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Jyoti Singh
Department of Horticulture,
CSAUAT, Kanpur,
Uttar Pradesh, India

AK Dwivedi
Department of Horticulture,
CSAUAT, Kanpur,
Uttar Pradesh, India

Pragya Ramgiry
Department of Horticulture,
JNKVV Jabalpur,
Madhya Pradesh, India

Correspondence
Jyoti Singh
Department of Horticulture,
CSAUAT, Kanpur,
Uttar Pradesh, India

Effect of 2, 4- D, NAA and GA3 on Morphological, yield and quality traits in vegetable crops (Review article)

Jyoti Singh, AK Dwivedi and Pragya Ramgiry

Abstract
To enhance productivity of vegetable crops by using plant growth regulators are very efficient and modern methods of Agriculture and Horticulture. Plant growth regulators has quicker impact on vegetative as well as yield, quality and morphology of the vegetable crops. Applications of plant growth regulators must lead to quantifiable advantages for the user plant growth regulators must be specific in their action and environmentally safe. Plant growth regulators in vegetables provides professionals and researchers with the information needed to effectively tap these versatile resources to enhance vegetables production. Most of the physiological activates and growth in plants are regulated by action and interaction of some chemical substance in them is called hormones. Recently, there has been global realization of the important role of PGR's in increasing crop growth, yield and quality traits of vegetable crops. Gibberellic acid, NAA and 2,4 –D are an important growth regulator that may have many uses to modify the growth, yield and yield contributing and quality characters of vegetable crops.

Keywords: Morphological, vegetable crops, Morphological

Introduction
Vegetable comprise of a large number of plants, mostly annual of which different parts like leaf, stem, flower bud, flower, fruit, root etc. are eaten. Vegetable plays an important role in Agriculture due to its food and nutritional importance. India is the second largest vegetable producer next to China accounting about 169478230 matric tones of production with 9542230 hectare area. Most vegetables are naturally low in fat and calories none have cholesterol. Vegetables are important sources of many nutrients, including potassium, dietary fiber, folate (folic acid), vitamin A, and vitamin C. The word plant hormones are also known as Phytohormones. These hormones helps to regulate growth of the plant and these hormones are small molecules that derived from different essential metabolic pathways. Thimann in 1948 was coined the term Phytohormone as organic substance that produce naturally in plants. The plant hormones are natural and plant growth regulators are synthetic in nature. They play an important role to growth of plant (P. Hazra and M.G. Som, 2006) [13]. In the present study we are concerned with chemical i.e. growth regulators GA_3, NAA and 2, 4-D. The growth regulators available are often inadequate in the plants. The specific quantities in the plants are directly responsible for the promotion, inhibition or otherwise modification in the physiological processes. It is obvious that the growth is directly related to the yield. Gibberellins promote shoot growth by accelerating the cell elongation and cell division in the sub apical meristem region which increases the length of internodes. Gibberellin regulates the mitotic activity of the sub apical meristem. Physiological effects of the gibberellins are (i) Stem elongation: It increases the length of internodes (ii) Parthenocarpic fruit: GA induces parthenocarpic development in tomato (iii) It increases the size of leaves and fruits. (iv) It increases the cell division and cell size.GA_3 significantly reduces the number of seeds per fruit but it increases the plant height and number of branches per plant. NAA is commonly used in horticulture crops. The higher concentrations of NAA inhibit growth and exert toxic effects on the plants so, optimum concentrations are required to find out to beneficial effects of NAA. The effect of NAA has been observed mainly as cell elongation, improved phototropism, apical formation, respiration and flower bud initiation. The mode of action of NAA is mainly by its (i) direct effect of cell wall components (ii) effect on permeability through plasma membrane (iii) function as co-enzyme or co enzyme components (iv) induction of synthesis of

specific R.N.A. and protein which in turn leads to an increase in cell wall elasticity and extension (Krishnamoor, 1981) [11, 12]. 2,4- D significantly reduces the plant height and, internodal length, days to flowering, acidity and number of seeds per fruits, but it increases fruit set, number of fruit, TSS, number of secondary roots and yield. Plant growth regulators (PGRs) are used extensively in horticulture to enhance plant growth and improve yield by increasing fruit number, fruit set and size (Batlang, 2008 and Serrani *et al*, 2007a) [1, 4]. Use of growth regulators had improved the production of tomato including other vegetables in respect of better growth and quality (Saha, 2009) [2]. Plant growth regulators such as auxins and gibberellins are known to affect parthenocarpy Matlob, A.N. and Kelly, W. C. (1975) [30], fruit setting Rappaport, L. (1957) and fruit size Osborne D.J., Went F.W. (1953) [35]; therefore synthesized auxins and gibberellins are often used for promotion of fruit set in some fruit vegetable production including tomatoes Kuo, C.G. and Tsai, C.T. (1984) [28] and yields can increase dramatically to four times Abdulla *et al.* (1978)

