Vol. 4 Issue- 7, March 2024 (e-ISSN: 2582-8223)

JUST AGRICULTURE
multidisciplinary e-Newsletter

Role of Recent Chemicals Including Phyto-Hormones in Increases Production of Bulb Crops

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ARTICLE ID: 44

Abstract:

Plant growth regulators, also known as phytohormones, are a class of organic chemicals, either naturally occurring or artificially synthesised, that exert control over specific physiological processes in plants. The application of these substances elicits a range of effects on vegetables, encompassing seed germination, the disruption of seed dormancy, the commencement of flowering, the induction of gametocidal effects, the promotion of fruit set, the stimulation of parthenocarpy, and the facilitation of fruit ripening, among others.

With a very diverse structure and small molecules, phytohormones are regulators of plant growth and development. Despite the fact that they are synthesized by plants in small quantities, they are highly active physiologically. According to their action, phytohormones can be divided into two categories, as either activators of plant growth and development or as inhibitors, with auxins and cytokinins belonging to the former group. Auxins are synthesized by plants in the apical meristems of shoots, but also in young leaves, seeds, and fruits. They stimulate the elongation growth of shoots and initiate the production of adventitious and lateral roots. Cytokinin's, in turn, are formed in root tips and in unripe fruits and seeds. These hormones are responsible for stimulating the growth of lateral shoots, they also stimulate cytokinesis and, consequently, cell division. Growth-inhibitor and gibberellin activity decreased before sprouting, but there was an increase in gibberellin and auxin activity as sprouting commenced. Gibberellin activity was highest in bulbs with well-developed sprouts whereas auxin activity occurred mainly in bulbs in which early sprout development was visible only on their being cut open. There was no conclusive evidence that bulb dormancy could be broken by application of the gibberellins GA3 and GA4/7, or the auxin 1-naphthylacetic acid (NAA). Maleic hydrazide (MH) completely inhibited root and sprout development but the

growth retardant (2-chloroethyl) tri methylammonium chloride (CCC) was mainly effective in reducing root development and sprouting was only slightly inhibited.

Keywords: phytohormones, auxin, gibberellin, cytokinin, ethylene, jasmonic acid, salicylic acid, bulbing, sprouting, onion, garlic, NAA, MH.

Introduction:

Plant growth regulators are also called as plant hormones, sometimes they are called Phyto hormones (a term coined by Thiman, 1948; the term phytohormones or plant hormones are used only in case they are produced organically or inside plant while the plant growth regulator is used when they are produced synthetically. They are the chemical or organic compounds (phytohormones) which are produced in the plant or created outside it, which affect the various plant metabolism and physiological activities that govern the growth and development of the plant. They are produced at one location and transported to another for their influence; however, some of them have the same site of synthesis and effect. Although both auxins and GAs can stimulate parthenocarpic fruit formation, there are still some differences in the development process of the parthenocarpic fruits.

Growth regulators like gibberellins and Cytokinin improved the chive (Allium fistulosum L) plant height, dry matter accumulation, bulb yield and its quality (Morales- Payan, 1994). Many studies have suggested that the application of GA3 can affect the growth and development of bulb crops and total yield (Rizk and El-Habbasha, 1996; Abdul et al., 2002; Islam et al., 2007; El-Shraiy and Hegazi, 2009). Gibberellins and Cytokinin have a particularly interesting role in modern agriculture (Ashraf et al., 2010). Also, GA3 supply promoted increasing onion and garlic growth and yield (Ouzounidou et al., 2011). Moreover, Liu et al. (2020) indicated that soaking garlic seed cloves in GA3 promotes axillary bud formation.

There is a lake in literature dealing with factors affecting garlic seed production, especially under Egyptian conditions. Furthermore, with the increasing export demand for Egyptian green garlic, there is an urgent need to devote studies on garlic seed production. This work was intended to study the role of nitrogen and potassium fertilization and growth regulators (Gibberellin and Cytokinin) on the production of large garlic bulbs as a source of high-quality seeds.

