

Original Research

The effect of different concentrations of foliar spraying of gibberellic acid and benzyladenine on *Berberis vulgaris*

Author:
Fatemeh Nakhaei

Institution:
Islamic Azad University,
Birjand branch, Birjand,
Iran.

Corresponding author:
Fatemeh Nakhaei

ABSTRACT:

Barberry shrubs (*Berberis vulgaris*) are resistant to drought and salt. They are exclusively cultivated in the South Khorasan province in wide area. This experiment was performed as a factorial study in randomized complete block design with four replications. In this study, Gibberellic Acid (GA₃) and 6-Benzyladenine (BA) each with three concentrations (0, 50, 100 and 200 ppm) alone and in combination with each other were sprayed on the barberry. The results showed that all concentrations GA₃ and GA₃ + BA and BA at 200ppm caused significant increase in the fruit length in comparison with the control. GA₃ and GA₃ + BA caused significant increase in fruit diameter and fruit weight in comparison with BA. GA₃ and GA₃ + BA (at all concentrations) and BA (100 and 200ppm) had significant effect on TSS (Total Soluble Solid) compared to the control. GA₃ (200 ppm), BA (200 ppm) and GA₃ + BA (at all concentrations) significantly increased anthocyanin in comparison with the control.

Keywords:

Anthocyanin, Fruit length, Fruit weight, Plant growth regulators.

Article Citation:

Fatemeh Nakhaei

The effect of different concentrations of foliar spraying of gibberellic acid and benzyladenine on *Berberis vulgaris*

Journal of Research in Biology (2020) 10(3): 2810-2816

Dates:

Received: 16 Feb 2020 **Accepted:** 21 March 2020 **Published:** 10 April 2020

Web Address:

[http://jresearchbiology.com/
documents/RA0716.pdf](http://jresearchbiology.com/documents/RA0716.pdf)

INTRODUCTION

Berberis vulgaris belongs to the family Berberidaceae. This is a drought-and-saline resistant shrub cultivated exclusively in south Khorasan province with large cultivation areas (Kafi and Balandari, 2004). The organs of this tree including root, skin, leaf, and especially the fruit, due to their different alkaloids, possess medicinal traits. In traditional medicine, fruits are used to strengthen the liver, heart, avoid bleeding, relieve pain, and blood purification. In recent years, the usage of barberry has gained a striking growth in the food industry, and various products are available, such as drinks, jellies, pasta, jam and a major food colour was also obtained from the fruit (Javadzadeh and Fallah, 2012). Plant growth regulators can alter the hormonal state of the plant, resulting in decreased fruit falling and increased yield and quality (Ghosh *et al.*, 2013).

Applying growth regulators is one of the way that stimulates cell division and cell growth, leading to the increased fruit size. Cytokinins are one of the most helpful and well-known growth regulators to ameliorate fruit size because they motivate cell division (Kim, 2006; Ahmed and Aal, 2007). Mousawinejad *et al.* (2014) reported using cytokinin in the commercial production of grapes and kiwifruit. Mishra *et al.* (2011) proposed that cytokines enhanced the size and weight of jujube, but decreased TSS and acidity.

Hassan *et al.* (2009) and Mousawinejad *et al.* (2014) also suggested that cytokine has elevated the size and quality of grapes and tomatoes. Gibberellic acid individually or mixed with benzyladenine has increased the size and weight of fruits, especially grapes. As it is indicated, this is owing to the stimulation of cell growth and cell division (Kranthikumar and Sharma, 2016; Omar and Elmorsy, 2000; Omar and Girgis, 2005). Zhang and Whiting, (2011) indicated that gibberellic acid was sprayed to increase the size of the fruit, the quantity and quality of the product. It has been presented that jujube spraying with gibberellic acid has

increased the fruit size and yield of the tree (Gill and Bal, 2013; Yang *et al.*, 2012).

Sharma and Singh (2008), Garner *et al.* (2011) and Reddy and Prasad (2012) reported that gibberellic acid foliar spraying escalated the size and weight of palm fruits, avocados and pomegranates. There is no information available on the influence of the growth regulators on the barley fruit. Hence, in the present study, the effects of different concentrations of gibberellic acid and benzyladenine on the characteristics of barberry fruit were examined.

