بسم الله الرحمن الرحيم

THE EFFECT OF FOLIAR APPLICATION OF 6-BENZYLADENINE (BA) ON BANANA (Musa spp. L.) SUCKER PRODUCTION

By
Howida Ahmed Awad Elkreem
B.Sc.(Agric.)
University of Zagazig
(1988)

A Dissertation
Submitted in partial fulfillment of the requirements
for the degree of Master of Science in Horticulture

Supervisor
Professor Abdel Gaafar Elhaj Saeed
Department of Horticulture
University of Khartoum

December 2002

تأثير الرش بالبنزيل أدنين (BA) علي إنتاج خلف نباتات الموز

إعداد

هويدا أحمد عوض الكريم

بكالوريوس زراعة

جامعة الزقازيق

بحث تكميلي مقدم لنيل درجة الماجستير

علوم البساتين

إشراف

بروفسير عبد الغفار الحاج سعيد

قسم البساتين

كلية الزراعة

جامعة الخرطوم

ديسمبر 2002م

Dedication

To the soul of my mother
And all my family with love

Acknowledgement

Greatly thanks to Allah who gave me health, strength and patience during the period of this study.

Thanks are extending to my supervisor Professor Abdel Gaffar El Haj Saeed for his advice and guidance throughout the period of this study.

Especial thanks are offered to Dr. Mustafa Mohamed Ali Elballa for his assistance.

Thanks are due to the staff of Department of Horticulture at Shendi and at the Faculty of Agriculture, Shambat for their support, assistance and help in completion of my research programme.

I am indebted to the Ministry of Agriculture of the River Nile for the financial support.

Thanks to my family for their patience and support during the course of the study.

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ABSTRACT

A field experiment was conducted to determine the influence of foliar application of 6-benzyladenine (BA) on sucker production on banana plants. The treatments were five concentration of 6-benzyladenine 10 mg/l, 100 mg/l, 250 mg/l, 500 mg/l and 0 mg/1 (control as a single foliar spray to runoff at 3 different times (January, Mach and May) after one month from planting. BA at 100 mg/1 stimulated lateral bud growth during the current season. The effectiveness of BA in breaking bud growth seems to be influenced by the time of application after planting. For optimum response to BA multiple spray applications to actively growing banana plants in non-fruiting condition were required. The results indicated that BA application may be a useful method for increasing sucker production in banana plant.

ملخص الأطروحة

أجريت تجربة حقلية لتقدير أثر الرش بالبنزايل أدينين (BA) علي إنتاج الخلف في نبات الموز.

كانت المعاملات بخمسة تركيزات من البنزايل أدينين 10 ملجم/لتر – 100 ملجم/لتر – 250 ملجم/لتر – 500 ملجم/لتر وصفر ملجم/لتر (الشاهد). الإضافة الأولى كانت بعد الزراعة بشهر في يناير ثم في مارس ثم في مايو.

البنزايل أدينين بتراكيز 100 ملجم/لتر حفز نمو البراعم الجانبية خلال فصل النمو النشط. تأثير البنزايل أدينين (BA) في نمو البراعم يبدو متأثراً بوقت الإضافة بعد الزراعة.

الاستجابة المثلي للبنزايل أدينين (BA) يجب إجراء العديد من الرشات لنبات الموز خلال فترة النمو النشط والنباتات غير المثمرة.

أشارت النتائج إلى أن إضافة البنزايل أدينين (BA) طريقة مفيدة لزيادة عدد الخلف لنبات الموز.

1. INTRODUCTION

Banana, a member of the Musaceae, is a predominately tropical crop which is grown in the hot humid lowland forest zones, with the varieties of the Cavendish group extending to high altitudes and into the subtropics wherever sufficient water is available. Bananas are the most important of the tropical fruits and provide sustenance to millions of people constituting the staple food in many countries in Africa and the Caribbean and Asian Pacific regions. Total world production was estimated to be approximately 88 million tones (Anon, 1999).