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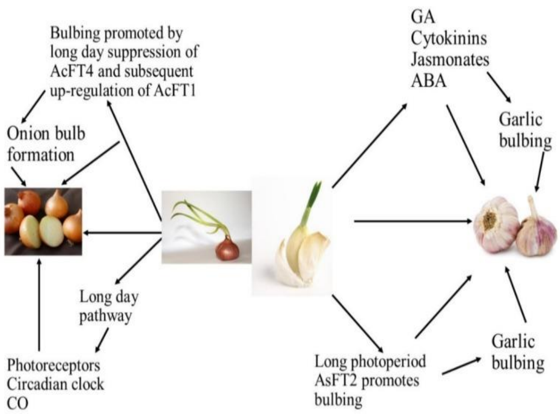
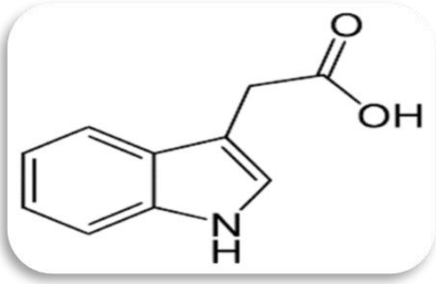
Phytohormonal Control of Bulb Enlargement:

Phytohormones are considered the most important endogenous substance for modulating physiological and molecular responses, and they are a critical requirement for plant survival as sessile organisms. Phytohormones act either at their site of synthesis or elsewhere in plants following their transport. The examination of the paraphernalia of photoperiod on bulb growth will offer vision into the mechanism of bulbing and environmental tools (adaptable photoperiods) for developing parameters. The directive of bulbing is comprised of intricate evolutions determined by an intricate system of signalling pathways. In order to improve propagation ability and bulb production through horticultural practices, regulating environmental conditions (photoperiod) and phytohormones are the most effective ways, which have a key role in the development of bulbs. Hormonal balance has a large effect on storage organ formation and development. The role of hormones in the sprouting of garlic cloves has been demonstrated. In addition to environmental cues, such as photoperiod, bulbing is also controlled by endogenous signals, including phytohormones level and plant age.



Auxin:

Auxin plays crucial factor in the development of several vegetable crops. Benkeblia, N., stated that in dormant bulbs, the strongest induction of sprouting was observed with auxin treatment (0.1 mg NAA per bulb, sprouting after 12 weeks). Hye et al., observed that the use of indole acetic acid in conjunction with gibberellic acid has been found to enhance the proliferation of roots, elongation of roots, rise in root weight, enlargement of bulb diameter, and augmentation of bulb weight. The bulb weight and diameter exhibit their maximum values when subjected to an application of 200 parts per million (ppm) for both variables.



Gibberellic Acid:

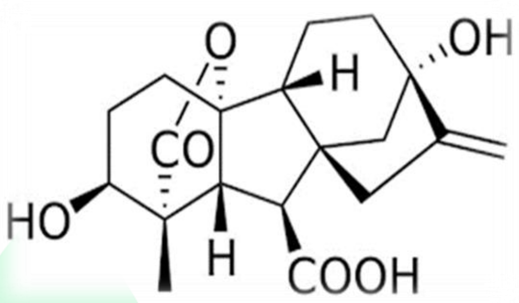
Endogenous gibberellins were found at high levels in the storage leaf during clove sprouting, and they also inhibited dormancy induction in bulbs. Long photoperiods are identified to improve the levels of endogenous gibberellins, with substantial flower sprout divergence. GA is a well-organized inhibitor of bulb growth.

The application of exogenous GA on garlic revealed that exogenous GA subdued the rise of the bulb produce. application of GA_3 increased bulb weight in onion under deficit irrigation.

The application of GA_3 also encouraged tillering in welsh onions, encouraged airborne tubers development in turnip, and promoted shoot branching in Jatropha curcas. GA was also used to progress fruit morphological characteristics (skin color and firmness) and nutritive quality.

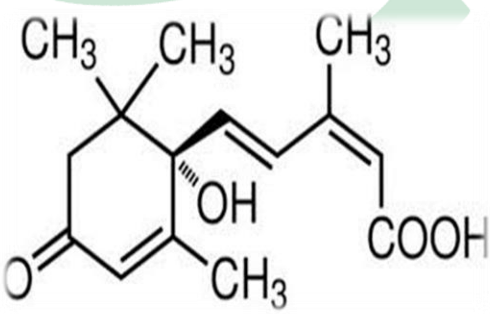
GA_3 treatment intensely encouraged lateral bud development but repressed the growth of plants and bulbs, and lateral bud formation doubled in garlic plants treated with GA3. Bulb nutritious qualities were enhanced by applying GA_3. Briefly, the number of cloves and whorls per bulb improved with a higher concentration of GA3. After application of a low concentration of GA_3, the number of cloves per bulb and the soluble sugar content were expressively improved, but the mean bulb weight was significantly reduced for plants treated with a high concentration of GA_3.

