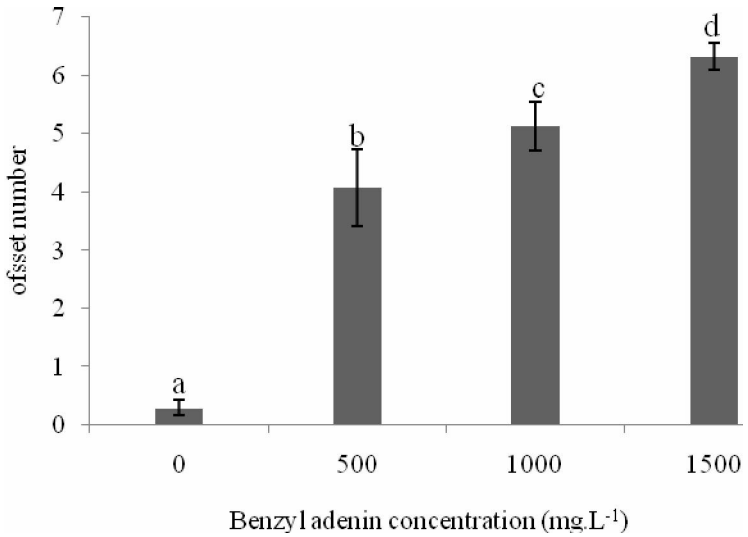

Figure 1: Effect of BA spray foliar on offset number in aloe vera plants. Values are mean ± SE (n = 4) and differences between means were compared by Fisher's least significance test. Different letters indicate significant differences with control at $P < 0.05$.

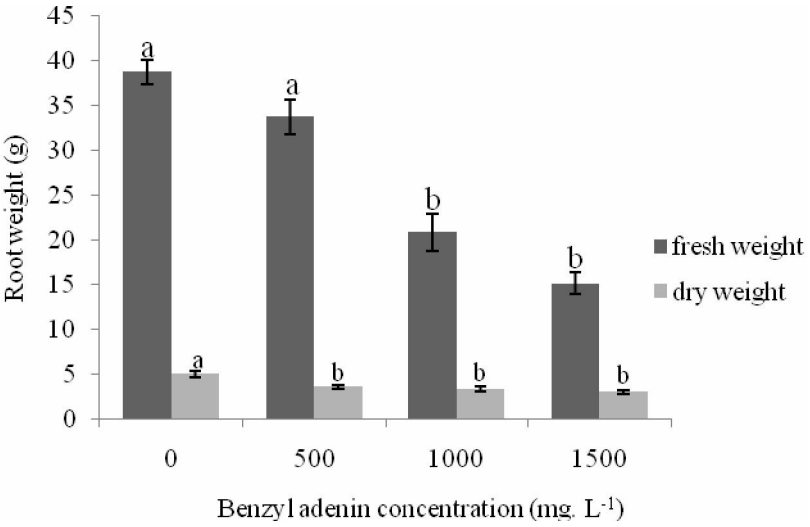

Figure 2: Effect of BA spray foliar on root fresh and dry weight in aloe vera plants. Values are mean ± SE (n = 4) and differences between means were compared by Fisher's least significance test. Different letters indicate significant differences with control at $P < 0.05$.

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