MATERIALS AND METHODS

This investigation was performed in the Barberry Research Garden of Birjand Islamic Azad University located at 32° 52'N, 59° 13'E and 1410 m above sea level. This factorial experiment was done in a randomized complete block design with three repetitions. Plant growth regulators such as Gibberellic Acid (GA₃) and Benzyladenine (6- BA) were taken individually and mixed as five concentrations (0, 50, 100 and 200 mg / L) and were sprayed during full flowering and after 10 days upon the fall of the petals.

In order to absorb the growth regulators, Moyan (Tween) was also used and irrigated before foliar spraying on the trees. Owing to the unfavorable effects of light on the growth regulators, foliar spraying was conducted on the sunset, when the intensity of the light was minimal, resulting in a more efficient adsorption until the morning. Repetitions were done on trees with the same age, strength and size. The operation was followed identically for all trees.

In early November, the fruit was harvested and the physico-chemical characteristics of the fruit were investigated. The weight of the fruit in grams were measured with a scale (accuracy, 10⁻⁴ g). Fifty fruit pieces were randomly selected from each repetition, and then their average weight was determined. To determine the dry weight, 15 g of barberry of each repetition was

Table 1. Analysis of variance of various concentrations of gibberellic acid and benzyladenine on physicochemical properties of barberry

S. No	Source of changes	D.o.F	Mean square							
			Fruit weight	Fruit length	Fruit diameter	Acidity	Anthocyanin	TSS	pH	Dry weight
1	Repetition	2	0.014**	0.029**	0.10**	2.85**	0.014**	1.43**	0.017 ^{ns}	0.022 ^{ns}
2	Growth regulator	2	0.106**	3.81**	1.48**	0.022**	0.131**	6.16**	0.003 ^{ns}	0.008 ^{ns}
3	Concentration	3	0.013**	18.45**	1.05**	0.001**	0.061**	4.98**	0.027 ^{ns}	0.018 ^{ns}
4	Growth and concentration regulator	6	0.040 ^{ns}	1.00**	0.10 ^{ns}	0.006**	0.044**	4.19**	0.039	0.042 ^{ns}
5	Error	70	0.001	0.282	0.214	0.212	0.004	1.32	0.039	0.034
6	Coefficient of variation		11.03	4.83	6.46	13.16	6.62	5.48	9.58	8.25

ns and **: no difference and significant difference in the probability level of 1%, respectively; D.o.F: Degree of freedom.

placed in an incubator at 72° C for 48 h. Afterwards, dry weight was measured with a scale (accuracy, 10⁻⁴ g). The caliper was used to quantify the length and the diameter of the fruit. The means were compared and the statistical calculations were done using MS Excel.

RESULTS

Analysis of the variance of the data discerned that the effect of type of the growth regulator *Vs* concentration, and the interaction effects of growth regulator type have an impact on the yield. The growth

regulator concentrations on the fruit length, the anthocyanin amount, TSS, and the effect of type of growth regulator and growth regulator concentration on diameter and the weight of the fruit were substantial. However, acidity, dry weight and pH had no meaningful effect (Table 1). The reciprocal effect of the growth regulator type and the growth regulator concentration presented that GA₃, GA₃ + BA at all concentrations and BA 200 mg / L compared to the control, remarkably increased fruit length. GA₃ 200 mg / L (12.09 mm) had the foremost enhancement in the fruit length and the

Table 2. Comparison of the means of growth regulator type and concentration on physicochemical characteristics of barberry

S. No	Regulator and concentration type	Fruit length (mm)	Anthocyanin (mg/g)	TSS (%)
1	GA ₃ 0 mg/L	9.86 ^{de}	0.91 ^c	18.53 ^d
2	GA ₃ 50 mg/L	11.11 ^{bcd}	0.90 ^c	21.98 ^{ac}
3	GA ₃ 100 mg/L	12.09 ^f	1.03 ^b	22.33 ^{ab}
4	GA ₃ 200 mg/L	11.32 ^{bc}	0.92 ^c	22.26 ^{abc}
5	BA 0 mg/L	9.84 ^c	0.92 ^c	18.20 ^d
6	BA 50 mg/L	10.50 ^{cde}	0.91 ^c	19.35 ^{de}
7	BA 100 mg/L	10.65 ^{cde}	0.92 ^c	21.63 ^{ac}
8	BA 200 mg/L	11.51 ^b	1.05 ^b	22.84 ^{ab}
9	GA ₃ +BA (each 0 mg/L)	9.84 ^c	0.92 ^c	18.42 ^d
10	GA ₃ +BA (each 50 mg/L)	11.68 ^{ab}	1.10 ^a	20.98 ^e
11	GA ₃ +BA (each 100 mg/L)	11.32 ^{bc}	1.09 ^{ab}	22.21 ^{abc}
10	GA ₃ +BA (each 200 mg/L)	11.79 ^a	1.09 ^b	23.02 ^a

