Manipulation of Okra plant height using Gibberellic acid and its biosynthesis inhibitors

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ABSTRACT
Gibberellic acid stimulated the elongation of plant internodes. Plants treated with gibberellic acid (GA_3), as the sole plant growth regulator, were at least three (3) folds greater in height in comparison to the Control and seven (7) folds higher than other treatments after 8 weeks of acclimatization. The Control plants, without any applied growth regulator or inhibitor of gibberellic acid biosynthesis, grew taller than the plants treated with either gibberellic acid (GA_3) and Ancymidol or GA_3 and Paclobutrazol. This result indicates that both Ancymidol and Paclobutrazol inhibited the activity of giberrellic acid in the plant, thereby giving rise to plants with shorter internodes and plant height. Gibberellic acid promoted leaf growth and apical dominance in Okra plants. However, the exogenously applied inhibitors of gibberellic acid biosynthesis such as Paclobutrazol and Ancymidol inhibited or blocked the synthesis of gibberellic acid which resulted in stunted growth or reduced stem elongation in plants treated with either of them.

KEYWORDS: Gibberellic acid; Ancymidol; Paclobutrazol; Plant hormones; Growth inhibitors; Plant height

1.0 INTRODUCTION

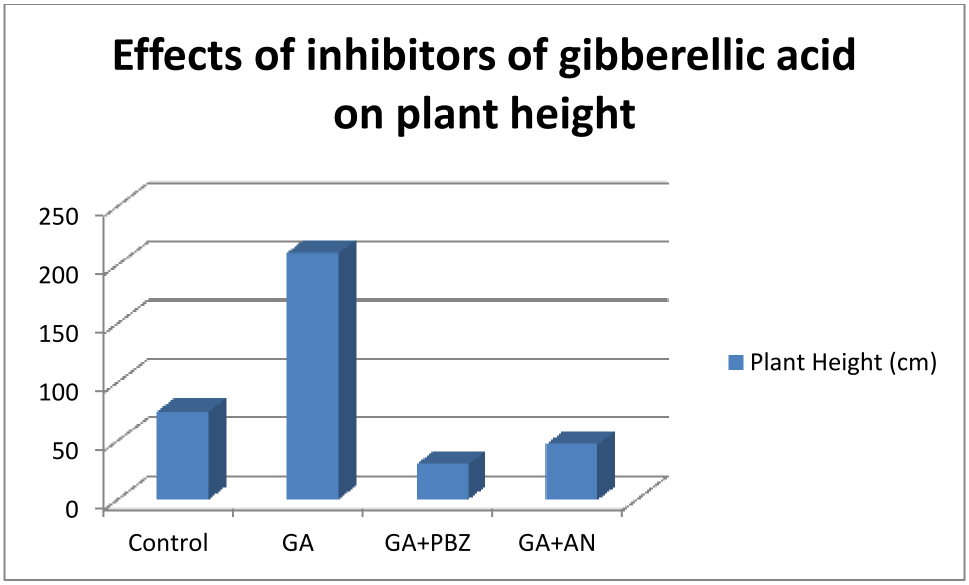
Plant hormones are also known as regulators of plant growth and development as they modulate these processes. Plant growth regulators exhibit growth control as well as influence adaptation of plant development to changing environmental conditions (Wolters and Jurgens, 2009) such as stress, photoperiodism, etc. They are also involved in the regulation of immune responses to microbial pathogens, insect herbivores, and beneficial microbes (Pieterse et al., 2012). The understanding of the regulation of the developmental and physiological processes that affect plant growth is crucial because greater growth will usher in a larger leaf area which in turn will promote photosynthesis and higher crop yields. On the basis of comparison of molecular changes in transcript and metabolite levels, low gibberellic acid (GA_3) levels affect plant growth by uncoupling growth from carbon availability (Ribeiro et al., 2012). Gibberellic acid has been shown to break seed dormancy and promote stem elongation in plants. Gibberellins can drastically bring about increase in stem growth and are involved in regulating physiological processes in plants just like auxins do. When gibberellins are applied to some kinds of plants, they induce flowering, breaking of seed dormancy, and plants may commence growth at lower temperatures than usual. However, growth retardants, which are produced commercially, inhibit or block the biosynthesis of gibberellins which could result to stunted growth in plants.

