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SHORT COMMNICATION

EFFECT OF GIBBERRELLIC ACID ON GROWTH AND FRUIT YIELD OF GREENHOUSE-GROWN CAPE GOOSEBERRY

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ABSTRACT

Cape gooseberry is wildly grown in most parts of the tropics. A study was conducted to establish the optimal concentration and the critical stage of application of gibberellic acid (GA_3) in promoting plant growth and fruit yield in Cape gooseberry. GA_3 concentration of 100 ppm, and 12.5 pp, were applied at one week after transplanting, at flower initiation, and at fruiting stages, respectively. A 5 x 3 x 3 factorial experiment was designed and data collected on number of plant branches, plant height, and number of the fruits on a weekly basis for the whole economic life of the plant. Data was then analysed by GenStat statistical program where least significant difference (LSD) was used to separate and compare the means at 5% level of significance. Application of GA_3 increased branching, flower bud formation and fruiting. The higher the concentration the greater was the growth and yield. However, applying GA_3 at 100 ppm one week after transplanting the seedlings resulted in plants producing significantly largest number of fruits (303 fruits per plant), number of branches (20 branches per plant), and plant height (112.4 cm).

Key Words: Apical dominance, hormone, *Physalis peruviana* L.

RÉSUMÉ

La grosseille à maquereau du Cap (Type de base) est cultivée à l'état sauvage dans la plupart des régions des tropiques. Une étude a été ménée en vue d'établir la concentration optimale ainsi que l'étape critique d'application de l'acide gibberelique (GA_3) dans le but d'encourager la croissance de la plante et le rendement en fruits chez la groseille à maquereau du Cap. Des concentrations de GA_3 de 100ppm et 12,5 pp étaient appliquées à une semaine après transplantation au niveau de l'initiation de la fleur et à l'étape de floraison respectivement. Une expéreinec factorielle à 5x3x3 était conçue et des données collectées sur le nombre de branches de la plante, hauteur de la plante et et nombre de fruits sur base hebdomadaire le long de toute la vie économique de la plante. Les données étaient alors analysées par le programme statistique GenStat avec lequel la moindre différence significative (LSD) était utilisées pour compoarer et séparer les moyennes à un niveau de signification (importance) de 5%. L'application de GA_3 augmentait les branches, la formation des bourgeons de fleurs et la floraison. Plus la concentration était élevée, plus la croissance et le rendement augmentaient. Cependant, une application de GA_3 à 100ppm une semaine après transplantation des plantules se soldait par des plantes produisant des fruits (303 fruits par plante), des nombres de branches (20 branches par plante) et la hauteur de la plante (112,4 cm) ; significativement plus élevés.

Mots Clés: Dominance apicale, hormone, *Physalis peruviana* L.

INTRODUCTION

Cape gooseberry is wildly grown in most parts of the tropics (National Research Council, 1989). In Kenya, the crop is grown by smallholder farmers, and sold on most streets in major towns. The crop has the potential of being commercially produced (Johns and Violet, 1985) and due to its good natural flavour can be used in the fruit processing industry to make jam, sauce, pies, puddings, chutneneys, ice cream and fruit salads (Facciola, 1990; Huxley, 1992). The processed products can then be sold to earn fairly good income and even be exported to earn foreign exchange.

Despite the good natural flavour of the Kenyan Cape gooseberry fruit and the potential to commercialised in the country, its growth and fruit yield are still poor compared to those commercially grown in other countries (National Research Council, 1989). Little or no research work has been reported on this fruit crop with respect to the use of gibberellic acid for improving plant growth and fruit yield.

The present study was designed to improve plant growth and fruit yield by the application of GA_3 and to determine the optimum concentration of GA_3 spray and critical stage of GA_3 application for Cape gooseberry.

MATERIALS AND METHODS

The study was conducted under greenhouse conditions at Makerere University Agricultural Research Institute Kabanyolo (MUARIK) located in central Uganda. Wild landrace Cape gooseberry was used in the experiment.

The study investigated the optimum concentration and critical application stage of GA_3 in promoting plant growth and fruit yield of *Physalis peruviana* L. Varied GA_3 concentrations namely, 100, 50, 25, and 12.5 ppm including the control, were applied at different plant growth stages, i.e. one week after transplanting, at flowering and at fruiting stages.