Plant Growth Regulators

Plant Growth Regulators are defined as small, simple chemicals produced naturally by plants to regulate their growth and development. Plant hormones (also known as phytohormones) are signal molecules produced within plants, that occur in extremely low concentrations. The hormones helps to regulate growth of the plant and these hormones are small molecules that derived from different essential metabolic pathways. They play an important role to growth of plant (P. Hazra and M.G. Som, 2006). In the present study we are concerned with chemical i.e. growth regulators GA_3, NAA and 2, 4-D. The growth regulators available are often inadequate in the plants. The specific quantities in the plants are directly responsible for the promotion, inhibition or otherwise modification in the physiological processes. It is obvious that the growth is directly related to the yield.

Effect of 2, 4- D, NAA and GA3 on morphology of vegetable crops

Vegetative growth or morphology of vegetable crops in terms of height, stem diameter, number of branches and shoot, number of primary and secondary branches, inter nodal length etc influenced by application of GA3, NAA and 2,4-D, has been studied by many workers. Plant growth regulator affects the physiology of plant growth and influence the natural rhythm of a plant. (NAA) and (GA) can manipulate a variety of growth and developmental phenomena in various crops. Vegetative growth of tomato increased by foliar sprays of GA_3 at 100 ppm (Bukovao (1957). Arun *et al.* (1982) reported that the application of GA3 @ 200 ppm resulted in maximum plant height followed by seed soaking with GA3 @ 15 ppm in brinjal cv Pusa Purple long. The application of bio-regulators such as GA3 at 500 ppm increased the length of the vine in muskmelon. GA_3 encourage the internodal shoot length**.** Patil and Mahajan (1971) found that tomato seedlings treated with NAA at 0.05, 0.10, 0.20 or 0.40 ppm before transplanting, yields were enhanced by highest rate of NAA. Kar *et al.* (1993) applied NAA (at 15, 25 and 50 ppm) to tomato cv. Pusa Early Dwarf by pre-soaking seeds with or without a foliar spray 30 days after transplanting. Plant growth, flowering, fruit retention and yield were evaluated. There was no consistent trend in response with increasing rates of plant growth regulator. Overall, the application as a seed pre-soak + spray gave the best fruit retention and yield. Four sweet potato (*Ipomoea batatas* L.) cultivars responded differently to growth regulator application for number of flowers produced, percentage capsule set. GA3, 2, 4-D and NAA application resulted in the highest number of flowers by 'Jewel', 'Shore Gold' and 'Vardaman' plants, respectively. The application of ethrel in Watermelon (Citrullus Lanatus) at 500 ppm GA3 concentration brought significant improvement in vegetative characters of plants i.e. main vine length and number of secondary branches plant-1 (Dixit *et al.*, 2001).

Effect of 2, 4 - D, NAA and GA3 on Yield and Yield attributing traits of vegetable crops