The averages of the same letters in each column do not differ substantially in the 5% probability level.

Table 3. Comparison of the mean of growth regulator type on barberry fruit diameter and weight

S. No	Growth Regulator Type	Fruit Diameter (mm)	Fruit Weight (g)
1	GA ₃	7.33 a	0.36 a
2	BA	6.93 b	0.32 b
3	GA ₃ + BA	7.20 b	0.37 b

The averages of the same letters in each column do not differ substantially in the 5% probability level.

lowest fruit length was linked to the control (86.9 mm) (Table 2). GA₃ and GA₃ + BA meaningfully escalated fruit diameter and fruit weight.

The highest fruit diameter (7.33 mm) and the highest fruit weight (0.37 g) were related to GA₃ and GA₃ + BA (Table 3). Compared to the control, all concentrations led to the increase of fruit diameter and fruit weight (Table 4). GA₃ and GA₃ + BA at all concentrations and BA at 100 and 200 mg / L effectively elevated TSS, compared to the control. GA₃ (100 mg / L), BA (200 mg / L) and GA₃ + BA at all concentrations increased the anthocyanin levels substantially. Growth regulators did not indicate a significant effect in terms of dry weight, acidity and pH (Table 2).

DISCUSSION

Fruit length

Compared with the control, gibberellic acid individually, and mixed with benzyladenine at all concentrations, and the highest concentration of

Table 4. Comparison of the mean of different regulator concentration on barberry fruit diameter and weight

S. No	Regulator concentration	Fruit diameter (mm)	Fruit weight (g)
1	0 mg/L	6.86 a	0.29 a
2	50 mg/L	7.21 b	0.36 b
3	100 mg/L	7.22 b	0.38 b
4	200 mg/L	7.32 b	0.37 b

The averages of the same letters in each column do not differ substantially in the 5% probability level.

benzyladenine significantly increased the length of the fruit. This enhancement was attributed to an increase in cell division and cell number. Gibberellic acid further increase cellular length, and benzyladenyl triggers cell division (Yuan and Greene, 2000).

Benzyladenine in the premature stages of growth triggers cell division, leading to increased fruit size. (Kranthikumar and Sharma, 2016). Associated with the results of this experiment, Khalil and Aly (2013), Garner *et al.* (2011) and Reddy and Prasad (2012) suggested that gibberellic acid spraying increased the size and weight of palm fruit, avocado and pomegranate. The findings of this study was also complied with the results of Tambe (2001), Liu (2002), Warusavitharana *et al.* (2008), Souze *et al.* (2010), Meena *et al.* (2012) and Khot *et al.* (2015).

Fruit diameter

Gibberellic acid and benzyladenine escalated the diameter of the fruit. As gibberellic acid enhances the cell length, benzyladenine triggers cell division, particularly in the premature steps of the fruit growth (Yuan and Greene, 2000). The results of this study complied with the findings of Khalil and Aly (2013), Tambe (2001), Liu (2002), Warusavitharana *et al.* (2008), Souze *et al.* (2010), Meena *et al.* (2012) and Khot *et al.* (2015).

Fruit weight

The weight enhancement of the fruit was ascribed to a considerable increase in fruit size, improved nutritional status of the fruit and increased photosynthetic capacity. The transfer of photosynthetic material to fruit increases during the treatment with gibberellic acid and benzyladenine. Letham (1969), stated that cytokinin, besides increasing cell division, expedites the transfer of food and amino acids to treated areas. Bangerth (2004), reported that the existence of gibberellic acid and benzyladenine in the fruit pericarpel motivates cell division and cell reproduction and enhances sink function.

