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# Foliar Spray of Salicylic and Gibberllic Acid on Productivity of Crops: A Review

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## ABSTRACT

Plant growth regulators are chemical substances and when applied in small amounts, they bring rapid changes in the phenotypes of the plant and also the plant growth, right from seed germination to senescence either by enhancing or by stimulating the natural growth regulatory system. Plant growth substances are known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates thereby helping in effective flower formation, fruit and seed development and ultimately enhance the productivity of crops. An attempt is made to review the some of the important growth substances like salicylic acid and gibberellic acid on growth and productivity of the crops.


**Key words:** Crops, Plant growth regulators, Photo-assimilates, Productivity, Translocation.

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Plant growth regulators are chemical substances and when applied in small amounts, they bring rapid changes in the phenotypes of the plant and also the plant growth, right from seed germination to senescence either by enhancing or by stimulating the natural growth regulatory system (Kaur *et al*., 2015). Plant growth substances are known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates, thereby, helping in effective flower formation, fruit and seed development and ultimately enhance the productivity of crops (Bai *et al*., 2016, 2017). An attempt is made to review the some of the important growth substances like salicylic acid and gibberellic acid on growth and productivity of the crops. In recent years, plant growth regulators are being employed increasingly to overcome physiological constraints leading to enhanced production in several crops (Malik *et al.,* 1990). Gibberellins are probably one of the growth regulators that have a significant effect on flowering (Takahashi *et al.*, 1991). These plant growth regulating substances have been found to improve the flowering of the crop, physiological efficiencies including disease resistance and play an inevitable role in raising productivity of crops (Dhashora and Jain, 1994; Kumar *et al*., 2015). Growth regulators can improve the physiological efficiency including photosynthetic ability and can enhance effective partitioning of accumulates from source and sink in the field crops (Solaimalai *et al*., 2001). Sritharan *et al*. (2005) observed in grain legumes that the application of plant growth regulators (PGRs) and nutrients decrease the leaf senescence by retaining more leaf nitrogen and chlorophyll. Plant hormones affect plant growth in multifarious ways affecting a number of physiological or biochemical processes in plants subjected to biotic and abiotic stresses and salicylic acid is one such plant growth regulators, which participate in the regulation of a number of physiological events taking place in the plant (Ashraf *et al.,* 2010).

### Importance of salicylic acid

Salicylic acid is ortho-hydroxybenzoic acid and is a secondary metabolite acting as analogues of growth regulating substances. It helps in protection of nucleic acids and prevention of protein degradation. The SA is also known to induce many genes coding for pathogenesis-related proteins in response to biotic and abiotic stresses (Yalpani *et al*., 1994). Foliar application of SA increased theindole acetic acid (IAA) content in broad bean leaves (Liu Xin *et al.,* 2000). Foliar application of SA exerted a significant effect on plant growth metabolism when applied at physiological concentration, and thus acted as one of the plant growth regulating substances (Kalarani *et al.,* 2002). Salicylic acid plays diverse physiological roles in plants which include plant growth, thermogenesis, flower induction, nutrient uptake, ethylene biosynthesis, stomatal movements, photosynthesis and enzyme activities (Hayat and Ahmed, 2007). Salicylic acid is an endogenous growth regulator of phenolic nature, which participates in the regulation of physiological processes in plants such as growth, photosynthesis, nitrate metabolism, ethylene production, heat production and flowering (Hayat *et al.,* 2010).

### Effect of salicylic acid on growth parameters

Sujatha (2001) reported that foliar application of salicylic

acid (100 ppm) on greengram at 75 DAS increased the plant height (50.4 cm), root length (16.9 cm), number of leaves (18.4) and leaf area index (1.30). Kalpana (2001) revealed that foliar spray of salicylic acid 100 ppm and 2% DAP increased the leaf area index and crop growth rate of soybean. Bekheta and Iman (2009) observed that foliar application of salicylic acid on corn and beans increased the plant height due to higher photosynthetic rate. Jayalakshmi *et al.* (2010) reported that foliar spray of salicylic acid at 100 mg $L^{-1}$ increased the plant height and dry weight of groundnut. Ali *et al.* (2013) revealed that foliar application of salicylic acid on mungbean significantly increased the plant height and number of branches $plant^{-1}$. Maduraimuthu and Desikan (2013) stated that foliar application of salicylic acid and NAA on sweet sorghum significantly increased the plant height.

**Effect of salicylic acid on yield and yield parameters**

Salicylic acid spray increased the grain number of cheena millet (*Panicum miliaceum*) (Datta and Nanda, 1985). Jeyakumar *et al.* (2008) reported that application of salicylic acid (125 ppm) on black gram increased the seed yield (855 kg $ha^{-1}$). Ahmad *et al.* (2009) stated that foliar application of salicylic acid at 100 ppm on sunflower significantly increased the number of achenes $head^{-1}$ (1164.67), achene yield (2857 kg $ha^{-1}$), biological yield (11412 kg $ha^{-1}$) and harvest index (25.18%). Jayalakshmi *et al.* (2010) reported that foliar spray of salicylic acid at 100 mg $L^{-1}$ increased the grain yield of groundnut. Ali *et al.* (2013) revealed that foliar application of salicylic acid on mungbean significantly increased the number of pods $plant^{-1}$, number of seeds $pod^{-1}$, 1000 seed weight, seed weight $plant^{-1}$ and seed yield $ha^{-1}$. Finger millet treated with salicylic acid under invitro condition results in early flowering on 50 day itself and in control, the flowering starts only after 60 days. Also the treated plant has more number of flowers and fruit set when compared to control (Manikandan and Sathiyabama, 2014). Noureddini and Sharafzadeh (2014) reported that foliar application of salicylic acid before flowering on maize increased significantly increased the ear length, number of ear $row^{-1}$, number of kernel $row^{-1}$, 1000 kernel weight (g) and kernel yield (g $plant^{-1}$).

