EFFECT OF SOME GROWTH HORMONES ON SEED GERMINATION AND SEEDLING GROWTH OF SOME SAVANNA TREE LEGUMES

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Abstract
Studies were made on the effect of some growth hormones including Indole Acetic Acid (IAA), Indole Butyric Acid (IBA), Kinetin and Gibberellic Acid (GA_3) on seed germination and seedling growth of four savanna tree legumes. The tree species include Prosopis africana *(Guil & Perr) Taub (Mimosoidae);* Parkia biglobosa *(Jacq) R. Br. Ex G. Don (Mimosoidae);* Albizia lebbeck *(Linn) Benth (Mimosoidae) and* Senna siamea *(Lam) Irwin Barneby (Caesalpinoidae). 0.01 - 0.04 ppm IAA enhanced germination in* A. lebbeck, P. biglobosa, P. africana *and* S. siamea. *0.01 - 0.05 ppm IBA enhanced germination in* P. africana *and* S. siamea. *0.01 - 0.05 ppm kinetin retarded germination in* P. biglobosa, P. africana *and* S. siamea. *0.01 - 0.05 ppm - GA_3 enhanced germination in* A. lebbeck and P. africana. *0.01 - 0.05 ppm IAA enhanced plant height and dry weight in the seedlings of the four tree species. 0.01 - 0.03 ppm IBA enhanced plant height and dry weight in S. siamea and only plant height only in* P. biglobosa. *IBA (0.03 - 0.04 ppm) enhanced leaf number in* P. biglobosa *and* A. lebbeck. *Kinetin (0.01 - 0.05 ppm) enhanced leaf number in* P. biglobosa. *GA_3 enhanced leaf number and plant height in* P. biglobosa *and plant height in* A. lebbeck.

Keywords: *Seed germination, seedling growth, growth hormones, savanna, tree-legumes.*

Introduction

The woodland savanna is a less dense and less luxuriant vegetation type than the rainforest. In Nigeria, the savanna consists of trees seldom more than 17m high, standing isolated from each other and forming an opening separated by grassland (Nielson, 1965). The woody species of the savanna are all fire tolerant with corky barks. Many species have shown signs of fire damage and most are deciduous species tending to flower in the dry season or the beginning of the rains (Nielson, 1965).

The savanna in Nigeria contains some general utility tree species including *Senna species, Parkia biglobosa, Afzelia africana, Prosopis africana, Daniella oliveri, Vitellaria paradoxa* etc. Many of the savanna tree species are faced with many problems including annual bush burning, over exploitation, seed viability and dormancy (Olatoye, 1968; Beets, 1989). The tree species face the danger of extinction, hence the need for continuous attention to solve these problems (Agboola and Etejere, 1991; Agboola, 1995).

In an attempt to enhance seed germination and seedling growth in economic plants, there is usually a back up with hormonal treatment. The categories of plant growth hormones associated with seed germination and seedling physiology are the Gibberellic Acid (GA_3),

Indole Acetic Acid (IAA), Ethylene, Kinetin etc. (Agboola and Adedire, 1998; Fasidi *et al.*, 2000).

The savanna tree legumes in focus include *Prosopis africana, Parkia biglobosa, Senna siamea and Alibzia lebbeck*. These are general utility tree species, abundantly found in the Guinea Savanna of Nigeria (Keay, 1989). The trees are sources of fodder, food, tannin and gum, apart from helping nutrient recycling (Etejere *et al.*, 1982; Beets, 1989).

This study aims at finding means of accelerating germination and enhancing seedling growth in these tree species using some well known plant growth hormones. This is with the view of raising more seedlings for establishment of more tree stands in the savanna.

Materials and Methods

Seed collection and Pretreatment

Seeds of *P. africana and P. biglobosa* were processed from pods collected from their stands in the part of the Guinea savanna between Ogbomoso and Ilorin in Nigeria (Latitude 8.32ºN and Longitude 4.34ºE). Seeds of *S. siamea* and *A. lebbeck* were collected from the seed store of the Forestry Research Institute of Nigeria (FRIN) Ibadan, Nigeria. Seeds were pretreated for dormancy release according to the method of Agboola (1993). This involved soaking seeds in concentrated sulphuric acid for 5min. for *S. siamea* and 15min. for *P. biglobosa, P. africana* and *A. lebbeck* due to problems of hard seed coat. Pretreated seeds were sundried and later used for studies on hormonal effects on seed germination and seedlings raised from them.

Hormone Treatment

Seeds were divided into five lots each of 1000 seeds and soaked in five concentrations (0.01, 0.02, 0.03, 0.04, 0.05ppm) of IAA, IBA, GA_3 and Kinetin for 24h. Five replicate samples of 50 seeds each were then prepared for germination in Petri dishes lined with sterile moist filter papers. Water-treated seeds served as control. The experiment was a Complete Randomized Block Design (CRBD) of 5 concentrations x 4 hormones x 4 tree species. Percentage germination was determined while the mean values were also calculated. Data were also subjected to analysis of variance (ANOVA) and treatment means compared with the use of the Least Significance Difference test (LSD) at P= 0.05.

Seedlings and Seedling Growth

Five pretreated seeds from each hormone-concentration were planted in sterile loamy soil in 18 cm diameter plastic pots for each of the four tree species. Seedlings were thinned to one per pot after emergence. Five pots were used for each concentration while those from water-treated seeds served as control. The seedlings were harvested at 4-month stage for dry weight measurement of root and shoot. Dry weights were determined after drying in an electric oven at 60ºC for 24h to constant weight. The plant height and leaf number per plant were also recorded. Plant height was measured with a ruler from the soil level to the tip of the apical meristem. The experiment was also a Complete Randomized Block Design emanating from the seed treatment. Data were also subjected to an analysis of variance (ANOVA) and treatment means compared with the use of the Least Significance Difference test (LSD) at P=0.05.