A 5 x 3 x 3 factorial experiment was designed. A randomised complete block design was used in a split-plot arrangement. Plant growth stages were the main plot and GA_3 were the sub-plots.

GA_3 in powder form was obtained from Sigma Chemical Company, St. Louis, MO63178, USA. Hormone stock solution of 5000 ppm was prepared. The required application concentration (100, 50, 25 and 12.5 ppm) were made by dilution method from this stock solution.

A stock solution of 5000 ppm per litre of solution was prepared by taking 5 g (in powder form) of the hormone using a precision digital balance. The hormone was dissolved in an appropriate solvent. In this case, 50% ethyl alcohol and distilled water was used to make the final diluted solution to one litre.

In all treatment, Cape gooseberry plants were subjected to the standard crop management practices for example water application, disease and pest management, prunning and nutrient application.

Data were collected on number of branches per plant, plant height (cm) and number of fruits per plant. Plant height was determined using a tape measure, while branch and fruit numbers were determined by physical counting and marking of the counted branches and fruits.

Data were then analysed using GenStat (2000) statistical programme (Lawes Agricultural Trust, 1995) where least significant difference (LSD) was used to separate and compare the means.

RESULTS

Effect of GA_3 concentrations and application stage. The effect of GA_3 concentrations and applications stages and their interaction are shown in Table 1. Plant sprayed with GA_3 at 100 ppm, one week after transplanting, produced plants with the highest branches (20 branches). This was followed by 50 ppm (16 branches per plant) and the control having the least (5 branches). However, there was a highly significant ($P<0.05$) difference between plants sprayed with at GA_3 level of 100 ppm compared with the rest of the treatments. Concentration 25 and 12.5 ppm were not significantly different ($P<0.05$) between themselves, but showed significant reduction in the number of branches when compared with 100 and 50 ppm. At flower bud formation stage, 100 ppm GA_3 concentration also produced the highest number of branches, followed by 50 ppm. Application 100 ppm was significantly higher than the rest of the treatments including the control.

At fruiting stage, 100 and 50 ppm had the highest number of branches, but were not significantly (P>0.05) different from the other treatments including the control (Table 1). GA_3 at all concentrations one week after transplanting the seedlings produced significantly more branches than the rest of the applications stages. There were no significant differences amongst the three stages of application when plants were sprayed with water and GA_3 at 12.5 ppm at both flower and fruit formation stages.

GA_3 concentrations and application stage on plant heights. Effect of GA_3 concentrations, application stage and their interactions on plant heights is shown in Table 2. At all application stages, GA_3 concentration 100 ppm produced the tallest plants.

There were also significant differences among treatments at flower bud formation stage with GA3 concentrations of 100 and 50 ppm having no significant differences in plant heights, but they were significantly greater from the rest of the treatments including the control.

GA_3 application at one week after transplanting produced the tallest plants compared to other application stages. At this stage, GA_3 at 100, 50 and 25 ppm produced significantly taller plants than their corresponding concentration at fruiting. On the other hand, 12.5 ppm was not significantly different from the control at flower bud and fruit formation stages.

GA_3 concentrations and applications stages on fruit yield of Cape gooseberry. The effect of GA_3 concentrations and applications stages on fruit yield is shown in Table 3. GA_3 of 100 ppm, applied at one week after transplanting, produced the largest number of fruits. This was followed by 50 ppm; the control (water only) had the least number (Table 3). Generally, the number of fruits with decreased as the GA_3 concentrations decreased and vice-versa

TABLE 1. Effect of GA_3 application stage and concentrations on plant branching of Cape gooseberry

Concentration (ppm)	Application stages		
	1 week after transplanting	Flower bud formation	Fruting stage
100	20	10	7
50	16	7	7
25	13	5	6
0	5	5	5
LSD (0.05)	1.6	1.2	2.7
CV(%)	18.8		

TABLE 2. Effect of GA_3 application time and concentrations on plant height (cm)

GA_3 concentration (ppm)	Applications stages		
	[a]1 weeks after transplanting	[a]Flower bud formation	[a]Fruiting stage
100	112.4	67.4	58.4
50	103.8	65.9	51.0
25	97.3	58.5	50.0
12.5	80.1	53.3	49.5
0	51.7	47.4	46.1
L.S.D (0.05)	4.9	3.8	8.4
CV(%)	7.6		

[a]Mean number of branches of 4 plants/treatment taken for a period of 5 weeks. After this period, plant heights could not be determined due to increased branching as the gooseberry plant is indeterminate in nature.