**Effect of salicylic acid on nutrient uptake and economics**

Umadevi (1998) reported that application of salicylic acid increased the leaf nitrogen and phosphorus contents in sesame. Application of brassinosteroid and salicylic acid increased the uptake of potassium in sesame reported by Umadevi (1998) and in greengram by Sujatha (2001). Gunes *et al*. (2007) at Turkey demonstrated that exogenously applied salicylic acid increased the plant growth in maize significantly both in saline and non-saline conditions. This may be related to its inhibiting effect on $Cl^{-1}$ and $Na^{+1}$ and improving the uptake of N, Mg, Fe, Mn and Cu due to its effect on lipid peroxidation. Foliar application of salicylic acid (100 ppm) improved the B:C ratio in greengram (Sujatha, 2001). Kuttimani and Velayutham (2011) revealed that foliar application of 2% DAP + 100 ppm salicylic acid twice showed the higher B:C ratio of summer greengram.

**Importance of gibberellic acid**

Gibberellins (GAs) have been known as growth promoters that mediate many responses in plants from seed germination to senescence. It also controls root development in the prevention or promotion of root elongation, flowering and fruit development (Yamaguchi and Kamiya, 2000). Fridborg *et al.* (2001) reported that exogenous application of $GA_3$ can suppress the activity of 'short internode' and 'GA insensitive' genes and hence leads to elongation growth of shoots. Gibberellic acid is one of the most important growth promoting substances used in agriculture since long ago (Naeem *et al.,* 2001). Gibberellins (GAs) are generally involved in growth and development. They regulate seed germination, leaf expansion, stem elongation and flowering (Magome *et al.,* 2004). $GA_3$ has been reported to increase the cell wall extensibility leading to elongation growth (Rahman *et al.,* 2004).

**Effect of gibberellic acid on growth parameters**

Iqbal *et al*. (2001) reported that application of 20 mg $L^{-1}$ $GA_3$ at flower initiation stage on chickpea increased the plant height, fresh and dry weight of shoot. Hoque and Haque (2002) reported that mungbean applied with foliar application of $GA_3$ at 200 ppm recorded higher relative growth rate, while 100 ppm recorded higher leaf area index, total dry matter, crop growth rate and net assimilation rate. Bora and Sarma (2006) revealed that foliar spray of $GA_3$ increased the shoot length, number of branches $plant^{-1}$ and number of flowers $plant^{-1}$ in pea. Emongor (2007) reported that exogenous application of $GA_3$ after emergence at 30, 60 and 90 mg $L^{-1}$ significantly increased the plant height, leaf area, number of leaves $plant^{-1}$ and dry matter accumulation in cowpea. Naghashzadeh *et al.* (2009) inferred that foliar application of $GA_3$ had a significant effect on plant height in maize. Azizikh *et al.* (2012) stated that foliar application of $GA_3$ (125 ppm) increased the number of lateral branches $plant^{-1}$ in soybean. Vahid Ghodrat *et al.* (2013) reported that foliar spray of gibberellic acid on maize significantly increased the crop growth rate and net assimilation rate.

**Effect of gibberellic acid on yield parameters**

Bora and Sarma (2006) reported that foliar application of $GA_3$ on pea increased the number of pods $plant^{-1}$ and seed index. Emongor (2007) reported that exogenous application of $GA_3$ after emergence at 30, 60 and 90 mg $L^{-1}$ significantly increased the pod length, pod number $plant^{-1}$, seed number $pod^{-1}$, 100 seed weight, seed yield and harvest index of cowpea. Naghashzadeh *et al.* (2009) inferred that foliar application of $GA_3$ has a significant effect on grain yield and 1000 seed weight of maize. Azizikh *et al.* (2012) stated that foliar application of $GA_3$ (125 ppm) increased the number of pods $plant^{-1}$ (101.5), number of seeds $pod^{-1}$ (2.65), 1000 seed weight (172.6 g), economic yield (4.24 t $ha^{-1}$), biological yield (47.62 t $ha^{-1}$) and harvest index (48.05%) of soybean.

Yakubu *et al.* (2013) revealed that foliar spray of gibberellic acid on groundnut at 100 mg $L^{-1}$ increased the pod yield, while 200 mg $L^{-1}$ increased the haulm yield of groundnut in both wet and dry conditions.

**Effect of gibberellic acid on nutrient uptake and economics**

Khan *et al*. (2002) revealed that the increase in nitrogen uptake following $GA_3$ application was due to increase in shoot growth, which requires more utilization of soil nitrogen and also $GA_3$ increased the nitrogen use efficiency due to enhancement of vegetative growth and pods.

Al-Rumaih *et al*. (2003) reported that foliar application of $GA_3$ increased the mineral nutrient levels of cowpea roots and shoots. Khan *et al*. (2007) stated that foliar application of $GA_3$ increased the uptake of nitrogen. Ashwini (2005) reported that foliar application of $GA_3$ (20 ppm) increased the B:C ratio in French bean (*P. vulgaris*) due to higher productivity.

## CONCLUSION

It is concluded that foliar application of plant growth regulators helps in bringing rapid changes in the phenotypes of the plants and also improves growth and translocation of nutrients to economic parts and ultimately leads to enhanced productivity of the crops.

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