2.0 MATERIALS AND METHOD

Okra seeds were surface-disinfected in 0.1% $HgCl_2$ for one minute and thoroughly washed in distilled water. Twenty seeds (20) were sown in each large petri dish containing No.2 Whatman filter paper and either 5ml distilled water (as Control) or 5ml of 450 mg/L Gibberellic acid (GA_3 = T1) or 5ml 450 mg/L GA_3 and Ancymidol (GA+AN = T2) or GA_3 and Paclobutrazol (GA+PBZ = T3). Each treatment was replicated four (4) times under same laboratory conditions *in vitro*. The petri dishes were placed in 4 rows and 4 columns in a large tray and placed on a laboratory bench. The Control had no plant growth regulator or inhibitor. The seedlings were then transferred into the greenhouse for acclimatization after 28 days from the date of seed sowing. Foliar application of 50 ml of the treatments, with the concentration of 100 ppm, was given to young Okra seedling in the greenhouse 7 days after transplanting. Subsequent foliar applications were conducted at 14 days intervals from the previous. Plant heights were measured in the greenhouse after 8 weeks of transplanting and acclimatization.

3.0 RESULTS AND DISCUSSION

Gibberellic acid stimulated the elongation of plant internodes. Plants treated with gibberellic acid (GA_3), as the sole plant growth regulator, were at least three (3) folds greater in height in comparison to the control and seven (7) folds higher than other treatments after 8 weeks of acclimatization. Treatment with gibberellic acid gave a mean plant height of 210 cm, while the Control plants were 75 cm tall. The results of this study agree with those reported by Gaba (2005) where gibberellic acid was used to enhance shoot elongation before rooting. Gibberellin stimulated elongation of internodes and proved to be necessary for meristem growth. Where gibberellic acid was combined with Paclobutrazol (PBZ), the plant height was only 30 cm. The combination of gibberellic acid and Ancymidol (AN) yielded a mean plant height of 47 cm. The control plants, without any applied growth regulator or inhibitor of gibberellic acid biosynthesis, grew taller than the plants treated with either GA_3 and Ancymidol or GA_3 and Paclobutrazol. This result indicates that both Ancymidol and Paclobutrazol inhibited the activity of giberrellic acid in the plant, thereby giving rise to plants with shorter internodes and plant height. Gibberellic acid promoted leaf growth and apical dominance in Okra plants. However, the exogenously applied inhibitors of gibberellic acid biosynthesis such as Paclobutrazol and Ancymidol inhibited or blocked the synthesis of gibberellic acid which resulted in stunted growth or reduced stem elongation in plants treated with either of them.



The results of this study show that exogenously applied gibberellic acid promoted plant higher height; this is in agreement with the work reported by many authors. The work of Huang et al. (1989) and Li et al. (1989) reported that the application of the plant growth retardant, paclobutrazol, caused a significant reduction on the stem length of Asian pears and peach trees respectively. Further, the investigations conducted by Aloni and Paskkar (1987) and Quinlan and Richardson (1984) support the findings of this research as paclobutrazol not only decreased vegetative growth but also reduced the length of shoots. In the same vein, Graebe (1985) reported that paclobutrazol is an effective GA_3 biosynthesis inhibitor; it inhibits the oxidation of kaurene to kaurenoic acid. Its mode of inhibition rests in its interaction with kaurene oxidase, a cytochrome P-450 oxidase, and inhibits the microsomal oxidation of kaurene, kaurenal and kaurenol. On the basis of comparison of molecular changes in transcript and metabolite levels, low gibberellic acid (GA_3) levels affect plant growth by uncoupling growth from carbon availability (Ribeiro et al., 2012).

4.0 CONCLUSION

Gibberellic acid (GA_3) was effective in producing Okra plants that were exceptionally tall. The effect of gibberellic acid in stimulating stem elongation and plant height can be inhibited using the growth retardants or inhibitors of gibbereliic acid biosynthesis such as Paclobutrazol (PBZ) or Ancymidol (AN).

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