GA_3 can significantly induce lateral bud formation and increase the clove number per bulb, which improves the reproduction efficiency in garlic. However, the physiological and metabolic changes of garlic plants. The effect of both soaking seed cloves in GA3 solution and injecting plants with GA3 on plant growth and bulb development in garlic. They detected that soaking seed cloves in GA3 solution induced secondary plant (equated with tiller or lateral branch) development and expressively increased the incidence rate of secondary plants, clove numbers per bulb, and bulb weight. Clove number per bulb and bulb weight were sharply increased by the application of GA3. Exogenous GA3 induced the axillary bud formation of garlic via the changes of soluble sugar content and soluble protein content in the stem.



Abscisic Acid:

Abscisic acid (ABA) normally plays a vital part in plant resistance to biotic or abiotic stresses. It was expected that ABA plays an important role in the initial phase of plant bolting. Su described that endogenous ABA influences the flower shoot distinction of welsh onion (*Allium fistulosum L.)*, which improved expressively and reduced subsequently after the flower bud variation. The increased endogenous ABA might accelerate the maturation process of garlic plants, which leads to the shorter growth period under longer photoperiods. A variation in ABA level was also confirmed in onion (*Allium cepa L.)*, where the level of ABA was higher during the dormancy period and decreased when dormancy broke. Exogenous ABA delays sprouting in Allium wakegi plants. higher ABA levels were observed in garlic cloves stored at warm versus cold temperatures, signifying that warm temperatures are a more effective sprouting inhibitor in garlic cloves.

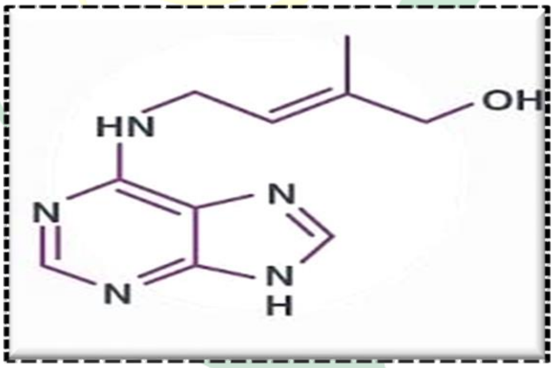


Cytokinin:

Zeatin riboside (ZR) was reported to have an enhancing effect on plant bolting. Cytokinin (CTK) was a bulbing originator but had no noticeable impact on bulb widening.

Exogenous cytokinin was revealed to induce early differentiation and cell division in developing leaves.

Sprouting of onion bulbs is inhibited at high storage temperatures. To investigate the role of cytokinins in this phenomenon small bulbs of the 'Rijnsburger' cv. Augusta were stored from four weeks after harvest at 5, 15 and 30°C for a period of 18 weeks. Bulb samples were investigated for time to rooting and subsequent sprouting in moist vermiculite at 15°C and assayed for endogenous cytokinins at six-week intervals. Root dormancy gradually decreased during storage, the fastest at exposure to 30°C; rooting was followed by sprouting. After 18 weeks of temperature exposure, no visible sprouting had occurred in dry storage; internal sprouts had relative lengths of 0.29, 0.72 and 0.31 at 5, 15 and 30°C, respectively. Cytokinin activity was low during the first six weeks of temperature exposure. At 5 and 15°C a sudden rise in cytokinin level was found after 12 weeks and a further increase after 18 weeks. At 30°C, however, cytokinin levels increased very little during the storage period. Injection of plant growth regulators into large bulbs of the 'Rijnsburger' cv. Hyton that had been stored for 28 weeks at 25°C showed that benzyl adenine strongly promoted sprouting. The data indicate that inhibition of sprouting at high temperature is caused by low levels of endogenous cytokinins. The obtained Cytokinin (CPPU) beneficial effects may be due to promoting protein synthesis, increasing cell division, and enlargement (Cheema and Sharma, 1982).