Yield is the ultimate economic product of the crop, which is determined mainly by fruit weight and number of fruits per plant. Most of the yield components show a direct influence on fruit yield. Under good crop management conditions, the highest yield levels could be obtained through improved package of practices, which includes the use of plant growth regulators. The foliar application of plant growth regulators eg - GA 3 (10 ppm) at two and four true leaf stages in watermelon recorded maximun fruit yield over control (Choudhury and Elkholy 1972). The total fruit yield per ha increased with the application of GA 3 (5 ppm) at 21 and 28 days after sowing in bottle gourd (Mishra *et al.*, 1972). The application of GA 3 (10 ppm) at 2, 4 and 6 leaf stages increased the fruit yield per hectare in muskmelon (Randhawa and Kirtisingh, 1973). The effect of plant bioregulators on the growth and yield of tomato cv. Pant T-3. The bioregulator treatments comprised CIPA (10 and 20 ppm); NAA (20 and 40 ppm); 2,4-D (5 and 10 ppm), GA_3 (5 and 10 ppm); ethephon (50 and 100 ppm); and the control (water, 0 ppm. All the bio-regulators hastened fruit maturity compared to the control. Application of 10 ppm 2, 4-D proved most effective. The maximum and minimum fruits per plant were recorded in 5 ppm GA_3 and 10 ppm 2,4-D, respectively. (Singh *et al.* 2001) [6]. The application of NAA, 2,4 –D and GA3 improved the quality of tomato cv. Punjab Chhuhara, NAA application increased total soluble solid percentage significantly. Application of 2,4-D at 5 ppm also increased the yield, but retarded the growth attributes and yield at higher concentration. The application of varying concentration of GA_3, 2,4-D and NAA increased number of flower and number of fruit per plant. Udden *et al.* (2009). It is also proved that the two foliar sprays of GA3 and NAA at 50 ppm produced significantly more number of flowers per plant, fruit set percentage, number of fruits per plant, fruit weight, yield, TSS and ascorbic acid. GA_3 at 75 ppm as foliar spray recorded significantly lower fruit drop percentage compared to the rest of the treatments. There were significantly higher total soluble solids, ascorbic acid content and TSS/acid ratio and lower acidity percentage with application of GA_3 at 50 ppm compared to 25 and 75 ppm GA_3 and NAA. (Meena *et al.* 2008).In vegetable crops the spray of NAA and GA3 can increase fruit size with consequent enhancement in seed yield. It also increases the flowering, fruit set, (Gurdev *et al.*, 1991). GA stimulated stem elongation increase dry matter accumulation (Hore *et al.*, 1988) and enhance vegetable seed yield. It was noticed both the fruit number and fruit yield significantly affected hormones. In case of sowing times, in case of hormone, Ripen-15 produced the highest yield of okra (14.06 t ha G1) and control produced the lowest (10.06 t ha G1) yield of okra (Dilruba *et al.*, 2009) [7]. In cluster bean spraying of thiourea 500 mg/l registered maximum number of pods plant-1, weight of 1000 seeds and seed yield with good

quality seeds (Satodiya *et al.*, 2012). Among PGRs, 2,4-D at 2 ppm was better for fruit set, number of fruits per plant, fruit length, number of seeds fruit-1, seed weight fruits-1, 1000 seed weight and fruit yield whereas NAA at 40 ppm gave the highest leaf area index. PGRs were ineffective in promoting flowering and fruiting during winter season. GA3 at 10 ppm exhibited maximum amount of ABA content.

Effect of 2, 4 - D, NAA and GA3 on Quality traits of vegetable crops

Quality traits in vegetable crops such as TSS, Acidity, Vitamine C, Total Sugar (Reducing sugar and non reducing sugar), Flavor and nutritional quality assessment could be obtained through improved package of practices, which includes the use of plant growth regulators. The foliar application of plant growth regulators eg; NAA, GA3, 2,4 –D effective for obtained maximum TSS and Total sugar. The two foliar sprays at 50 ppm GA3 and NAA produced significantly more number of flowers per plant, fruit set percentage, number of fruits per plant, fruit weight, yield, TSS and ascorbic acid. GA_3 at 75 ppm as foliar spray recorded significantly lower fruit drop percentage compared to the rest of the plant growth regulator treatments. There were significantly higher total soluble solids, ascorbic acid content and TSS/acid ratio and lower acidity percentage with application of GA_3 at 50 ppm compared to 25 and 75 ppm GA_3 and NAA. (Meena *et al*. 2008). The effect of growth regulators namely NAA (0, 25, 50 and 75 ppm) and GA_3 (0, 15, 40 and 60 ppm) in factorial randomized block design on yield and fruit quality of tomato. Significant response of NAA (25 ppm) with respect to number of fruits/plant, fruit weight/plant, total soluble solid (TSS) and vitamin C and yield was obtained over the control. Similarly maximum yield and vitamin C was obtained with the application of 40 ppm GA_3. Combined application of NAA (25 ppm) and GA_3 (40 ppm) was more effective than their individual application in terms of yield, TSS and vitamin C content, respectively. (Saha *et al*. 2009) [2].

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