World Journal of Agricultural Sciences 4 (3): 321-325, 2008
ISSN 1817-3047

The Characteristics of Substances Regulating Growth and Development of Plants and the Utilization of Gibberellic Acid (Ga_3) in Viticulture

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Abstract: Growth is controlled by growth regulators. Today, well-known natural growth and growth regulators are examined in 5 groups; these are Auxins, Cytokinins, Gibberellins, Abscisic acid (Dormins) and Ethylene. Gibberellic acid is especially used in viticulture. It affects grape berry by means of different ways. Some of these effects include formation of flower cluster, berry set, berry enlargement, cluster lenghts elongation, berry thin in cluster, prevention of berry cracking, pollinicide effect of Gibberellic acid in seeded grape varieties to create seedlessness, etc. Besides, it was also found that it has effects on rooting, but this effect was not found beneficial. Owing to the fact that Gibberellic acid is not harmful for human health, it can be suggested for different purposes. The application time, the application dose, the age of the plant, the development of the plant, etc. are important.

Key words: Growth and development regulating substances % Gibberellic acid (GA_3) % *Vitis vinifera* L.

INTRODUCTION

Growth is one of the most important physiological events for plants. Researchers have tried to obtain detailed information about the reason for the growth of plants for long years. Although the physiology of the growth of plants is known in general sense, some researches has been done on the substances that provide growth of plants. Also, it has been detected that there are some substances, which are synthesized within the body of plants and improve growth and these substances have been named as hormones. In time, it has been observed that not only growth stimulating substances but also growth inhibiting substances have been synthesized within the body of the plants.

Hormones were firstly isolated from mushrooms called "*Gibberella fujikuroi*" in Japan. These mushrooms were observed and it was realized that they caused excessive growth in the paddy. Synthetic regulators, which were similar to natural hormones, were produced and the name of these hormones became growth and development regulators as they did not identify the substances they were made of. Some of the substances, which were obtained, improved growth in plants while some others hindered it. Even the same regulator reached different results when it was applied in different times and concentrations. Thus, the time and the concentration of the application must be arranged well in order to obtain the desired results for the use of growth and development regulators [1-3].

Gibberellins are named as GA_2, GA_3, GA_4, etc. GA_3 is known as "Gibberellic acid", which intensively exists in high plants and is mostly used in practice.

DEFINITION AND GROUPING THE SUBSTANCES REGULATING GROWTH AND DEVELOPMENT OF PLANTS

The substances regulating growth and development of plants, which are known today, are examined in 5 groups. These are 3 auxins, a few cytokinins, many gibberellins, abscisic acid and ethylene.

The substances used for regulating natural growth include ethylene at the maximum rate of 23%. This grouped is followed by auxins. Gibberellins are the third group at rank with the rate of 17%. Cytokinins and dormins (10%) has not commonly used in the world yet.

Auxins, Cytokinins, Gibberellins, Abscisic acid (Dormins) and Ethylene are the groups. Among these, Auxins, Cytokinins, Gibberellins are encouraging and dormins (ABA) and ethylene are hindering substances [3-7].

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The Natural Substances Regulating Growth and Development

Auxins: Auxins reach the highest concentration inside the peaks of plants (root, bud, leaf and etc.), which indicates growth. Generally, auxins are formed in meristematic tissues. Auxins accelerate the elongation and increase the growth and division of cells. The fact that growth is dominant at the peaks of the plant due to the high concentrations of auxins in plants, the apical dormancy is formed. Thus, the germination of the side buds is under pressure.

Winkler *et al*. [8] applied 4-CPA immediately after the grapes developed 15 ppm-grains and they detected that this substance increased the weight of the bunch and grains of the grapes and also it increased the link between the grain and the stalk of the grain [8].

Cytokinins: The substances, which are effective in the regulation of the growth of plants by increasing the division of cells, are called cytokinins. The most common types of cytokinins are Zeatin, 2ip, BA (Benzil Adenine) and PBA (Tetrahydro piranil benziladenine).

It was detected that cytokinins accelerate the division of cells, regulate nucleic acids, they encourage the dominance and branching on the peaks, stimulate the start of bud burst, prevent flowers, fruit and trees from aging and also falling down [1-3].

BA was proved to be very effective on inner stimulators when it was applied to the grapevines from outside. BA accelerated bud burst by breaking the dormancy within the core. After the bud burst, the effect of BA increased on canes [9].

Gibberellins: Gibberellins provide elongation of plants by increasing the growth and division of the cells like auxins. The plants, which are rich in gibberellin, have long internodes. Gibberellins are less sensitive to light when compared to auxins and they show less depressive effect in high-dose applications.