Ethylene:

Exogenous ethylene inhibited sprout growth of onion bulbs when supplied during sprouting and when supplied during dormancy. It is suggested that in both cases ethylene action was primarily on sprout leaf elongation and not on dormancy. after stopping ethylene ventilation during dormancy (week 4) the increase in percentage of sprouting bulbs occurred at the same time as in air-stored bulbs, i.e., at the end of natural dormancy. it seems that the

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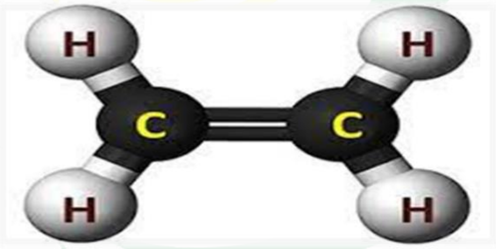
presence of ethylene prevented sprout growth after the bulbs were released naturally from dormancy. The nature of growth inhibition of onion sprout leaves by ethylene is not known, except that ethylene inhibits leaf blade elongation. Recently, it has been demonstrated that growth of dark-grown arabidopsis seedlings is inhibited by ethylene concentrations as low as 0·2 nL L−1. endogenous ethylene is involved in the control of sprout growth during later stages of sprout development, e.g., when sprout leaves press through the tightly closed neck of the bulb, would be an interesting aspect to investigate.

Treatment of dormant onion bulbs with 1-MCP caused breaking of dormancy 2 weeks before natural dormancy release was detectable (Fig. 4A). However, the dormancy-breaking effect of 1-MCP was not very strong, as indicated by the relatively slow increase in percentage of sprouting bulbs compared with untreated bulbs. Possibly only some of the bulbs responded to 1-MCP owing to the non-uniform sprouting behaviour of onion bulbs. On the other hand, a 2-week exposure of dormant onion bulbs to 10·6 μL L−1 exogenous ethylene did not affect the duration of dormancy compared with air-treated bulbs. It seems, therefore, that relatively low concentrations of endogenous ethylene may be somehow involved in the regulation of dormancy but relatively high concentrations of exogenous ethylene are not. If, however, the ethylene treatment was extended to 9 weeks after harvest, the time to reach 50 % initial sprouting was shorter (2 weeks versus 3 weeks) than for the air treatment.



Jasmonic Acid:

Jasmonic acid (JA) and connected amalgams are extensively dispersed amongst higher plants and play significant parts in the directive of plant growth. Jasmonates have been shown to be effective inducers of nonsexual storage protein gene expression and proteinase inhibitors of resistance proteins. It is usually supposed that the bulbing course is controlled by the equilibrium amid the 'bulbing hormones and GA. Regvar et al. and Žel et al. testified that JA improved the bulb growth in vitro in absorptions from 1 to 10 μM and recommended that JA could play a significant role in the development of storage tissues in plants, for instance bulbs.

Nojiri et al. observed that bulbing was complex in the disorder of microtubules and suggested that jasmonic acid (JA) and methyl Jasmonate (MeJA) were candidate bulbing hormones due to their microtubule-disrupting activities and extensive transport in higher plants.

Salicylic Acid:

Salicylic acid (SA) also has a significant role in garlic bulb development, and MeJA probably boost the endogenous SA content of garlic plant, therefore refining bulbing.

Conclusion:

The aforementioned analysis provides evidence that plant growth regulators (PGRs), specifically auxins and gibberellins, possess the ability to significantly augment multiple facets of plant productivity. These objectives encompass enhancing crop productivity, optimizing product attributes, manipulating reproductive traits, facilitating fruit development, and augmenting resistance against both living organism-related and environmental challenges. The aforementioned improvements play a critical role in addressing the increasing requirements of food production and diverse breeding initiatives.

References:

Kaur P, Mal D, Sheokand A, Singh L, Datta D. Role of plant growth regulators in vegetable production: A review. Int. J. Curr. Microbiol. Appl. Sci. 2018;7(6):2177-2183

Pallabi N, Dhanalakshmi TN, Rudramuni T, Priyadarshini SK. Glimpses about role hormones in plants. Innov. Farm. 2016;1(2):59-61.

Prajapati S, Jamkar T, Singh OP, Raypuriya N, Mandloi R, Jain PK. Plant growth regulators in vegetable production: An overview. Plant Arch. 2015;15(2):619-626.

Thakur O. Recent advances of plant growth regulators in vegetable production: A review. Pharma Innov. J. 2022;11(3): 1726-1731.

Toungos MD. Plant growth substances in crop production: A Review. IJIABR. 2018; 6:1-8

Zhang X, Zhao B, Sun Y, Feng Y. Effects of gibberellins on important agronomic traits of horticultural plants. Front. Plant Sci. 2022; 13:978223.