Bananas are cultivated for their parthenocarpic, seedless fruits. Most fruit is consumed locally where bananas occupy a large proportion of the diet in many bananas growing regions specially in the Great Lakes Region of East Africa and the Island of New Guinea. Export bananas are mostly grown in the Latin American-Caribbean region and account for only about 10% of total world production of bananas (Anon, 1992).

Although bananas for domestic consumption are all sterile clones, they have became diverse through the accumulation of somatic mutations and sports formation. A multitude of cultivars exist

supplying bananas for domestic consumption, grown on a wide variety of soils, under different environmental conditions and on holdings that range from small permanent plantations around settlement to garden plot inter-cropped with other crops and forest clearings. The number of different cultivars of banana has been estimated to approximate 500. (Stover and Simmonds 1987; Perrier and Tezena du Montcel 1990).

The Cavendish subgroup is responsible for 30% of the world production of banana fruits. In the Sudan bananas of the Dwarf Cavendish clone is the main banana type grown throughout the country. It is characterized by a short stature resistant to toppling by winds, is better adapted to cooler climates than most other Cavendish clones and has thus been the basis of banana cultivation in Sudan. However screening trials in Wad Madani has shown Giant Cavendish types, to be promising under Sudan conditions. They are also suited to cooler environments and cultivars such as Williams and Valery are taking over the role of leading cultivars of the Dwarf Cavendish banana type.

"Williams" can be grown in the Northern and River Nile States where it is cool during the winter months. "Valery" on the other hand

is known to be more resistant to nematodes and is higher yielding and can thus replace the Dwarf Cavendish grown in Kassala State which is plagued with this pest. "Americani" is drought resistant and can thus be grown in places where irrigation become difficult at certain time of year and seasonal droughts are common.

Banana fields in Sudan are known to be infested with nematodes. Only four or five ratoons (i.e. four or five crops) may be harvested from a banana field. Yields are drastically reduced both in quantity and quality. Banana growers adopt two cultivation systems where old banana grown fields are left fallow for 3- 4 years. The land is ploughed and is exposed to solar sterilization before it is replanted with suckers from old banana fields. No phytosanitary measures are taken and nematode infested suckers are used as planting material for the nematode free banana field soils.

Bananas are propagated vegetatively by suckers. The number of suckers introduced is limited and is not desired in production banana field.

Earlier trials to increase the number of suckers produced by banana plants, mechanically by stripping the outer leaf sheath, have been described by Barker (1959) and by Hamilton (1965). Growth

regulators have been reported to induce lateral bud growth in many plant species. Various growth regulators have been found effective such as dikegulac (Sach, *et al*, 1975; Arnold, *et al* 1983a), Mefluidide (Arnold *et al*. 1983b; Woodson and Rainford, 1986) and cytokinins (Boswell and Storey, 1974, Kossuth, 1978, Henny, 1985, Stiff and Boe, 1985, Shaheen and Said, 1986).

The objective of this study is to evaluate the effects of different concentrations of the cytokinin benzyladenine (BA) [(syno benzylaminopurine) (BAP)] on the induction of the growth and development of lateral buds in banana plants grown for propagation purposes.

2. LITERATURE REVIEW

2.1. Origin:

Bananas originated in South East Asia and were widespread as an important food crop there. Different groups of edible bananas originated between India and eastern Malaysia (Simmond, 1966). The wild ancestors of edible banana are still found in Malaysian forests. *Musa acuminata* (seeded diploid spp.) seem to be native of the area. The properties of *M. acuminata* has been altered in the tropical areas. These plants were taken to drier monsoon areas where *Musa balbisiana* is native. The two spp. crossed spontanously and the genome groups AB-AAB-ABB came into existence (Samson 1986).

Malaysian sailors probably took bananas to Madagascar about the fifth century AD and from there they spread to the east cost and main land of Africa.

Later Musa was introduced into the western hemisphere and into other parts of the world. Nowadays it is found in every tropical country. One cultivar only the Dwarf Cavendish, can be grown successfully outside the tropics in such places as the Canary Island, Egypt, Palestine, Natal and Southern Australia (Samson, 1986).