TABLE 3. Effect of GA_3 application time and concentrations on number of fruit of Cape goosebery

Concentration levels (ppm)	Application stages		
	1 week after transplanting	Flower bud formation	Fruting stage
100	303	201	99
50	278	183	94
12.5	175	163	88
0	108	103	82
L.S.D (0.05)	18.9	14.6	32.7
CV(%)	12.5		

Application of 100 ppm produced plants with the highest number of fruits compared with the rest of the treatments including the control when GA_3 was applied at one week after transplanting stage. However, application at fruiting stage, led to significant differences (P>0.05).

DISCUSSION

Plant branching. GA_3 promoted branching probably by breaking apical dominance. This is in agreement with the work done by Khan and Rashid (1983) who reported an increase in the number of branches when gram plant was treated with GA_3. The optimal concentration of GA_3 application was 100 ppm and the critical stage of GA_3 application for increased Cape gooseberry plant branching was when applied at one week after transplanting. This was probably because GA_3 was applied earlier in plant development and thus growth was promoted in terms of increasing the number of branches (Khan and Rashid, 1983).

Plant height. Application of GA_3 generally resulted in greater increase in plant height than the control or when applied one week after transplanting. The increase in plant height was probably due to increased cell enlargement by enhanced auxin status of the plant by probably suppressing auxin destruction or by stimulating auxin biosynthesis; hence increasing the endogenous auxin level of the plants (Wilkins, 1998) thus resulting into increased cell division. GA_3 could have also promoted cell enlargement by stimulating the biosynthesis of α-amylase, which hydrolysed starch, thereby increasing the level of reducing sugars and, hence, causing increased osmotic pressure of the cells (Lehmann and Sembder, 1986). This could have been followed by uptake of water, which enters the cells through osmosis resulting into cell enlargement (Purohit, 1992; Malik, 1999). This is in conformity with the results obtained by Khan and Rashid (1983) and Doere and Bharud (1990), who reported that the growth was maximum in “”fenugreek” treated with GA_3.

Fruits yield. Fruit yield was generally higher in plants treated with GA_3 than with the control, at all stages and concentrations. This is in agreement with results obtained by several researchers (Gozales *et al.*, 1978; Rao and Rao, 1981; Joshi and Singh 1982; Khan and Rashid, 1983; Bavaria and Rastogi, 1988; Jain and Agarwal 1988), who observed that yield was best in plants treated with GA_3. Promotion of fruits setting was probably due to increased leaf expansion as a result of cell enlargement, which could have resulted in increased rate of photosynthesis; hence increased accumulation and partitioning of the photosynthates thereby leading to increased fruit set (Parthier, 1979; Derkx and Karssen, 1993).

Fruit yield was positively correlated with the GA_3 concentrations at all the stages of application. In this case, 100 ppm GA_3 was the optimal concentration, yet the critical stage of application of GA_3 for increased fruit yield of the Cape gooseberry crop was when applied at one week after transplanting the seedlings. This was probably because when GA_3 was applied earlier in development, it generally promoted growth in terms of increasing the number of branches and plant height; hence increasing the number of flowering sites and eventually resulting in increased number of fruits per plant. Increase in the number of branches increased the probable sites for photosynthesis, hence increased accumulation of the photosynthates/assimilates for partitioning.

CONCLUSION

The optimum GA_3 concentration spray and the critical stage of application for general increased growth and fruit yield of the gooseberry crop are 100 ppm and one week after transplanting the seedlings, respectively. Applications of GA_3 can therefore be recommended to help improve Cape gooseberry plant growth and development; hence resulting in increased fruit yield. Thus, for commercial greenhouse production of the Cape gooseberry crop, the practical application of GA_3 would be an appropriate technology for improved crop production.

Further research into the application of PGRs to alter crop plants to suit the environment and enhance plant growth or pattern of development in the desirable directions is also recommended for Cape gooseberry plant. One could use higher concentrations other than the ones used in this study and find out how this would affect plant growth and fruit yield of Cape gooseberry in comparison of what has been achieved. One could also try other alternatives of applying hormones other than the method used in this experiment (foliar application); for example soil application of plant hormones and investigate their effectiveness promoting plant growth and fruit yield of Cape gooseberry.

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