Huang *et al.* (2002) indicated that BA gives rise to the transfer of nitrogen and carbonic acid from treated leaves to fruit. The weight gain of fruit with the use of gibberellic acid and benzyladenine is consistent with the findings of Khalil and Aly (2013), Tambe (2001), Liu (2002), Warusavitharana *et al.* (2008) and Meena *et al.* (2012). Also, Sharma and Singh (2008), Garner *et al.* (2011) and Reddy and Prasad, (2012) reported that spraying of gibberellic acid had showed an increase in the size and weight of palm fruits, avocado and pomegranate.

TSS

Gibberellic acid and benzyladenine remarkably increased TSS in this study. According to Khalil and Aly (2013), El-sabagh and Ahmed (2004) and Saleem *et al.* (2008), the beneficial effect of these hormones on the TSS enhancement was reported. Khalid *et al.* (2012), however, reported that the gibberellic acid had no effect on TSS of mandarin.

Anthocyanin

According to the findings of this study, Gibberellic acid increased the amount of pomegranate Anthocyanin, which is also supported by the experiments of Khalil and Aly (2013).

CONCLUSION

Foliar spraying of gibberellic acid and benzyladenine improved the physico-chemical properties of barley

REFERENCES

Ahmed FF and Aal AMKA. 2007. Effect of concentration of spraying sitofex (CPPU) on yield and quality of Le-Conte pear fruits. 8th African Crop Science Society Conference, 2007 October 27-31; El-Minia, Egypt. 523-527.

Bangerth FK. 2004. Internal regulation of fruit growth and abscission. *Acta Horticulturae*, 636: 235-248.

El-Sabagh AS and Ahmed HS. 2004. Effects of gibberellic acid (GA₃) and Sitofex on Anna apple crop load and fruit quality. *Alexandria Journal of Agricultural Research*, 49(1): 71-79.

Garner L, Klein G, Zheng Y, Khuong T and Lovatt C 2011. Response of evergreen perennial tree crops to gibberellic acid is crop load-dependent: II. GA₃ increases yield and fruit size of 'Hass' avocado only in the on-crop year of an alternate bearing orchard. *Scientia Horticulturae*, 130(4): 753-761.

Ghosh S, Roy SK, and Bera B. 2013. Effect of NAA on controlling fruit drop and yield of *Banarasi Karka* cultivar of ber grown in close spacing. *Environment and Ecology*, 31(3): 1217-1219.

Gill KS and BAL JS. 2013. Impact of application of growth regulators on Indian jujube. *Acta Horticulturae*, 993: 119-124.

Hassan HSA, Mostafa EAM and Saleh MMS. 2009. Effect of foliar spray with biozyme and sitofex on yield and fruit characteristics of Grand Nain banana. *Green Farming*, 2(10): 661-663.

Huang W, Zhang P and Li W 2002. The effects of 6-BA on the fruit development and transportation of carbon and nitrogen assimilates in grape. *Acta Horticulturae Sinica*, 29(4): 303-306.

Javadzadeh SM and Fallah SR. 2012. Therapeutic application of different parts of *Berberis Vulgaris*. *International Journal of Agriculture and Crop Sciences*, 4 (7): 404-408.

Kafi A and Balandari M. 2004. Barberry (*Berberis vulgaris*): production and processing, Ferdowsi University Press, 20 P. (In Persian).

Khalid S, Malik AU, Khan AS and Jamil A. 2012. Influence of exogenous applications of plant growth regulators on fruit quality of young 'Kinnow' Mandarin

(*Citrus nobilis* × *C. deliciosa*) trees. *International Journal of Agriculture Biology*, 14(2): 229-234.

Khalil H and Aly SSH. 2013. Cracking and fruit quality of pomegranate (*Punica granatum* L.) as affected by pre-harvest sprays of some growth regulators and mineral nutrients. *Journal of Horticultural Science and Ornamental Plants*, 5(2): 71-76.

Khot AP, Ramteke SD and Deshmukh MB. 2015. Significance of foliar spraying with gibberellic acid (40% WSG) and CPPU (1%SP) on yield, quality, leaf photosynthesis and biochemical changes in grapes. *International Journal of Tropical Agriculture*, 33(2): 221-227.