2.2. Botany:

. Banana is a large herb, perennial and monocarpic and has modified underground branched stem (rhizome) with roots and vegetative lateral buds, and an erect pseudostem composed of tightly packed leaf bases. An apical meristem is located in the center of the pseudostem grow and develop to gives rise to a succession of leaf primordia. Each primordium sheath contains an axillary bud at its base.

The root system is adventitious and shallow. Roots usually arise in groups at the surface of the rhizome. Most of them arising from the upper part while others arise from the lower parts, and these tend to have a more nearly vertical orientation.

The rhizome system of banana is a sympodial underground stem. The shoot turn up to form a new aerial stem. These aerial stems are tall and are supported by the closely compact leaf sheathes which grow direct from the top of the rhizome and support the aerial stem, which then carries the inflorescence. The leaf sheathe circular at first, completely enclosing the aerial stem but later the free margins of the sheath are forced apart by the growth of new leaves enclosed within the pseudostem.

The vegetative growth of each shoot is terminated by the transformation of the apical meristem into an inflorescence. They differentiate in the heart of the pseudostem and by the extension of the internodes below it. The basal nodes of the inflorescence bear female flower. However, the distal end bear male flowers with one or few clusters of bisexual (hermaphrodite) flowers carried in the middle internodes of the inflorescence.

2.3 Economic Importance:

Banana is a major fruit crop of the tropics and subtropics and is consumed by the rich and the poor alike. In some parts it is used as a staple food. India has got the highest acreage under cultivation compared with other parts of Asia and banana is only second in area to mango amongst other fruit crops of India.

Banana is an attractive perennial crop for farmers. The fruit can be produced all-year-round thus providing steady cash income and supply of food. It is also famous for its high yielding capacity and can be safely listed under the crop giving record yields per acre. The plant covers a very little space, so it can be very easily planted in the unutilized field strips where it is not possible to grow some other fruit plant. Banana fields can also be inter-cropped with other annual crops

especially vegetable and berseem. Every part of the banana plant is of importance. The main product, the fruit, is eaten after ripening. Many other products are made from the fruit and the other plant parts. Banana figs and chips can be made from sun or oven dried fruits. The fruits can also be turned into flour.

The pseudostems and the male buds are cooked or eaten fresh as vegetables. The leaves are extensively used as plates, decorative material and as food for animals. The fruit crop having so much an economic importance has been neglected and is under valued among the many other food crops of the world.

Banana plants are generally grown from suckers and set fruits when they are about 8-10 months old, at which time they have produced 40-50 leaves. The apical growing point of the rhizome becomes transformed into a reproductive bud and produces an inflorescence.

Bananas are known to be very heavy feeders requiring considerable amounts of fertilizers and manuring and copious irrigation. Nitrogen has been found to be the most important element for the successful cultivation of this crop. It affects both vegetative

and reproductive vigor of the plant and results in a market improvement in quality and quantity of the products.

2.4. Propagation:

2.4.1. Traditional propagation method:

Banana is conventionally propagated by separating suckers from their mother plants and planting them in the field to grow and develop as separate new individuals. A sucker is a lateral bud formed on the rhizome, the underground true stem of the banana plant. The number of suckers produced by an ordinary banana plant is limited hindering large-scale expansion. In addition to that these few suckers become available only when an old banana plantation is abandoned due to reduction in yield associated with pests and/or disease infestation.

Propagation in Sudan:

Bananas can be grown in most, if not all, States of Sudan. Though important as the most popular fruit, bananas are the most under valued and under searched fruit crop in Sudan. It is grown predominantly in small holdings (called Sagias) in Kassala State and in narrow strips along the shores of the White Nile and Blue Nile.