Gibberellins encourage germination by breaking the dormancy of the seeds. The completion of the dormancy within the botanical organs is proportional to the amount of increase in gibberellin. Gibberellins are known to increase the parthenocarpic fruit production like auxins and even they are sometimes more efficient [2, 3, 5, 10].

Dormins (Abscisic Acid): It is commonly recognized that Abscisic acid (ABA) and similar substances have a great role in preventing growth and such biophysiological cases. The most typical effects of these substances are that they prevent germination and bud burst by affecting the division of cells. It is seen in many research that ABA, which is given from outside, induced the closing of the stomata and, thus, it hinders transpiration [2, 5, 11].

Researchers, who used ABA before blooming, just when full bloom, during fruit set and after fruit set, applied these to the types of grapes named "Sultani Çekirdeksiz, Carignane and Muscat of Alexandria" (0.1, 1, 10, 100, 1000 ppm) and expressed that this substance is effective on the fall of the fruit in all three types and especially 100 and 1000 ppm are more effective than other doses [12].

Ethylene: Ethylene (C_2H_4), is a simple compound and known to be a highly efficient substance in gas form, which is generated by the plant itself, ethylene could control growth and development and it is produced in all tissues.

The principal effects of ethylene on plants are increasing the maturity of the fruit, accelerating the fall of leaf and fruit, regulating bloom, limiting elongation of plants, encouraging rooting on canes and preventing axillary bud formation of the plant [2, 3, 5, 6].

Ethrel (CEPA) is effective in the acceleration of physiological cases inside the berry, when it is used correctly in viticulture just before maturation of the vineyard. It brings the maturation earlier [13], but, the effect might change according to the time of application [14, 15]. Also, Ethrel is used in vineyard as a defoliant [16, 17].

Synthetic Substances for Growth: Various synthetic substances, whose effects are similar to and sometimes more powerful than the hormones for plant growth, were obtained. These kinds of substances are generally called synthetic substances for growth [18].

Synthetic substances are used to get abundant and high quality crops from the plants, enable the date of blooming to come to an earlier or later period, regulate the fruit production and provide parthenocarpy. The most important of these are; Indole Butyric Acid (IBA), Naphthalene Acetic Acid (NAA) and 2.4 Dichlorophenoxy Acetic Acid (2,4-D).

Substances Encouraging Growth

Auxins: $-Indole Butyric Acid (IBA), which is similar to Indole Acetic Acid (IAA), Naphthalene Acetic Acid (NAA) and 2.4 Dichlorophenoxy Acetic Acid (2,4-D). Phenyl Acetic Acid (PAA) and Phenoxy Acetic Acid (POAA) are within the group of auxins that are not botanical.

Cytokinins: Benziladenin (BA) is the most well-known cytokinin of all.

Synthetic Substances Delaying Growth: They limit the growth and shortening the elongation of the calls. The effects of these are seen through preventing the biosynthesis and transmission of Gibberellin.

These are; 4-Hidroxyl-5-Isopropyl-2Methyl-phenyltri-methyl Ammonium Chloride, I- piperidin carboccilate (Amo 1618), Daminozid (Succinamic Acid), N-dimethylaminesuccinamic Acid (B995 or B9), B-Hydroxyl ethylhydrazide (BOH) and 2-4 Dichlorobenziltributile phosphoniumchloride and Chlorcholinchloride (CCC) is the one that is the most intensively used [10].

Synthetic Substances Preventing Growth: Their basic effects are different from the retardants and on the apical meristem. Maleic Hydrazide (MH-30), Atrynal (Na-dikegulac) and Alkyl esters (oil acids, methyl esters).

THE USE OF GIBBERELLIC ACID IN VITICULTURE

The applications of GA_3, which is used in viticulture to increase the productivity of seedless fruit, develop the largeness of fruit and balance the structure of bunches, need to be done quite consciously. Only then it might contribute to the aim of viticulture. The combination between the time of application, the dosage and the open-air temperature is directly related to the expected utility [19-21].

GA_3 should be used within the suggested time period, with an eligible temperature and a correct dosage. The untimely and over dosage usages affect the crop of that year negatively and it causes excessive tiredness on the grapevines and so affects the crops of the next years. The application should be in the way that includes dipping the bunch of grapes into the substance. The application of spraying affects the grapevines and causes bud bursts.

In viticulture, GA_3 is used for many reasons. This substance provides rapid growth and elongation if it is applied to the growth parts of the plant. When it is applied, the growth of cells and the division of normal cells increases. The first effect is seen on the parts that grow over the soil and it increases the area of leaves and the main stalk [22].

The Effects of Gibberellic Acid on the Formation of the Bunch of Flowers of the Grapevine: Applying Gibberellic acid to a full-grown plant provides early inflorescence and an improvement on fruit set. For early inflorescence, concentrations which are generally 10-20 ppm and concentrations which are 200-300 ppm for female flowers influences positively. However, concentrations higher than 600 ppm, stops distinctively the growth of both male and female flowers.