Kim JG, Takami Y, Mizugami T, Beppu K, Fukuda T and Kataoka I. 2006. CPPU application on size and quality of hardy kiwifruit. *Scientia Horticulturae*, 110(2): 219-222.

Kranthikumar T and Sharma MK. 2016. Effect of GA₃ in combination with urea phosphate and BA on yield and physical quality parameters of grape cv. thompson seedless. *The Bioscan an international Quarterly Journal of life*, 11(1): 49-52.

Letham DS. 1969. Cytokinins and their relation to other phytohormones. *Bio Science*, 19(4): 309-316.

Liu JL. 2002. Effect of 6 BA and GA₃ on the fruit growth and development of Fujiminori grape variety. *China Fruits*, 5: 20-21.

Meena VS, Nambi VE, Vishwakarma RK, Gupta RK and Nangare DD. 2012. Effect of gibberellic acid on fruit quality and storability of grape in semi-arid region of Punjab. *Agricultural Science Digest*, 32(4): 344-347.

Mishra S, Choudhary MR, Yadav BL and Singh S. 2011. Studies on the response of integrated nutrient

management on growth and yield of Ber. *Indian Journal of Horticulture*, 68(3): 318-321.

Mousawinejad S, Nahandi FZ and Baghalzadeh A. 2014. Effects of CPPU on size and quality of tomato (*Solanum lycopersicum* L.) fruits. *International Journal of Farming and Allied Sciences*, 3(8): 930-934.

Omar AH and El-Morsy FM. 2000. Improving quality and marketing of Ruby Seedless Table grapes. *Journal of Agricultural Science Mansoura University*, 25(7): 4425-4438.

Omar AH and Girgis VH. 2005. Some treatments affecting fruit quality of crimson seedless grapevines. *Journal of Agricultural Science*, 30(8): 4665-4676.

Reddy PA and Prasad DM. 2012. Effect of plant growth regulators on fruit characters and yield of pomegranate (*Punica granatum* L.) cv. Ganesh. *International Joint Polytechnic Admissions Exercise Science*, 2(2): 2331-4490.

Saleem BA, Malik AU, Pervez MA, Khan AS and Khan MN. 2008. Spring application of growth regulators affects fruit quality of blood red sweet orange. *Pakistan Journal of Botany*, 40(3): 1013-1023.

Sharma MK and Singh SR. 2008. Effect of bio-regulators on tree growth, fruit yield and quality of plum (*Prunus salicina* L.) cv. Santa rosa under Kashmir valley. *Journal Environment and Ecology*, 26(4A): 1792-1794.

Shou Yang L, YouKe W, Xia Z and XinGuang W. 2012. Effect of plant growth regulators on yield and water use efficiency of jujube in northern Shaanxi. *Journal of Northwest A and F University- Natural Science*, 40(12): 184-190.

Souza TR, Nachtigal JC, Marante JP and Santana APS. 2010. Effects of plant growth regulators for growth in seedless grape cv. BRS Clara, in tropical

region. *Revista Brasileira de Fruticultura*, 32(3): 763-768.

Tambe TB. 2001. Growth regulator in grape. In: Physiology and bio-chemistry in fruit crops. *MPKV Publications*, 18: 117-121.

Warusavitharana AJ, Tambe TB and Kshirsagar DB. 2008. Effect of cytokinins and brassinosteroid with gibberellic acid on yield and quality of Thompson seedless grapes. *Acta Horticulturae*, 785: 217-223.

Yuan R and Greene DW. 2000. McIntosh apple fruit thinning by benzyladenine in relation to seed number and endogenous cytokinin levels in fruit and leaves. *Scientia Horticulturae*, 86(2): 127-134.

Zhang C and Whiting DM. 2011. Improving bing sweet cherry fruit quality with plant growth regulators. *Scientia Horticulturae*, 127(3): 341-346.

Submit your articles online at www.jresearchbiology.com

Advantages

- **Easy online submission**
- **Complete Peer review**
- **Affordable Charges**
- **Quick processing**
- **Extensive indexing**
- **You retain your copyright**

submit@jresearchbiology.com

www.jresearchbiology.com/Submit.php