Availability of traditional planting materials can be cited as the most important single factor that hinders the expansion of banana cultivation in Sudan. Kassala State is the only source of suckers for establishing new banana fields. Seasonal flooding of the Blue and White Niles often destroy banana plantation causing extensive and complete damage to banana plantation along the shores. Banana growers are obliged to import planting suckers from Kassala. Establishing banana nurseries has never been thought of in Sudan. Importation of suckers from Kassala is still a high risky and expensive operation. The traditional means of transportation by lorries, make fast delivery of the bulky suckers before they rotten during the rainy season or dry out and wilt during the hot summer season an impossible mission.

Except in breeding work, all bananas are propagated vegetatively. According to Purseglove (1972) the types of planting materials used are as follows:

1. Peepers: very young suckers appearing above ground with scale leaves only.

2. Sword suckers: formed from buds or eyes low in the rhizome and bear narrow sword-like leaves. These are usually planted out intact when not more than 75 cm high and with rhizomes about 15 cm in diameter.

3. Maiden suckers: these are taller suckers which have broad leaves. They are still in the vegetative stage and are 5-8 months old with rhizome about 25 cm in diameter. After lifting they are cut back about 10-15 cm above the rhizome the central meristem is destroyed and the roots trimmed. They are usually planted on their sides with one bud or an eye that will grow and form a new plant from about 25-30 cm below soil level.

4. Bits of rhizomes: these are obtained from rhizomes, which have borne a bunch. These are dug up after removing all the aerial parts and are cut into two or more eyes and weigh usually over 2.5 Kg. They are usually planted with the eyes down and covered with 25-30 cm of soil.

5. Water suckers: these are suckers of superficial origin bearing broad leaves.

The material used for planting varies widely in different parts of the world. In the West Indies bits of large rhizomes, maiden and

sword suckers are usually used, while in Latin America pieces of maiden suckers10-15 cm in diameter are usually planted (Purseglove 1972). Small suckers are usually used in Sudan for propagation purposes because they are cheap and easy to handle and transport.

The type of planting material may have some effects on the rate of development, taking longer for small propagules, but this has little or no effect on bunch size (Purseglove 1972). The sword suckers, however, are considered to be the best type of planting material, because they bear earlier and tend to carry a heavier crop. A uniform type of planting material will tend to produce a crop at one time, however, reliable quantities of planting material can not always be obtained by collecting suckers since some clones are known to sucker infrequently or erratically. Barker, (1959) showed that additional buds along the surface of the rhizome could be stimulated to grow by striping away some of the outer leaf bases. The small side shoots that develop could be removed from the mother plant as an off shoot and in this way, additional planting material could be obtained. Hamilton (1965) has reported several other means of stimulating bud development.

Most angiosperms produce axillary buds at the base of each leaf. Banana is not an exception. Exogenously applied cytokinins to whole plants has been shown to promote lateral bud and shoot development in many plant species including woody (Kender and Carpenter, 1972; Boswell and Storey 1974; Broome and Zimmerman, 1976; Nauer and Boswell, 1981, Shaheen and Said, 1988) and foliage and shrub plant species (Higaki and Rasmussen 1979; Criley, 1980; Maene and Debergh, 1982; Wilson and Nell, 1983. Henny, 1985 Henny and Fooshee, 1985).

In vitro studies have also shown the influence of cytokinins in stimulating auxiliary shoot development. Benzylamino purine (BAP) (syn. Benzyladenine (BA) has been the cytokinin of choice, both for *ex-vitro* treatments of whole plant or explants. It is effective, available and cheap (Anon, 1981).

Exogenously applied (BA) alter the endogenous balance between auxins and cytokinin levels in the plant tissues thus counteracting the inhibiting effects of the apical dominance and inducing the axillary bud and lateral shoot growth (Sach and Thimann, 1967; Phillips, 1975, Wareing and Phillips 1981).

Propagation materials should be collected from vigorously growing disease free plants. After the sucker have been removed and dirt washed away until clean tissue is exposed, the pseudostem is cut 5-10 cm above the rhizome surface and two layers of outer leaves are removed.