The Effect of Gibberellic Acid on the Extension of Bunch of Grapes: This effect can be observed with the applications before inflorescence. The best effect can be obtained from the applications done 3 or 4 weeks before the beginning of inflorescence. The formation of small grains grows with the applications done before the inflorescence, but this happens rarely with the applications done with lesser than 10 ppm dose [21, 23].

The Effect of Gibberellic Acid on Dilution of Bunch of Grapes: At the end of the applications in the inflorescence period, the dilution emerges. The application of 20 ppm's GA_3 decreases the number of grape grains on an average of 20-25% especially in this period [23].

The Effect of Gibberellic Acid on Upsizing of Grape Berries: The grape berries being small in seedless grapes is directly related with the absence of seed in the berry. In the researches, the seed is shown as the centre of the Gibberellic acid synthesis [24, 25]. In this way, application of Gibberellic acid outwardly eliminates the deficiency of Gibberellic Acid partly and enables the berry to be as large as the kinds which are having seeds [26, 27]. Gibberellic acid improves the corpulence of a grape berry 50%. The most effective application time for enlargement of grape berries is when the size of small grape berries become mm. The applications done before or after this period make the grape berry less big. The best effect is observed around 75-100 ppm dose [29, 20, 28].

The Effect of Gibberellic Acid on the Cracking of Grape Berry: The applications done in the periods of inflorescence and small grape berries reaching mm (10 days later than full bloom), make important effects on grape berry hardness and the elasticity of the skin [27]. Gibberellic Acid applied the grape berries are more resistant against to the cracks caused by the rains especially when it' close to harvest period.

The Effects of Gibberellic Acid on Rooting: For the Çavuû grape layers' rootings, GA_3 which are 50, 100, 200 and 400 ppm doses had been used and the formation of roots has been prevented in all doses [29].

The Effects of Gibberellic Acid on Berry Set: In order to improve berry set, some techniques such as the Gibberellic Acid application, girdling and peak taking are applied. It supports branching after fallen grape grains after inadequate granulation and it takes part in fruit efficiency [28]. GA_3 is a hormone which starts cell growth and enlargement shows a rapid growth in the 1st growth period just after berry set and reaches the highest level towards the middle of this period. At the end of the researches, it is displayed that Gibberellic acid is active on the point of the full bloom of stamens of kinds of grapes which are having seeds and which are seedless etc. Italy and Razaki cvs. [18-20].

Among Gibberellic Acids, GA_3 is widely used in the enlargement of grape berries in seedless grape varieties in practice [30].

The Effects of Gibberellic Acid on Table Grape Growing: Gibberellic acid should be between doses of 25-50 ppm when it's used for table grape varieties. The reason for this is that the doses less than 25 ppm cannot provide enough berry size. The doses more than 50 ppm results in the formation of many bunch of grapes and that's why decreases the table grapes and conservation value [21].

The Effect of Gibberellic Acid on Drying Grape Varieties: If it's desired to have enlargement in drying grape varieties, GA_3 should be applied two times 1 week before and 1 week after the full bloom. Application dose should be determined according to the grapevine's growth strength.

The Effects of Gibberellic Acid on Parthenocarpic Fruit Formation: Gibberellic acid causes grape varieties with seeds becoming seedless. It is stated that when Gibberellic acid is applied to the grapevine before the inflorescence, it is observed that pollens' germination ability lessens, the seed tracing degenerates and fruit flesh cells become abnormally thick [14, 21, 32, 33].

Gibberellin which is applied outwardly has alerted parthenocarpic fruit formation and improved seedless berry formation 20-25% [19, 20 34].

100 ppm Gibberellic acid which is applied before the inflorescence period and on the full bloom causes some grape varieties become seedless. Because of the reason that the Gibberellic acid regulates growth, it causes big differences although it is applied in small amounts. The Gibberellic acid concentrations which are used in high doses may result in unexpected results [35].

The Effect of Gibberellic Acid on Berry Fall after the Harvest: It is observed that Gibberellic acid is not very effective on Thompson Seedless grape variety if it is applied after the harvest [36].

CONCLUSION

Plant growth regulators are important in regulating the plant growth. Among these, Gibberellic acid has influenced grape berry very distinctively. These effects can be counted as; the formation of bunch of flower, berry set, berry enlargement, extension of bunch of grapes, dilution of berry in a bunch of grapes, preventing berry cracking, killing pollens and causing grape varieties having seeds becoming seedless. Additionally, some effects on rooting have been found but this effect is not counted as beneficial.

Gibberellic acid which has no harmful effect on human health can be suggested to use for different aims. However, the application time and dose; and the age, the growth period and etc. of the plant that the application is done on, are important.

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