A great advantage of the use of rhizome (Bullshead) as a planting material is that they can be transported for long distances in lorries without rotting or drying out. In addition to that they can be disinfected easily by hot water treatment. A major disadvantage, however is that sucker for propagation purposes should be allowed to grow bigger for rhizome formation thus interfering with the pruning system in banana which aims at maintaining a balance between vegetative and reproductive growths. Few (usually two) suckers are allowed to grow with the 'mother' plant (every four month) thus ensuring all year round yield of banana fruits. In addition, the removal of big suckers usually causes great damages to the rhizome, as they have to be cut off deeply. The number of suckers produced by rhizomes that are suitable for propagation purposes is thus limited. Sucker must be left on the mother plant until they at least over 50 cm high and/or weigh 800 - 1000 gm, thus competing with the mother plant for food, water and light. The yield will be adversely affected.

Abdel Hay (1992) indicated that best results are obtained if dipping in heated water at 60^{o}C for 20 minutes disinfects these rhizomes. Treated rhizomes are then kept in well aerated shaded area until they are planted.

2.4.2. Propagation by tissue culture:

Rapid colonal propagation was the first major practical application of tissue culture techniques (George and Sherrington, 1984). Other important applications included the eradication of diseases and the conservation and exchange of germplasm (De Langhe, 1984; Withers and Williams, 1985). These have also been the objectives of the first application of tissue culture to Musa. The earlier reports of banana plants produced by *in vitro* shoot tip culture came from Taiwan, China in the early 1970s (Ma and Shii, 1972; Ma *et al*., 1978). Berg and Bustamante (1974) used merislem culture combined with heat therapy to produce virus-free bananas in Honduras. In the Philippines, banana shoots tips were produced from mutation induced by irradiation (De Guzman *et al*., 1976, 1980). These first reports were based on research carried out on a very limited number of dessert banana cultivars of Musa AAA group, mainly Cavendish types (Vuylsteke, 1989).

Since 1980, however a wide range of Musa species and cultivars of all genomic constitutions have been found amenable to *in vitro* shoot tip culture (Cronauer and Krikorian, 1984a; 1984b; Jarret *et al*., 1985).

In vitro multiplication rates are several orders magnitude higher than the conventional propagation method. Large scale field establishment of *in vitro* propagated plants of banana and plantain has been reported in Taiwan and China (Hwang *et al*, 1984). The Philippines (Epp, 1987; Zamora *et al*, 1986); Jamaica (Oglesby and Griffis, 1986; Stover, 1987); Virgin Island (Ramcharan *et al*., 1987); Palestine (Reuveni *et al* 1985); Morocco (Kenny and Aaouine 1987); Nigeria Vuylsteke *et al*, (1986) maintained *in vitro* 91 accessions from Malaysia the Philippines and Thailand. Sun (1985) reported the successful *in vitro* multiplication of 93 species and cultivars of six genomic groups. Jarret *et al*., (1985). Vuylsteke and De Langhe (1985), Novak *et al* (1986), and Wong (1986) also described successful *in vitro* culture and plant production in cultivars belonging to four and six different genomic groups. In the field, growth of *in vitro* propagated plants is vigorous due to the diseases free nature of the planting material (Hwang *et al*., 1984; Hwang and Ko, 1987).

Cytokinins, however, have been shown overcome apical dominance in plants (Sachs and Thimann, 1964, 1967) and several reports have indicated these chemicals can specifically stimulate lateral bud, growth in apple (Poll 1968, Williams and Stahly 1968).

3. MATERIALS AND METHODS

3. Materials and methods:

The experiment was carried out for one season 2001- 2002 at the nursery of the Horticultural Department, Shendi town, 172 kilometer North of Khartoum, (longitude 33^{o} $26^{'}$ and latitude 16^{o} $42^{'}$ and altitude 360 m.).

3.1. Plant materials:

The planting materials of the local cultivar (Dwarf Cavendish) were used. The selected planting materials were sword suckers, of uniform size and appearance. The suckers were washed and cut off to 30 cm. height. Sixty suckers were used in this experiment.

3.2. Land preparation:

The experimental site was ploughed, harrowed, leveled and divided into plots (2 X 2 m^2). Each plot consisted of four planting pits 1 X 1 m apart. The suckers were then planted one in each planting

pit and their bases were completely covered with soil. Planting was done at the beginning of December.

3.3. Irrigation:

After planting irrigation was done once every week. During the summer months however irrigation was done once every three days.

3.4. Fertilization:

Urea fertilizer was applied at the rate of 600 g/plot splitted into three doses. The first dose in December after planting, and the second in February, and the third in April. Weed control was done regularly at monthly intervals by hands as needed.

3.5. Preparation of benzyladerine (BA) solution:

BA powder was weighed in the amount of 10 mg, 100 mg, 250 mg and 500 mg and each weighed amount was placed in a 500 ml glass Beaker. The powder was dissolved in 0.1 N HCL added in drops until all the BA material is completely dissolved. Distilled water was then added and the solution was transferred to 1000 ml volumetric flask. The pH of the solution was adjusted to pH 5.0 $\pm$ 0.2. The final volume was made to 1000 ml for each concentration by adding distilled water. The test solutions were stored in a refrigerator until use. Four different concentrations of (BA): 10 mg/l, 100 mg/l, 250

mg/l and 500 mg/l in addition to the control, which is distilled water without BA, were tested.

After one month from planting banana plants were treated with sprays of benzyladenine (BA) solution. The test solutions were added in three split doses, applied in January, in March and in May.

The experimental design used was a randomized complete block design with four plants representing the experimental unit. The 5 treatments were completely randomized and replicated three times. Observations on bud activity were made over a 4-week period.

3.6. Data Analysis:

Duncan's Multiple Range Test, 5% level, separated means of treatments.

3.7. Parameters recorded:

The following growth parameters were measured: Number of suckers, number of leaves, number of visible buds, girth of rhizomes and weight of rhizomes. Data were taken after two months from the first spraying and then once every two months for a total of three times.

3.7.1. Number of suckers:

The number of suckers was counted three times: in March, in May and in July.

3.7.2. Number of leaves:

The numbers of leaves produced were counted three times n March, in May and in July.

3.7.3. Number of visible buds:

The number of visible buds were counted at the end of the experiment when the suckers were up rooted and washed with water to expose the surface of the rhizome.

3.7.4. Girth of rhizomes (Diameter):

Rhizome girth was measured at 5 cm above ground level using a tape-meter.

3.7.5. Weight of rhizomes:

The pseudostem of each sucker was cut and a top loading balance was used in weighing the rhizome.

4. RESULTS

4.1. Number of suckers:

The data taken after three months from planting is shown in Figure (1). In March the results showed that there was no significant difference between all tested concentrations. However, 100 mg/l (BA) increased the number of sucker appreciably. The mean number of suckers was 1.14 in the control and increased to 1.73 in the 100 mg/l (BA).

In May the results also showed no significant difference between the means of the different treatments and again 100 mg/l BA increased the number of suckers (mean 1.99) compared to the control (1.33).

In July no significant difference between the different treatment was observed. However 100 mg/l BA increased the number of sucker appreciably (2.15) compared to the control (1.58).

4.2. Number of leaves:

The data in Figure (2), showed that 100 mg/l BA gave the highest increase in mean number of leaves compared to the control in all three readings in March, in May and in July.

4.3. Number of visible buds:

As shown in Figure (3), 10 mg/l BA gave the highest number of visible bud (2.98) compared to the control (1.38).

4.4. Girth of rhizomes:

The data presented in Figure (4), Table showed that 100 mg/l BA gave the highest value for the girth of rhizome (20.975) compared to the control (10.175).

4.5. Weight of rhizome:

The data taken in July at the end of the experiment as shown in Figure (5) showed that 100 mg/L (BA) has the greatest increase in the weight of rhizomes.

5. Discussion

Cytokinins have been shown to overcome apical dominance in plants (Sachs and Thimann, 1964, 1967; Phillip, 1975) and several reports have indicated that these chemicals can stimulate lateral bud growth and branching in a diverse number of fruit plant species (Poll, 1968; Williams and Stahly, 1968; Kender and Carpenter, 1972; Boswell and Storey, 1974, Richards, 1980; Boswell *et al*., 1981; Nauer and Boswell; 1981; Shaheen and Said, 1986; Popenoe and Barritt 1988).

Stimulation of sucker production in banana plants following BA treatments is not surprising in light of similar responses reported above for several other fruit trees. BA applied to the foliage of newly planted banana sword suckers stimulated sucker production in the current season. Treatments of 100 mg/l BA resulted in a significant increase in sucker formation at all times. Higher concentrations seem to be less effective and are not phytotoxic contrary to date palm where higher concentrations than the optimum (500 mg/l BA) caused pygmy formation on induced lateral bud growth and development of the date palm (Shaheen and Said, 1986).

Various factors have been suggested to influence the effectiveness of BA in inducing lateral branching in plants (Kender and Carpenter 1972). These limiting factors include fruiting, the state of dormant growth; the frequency of application of the chemical and the difficulty in its transport. The morphology of banana plants favour greatly the occurrence of a role of most of the above mentioned hindering factors.

The above ground pseudostem of the banana plant being composed of tightly clasping leaf sheaths may limit the transport of the chemical down to the lateral buds located at the base of each leaf. The apical meristem of each banana plant is located in the center of the pseudostem at about soil level. It divides giving rise to succession of leaf primordia. Each leaf primordium grows upward differentiating into a petiole and a tightly rolled lamina and emerge at the top of the pseudostem. This act adds to the difficulty in the transport of BA downward to reach the dormant bud. The influence of BA on lateral bud growth has been found to be localized and bud activity was detected only at and below the site of application (Kender and Carpenter, 1972), necessitating the applications of BA directly to the buds on the rhizome rather than the foliar application to banana plants.

Similar observations have been suggested by Williams and Billingsley (1970).

It also worth mentioning that the apical meristem of a banana plant stops initiating leaves and develops an inflorescence thus regating the BA induced suckering effects.

The importance of active growth at the time of application has been presumably attributed to high gibberellin activity at the dividing apices of growing shoots which was made available to enhance the elongation of induced lateral buds. The activity of gibberellins in non growing banana plant, on the other hand may have been low and the lateral buds may have been induced to grow and develop but failed to elongate. Williams and Billingslay (1970) have suggested similar observations. These authors reported the need for the application of a combination of exogenous gibberellins and cytokinins to allow for the elongation of induced dormant lateral bud of apple. The combined effect of exogenous applied gibberellins and cytokinin has also been observed by Kender et al. (1971) on runner formation in strawberry.

The studies of Friendrick *et al*., (1970) and Moses and Altman, (1977) showed the uptake of BA by the roots and its movement in plant tissue both acropetally and basipetally suggesting the possibility

of applying BA as oil drench to banana plant instead of the method of foliar spraying. Trials with other plant species were successful (Henny and Fooshee, 1985).

The findings of Kender and Carpenter, (1972) that the stimulus produced by BA application was only local and enhancement of lateral bud growth was detected only immediately below the site of application suggest the importance of presoaking rather than foliar application if ever BA is to be fully effective. In one study (Shimomura and Fujihaa, 1980) BA applied as a presoak to cuttings enhanced axillary bud growth and development and subsequent shoot formation.

The direct application of BA to dormant bud (Richards 1980; Williams and Billingsley, (1970) and the adoption of a method of multiple applications at optimum times should be have first priority in the further studies to come.

The data reported herein suggest that BA at 100 mg/l be applied repeatedly at determined intervals to the bullshead (rhizome) plants.

Recommendation

1. Banana plant responded to foliar application of BA.

2. Further studies are required on site, method and interval of application using the rhizomes as test plant material.

3. The stimulation of shoot emergence caused by BA in this study confirms once more the systemic character of this chemical.

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