Results

The results showed that 0.01-0.04 ppm IAA enhanced germination in seeds of *A. lebbeck* and *P. biglobosa* giving 80-100% germination within four days (Figs 1 & 5) while 0.01-0.02 ppm of IAA enhanced germination in *P. africana* and 0.01-0.03 ppm in *S. siamea* within 2-4 days (Figs. 9 & 13). IBA did not enhance germination in seeds of the four tree species (Figs. 2, 6, 10 & 4). Instead 0.03 and 0.05 ppm IBA retarded seed germination in *P. biglobosa*. For example, 20-50% germination was achieved in water (control) (Fig. 2). 0.01-0.05 ppm IBA also retarded germination in *P. africana* and *S. siamea* as germination in water was better (Figs. 10 & 14.)

It was also observed that Kinetin did not enhance seed germination in the four tree species. However, result showed that 0.04-0.05 ppm and 0.01-0.05 ppm concentration of kinetin retarded seed germination in *P. biglobosa, P. africana* and *S. siamea* respectively (Figs. 3, 11 & 15). There was a significant enhancement of germination by 0.01-0.05 ppm GA_3 in *A. lebbeck* (Fig. 8), 0.02 & 0.05 ppm in *P. africana* (Fig. 12); 0.01-0.05 ppm GA_3 did not enhance germination in *P. biglobosa* and S. *siamea* (Figs. 4 & 16).

There was a significant increase in plant height and dry weight ($P = 0.05$) than the control in seedlings of *P. biglobosa* and *A. lebbeck* raised from seeds treated with 0.01-0.05 ppm IAA (Tables 1 & 3). For example, 2.04-2.97 gm of plant dry weight was achieved as against 7.61 gm in the control in seedlings from the seeds treated with 0.03-0.04ppm IAA in *P. biglobosa* (Table 1). The plant height and dry weight were enhanced two-three times by 0.01-0.03 ppm IAA in S. *siamea* and *P. africana* (Tables 2 & 4). For example, in *C. siamea* a value of 3.56-5.30 gm was achieved under 0.02-0.03 ppm IAA treatment as against 1.68 gm in the control (Table 2). 0.01-0.03 ppm IAA enhanced the plant height and dry weight in *S. siamea* (Table 2); while 0.01-0.04 ppm IAA enhanced only the plant height in *P. biglobosa*. 0.03-0.04ppm IBA significantly enhanced the leaf number in *P. biglobosa* and *A. lebbeck* (Table 1 & 3).

Kinetin (0.01and 0.03 -0.05 ppm) enhanced leaf number in *P. biglobosa* (Table 1); while 0.02 and 0.03 ppm of the same hormone enhanced the plant dry weight only in *S. siamea* (Table 2). 0.01-0.03 ppm GA_3 significantly ($P = 0.05$) enhanced leaf number and 0.01 – 0.04ppm GA_3 plant height in *P. biglobosa* (Table 1) and only plant height in *A. lebbeck*.

IAA (0.02 and 0.03 ppm), Kinetin (0.02 and 0.04 ppm) and GA_3 0.01-0.03 ppm significantly enhanced the dry weight of *P. africana* (Table 4). Only 0.04 ppm IBA enhanced the leaf number in *P. Africans* (Table 4). 0.02 – 0.04 ppm IAA, 0.04 ppm IBA and 0.02 – 0.03 GA_3 significantly enhanced the plant height in *P. africana* (Table 4).

Table 1: The effect of some growth hormones on seedling growth of *Parkia biglobosa* . Data are mean ± SE of 5 replicates

Hormone treatments (%)	Dry weight ($x10^2$gm)	Leaf No.	Height (cm)
Control	1.61 ± 0.34	22	14.6 ± 1.7
IAA			
0.01	1.98* ± 0.13	27	25.9* ± 2.4
0.02	1.72 ± 3.4	18	22.3* ± 0.9
0.03	2.97* ± 5.6	31	24.1* ± 0.7
0.04	2.04* ± 6.6	26	25.1* ± 0.8
0.05	1.23 ± 2.4	18	18.7* ± 1.2
IBA			
0.01	1.91* ± 15.7	31	24.8* ± 3.4
0.02	1.29 ± 1.8	19	16.1 ± 1.7
0.03	7.9 ± 3.4	20	22.5* ± 1.8
0.04	1.67 ± 9.2	41*	19.5* ± 3.4
0.05	4.8 ± 1.1	12	11.07 ± 0.09
KINETIN			
0.01	0.90 ± 0.34	28	17.4* ± 5.6
0.02	1.07 ± 0.24	18.00	11.8 ± 0.06
0.03	1.55 ± 0.56	33	16.3 ± 0.09
0.04	3.57** ± 0.98	35	23.9* ± 1.4
0.05	3.15** ± 0.76	24.50	18.0* ± 2.4
Gibberellic Acid			
0.01	1.05 ± 0.34	28*	16.9 ± 2.6
0.02	2.40* ± 0.56	27*	17.7 ± 2.4
0.03	2.08* ± 0.64	32*	24.4* ± 5.2
0.04	1.59 ± 0.72	22	19.1* ± 3.2
0.05	2.9 ± 0.63	23	12.9 ± 1.7

* Significant; ** Highly significant (P = 0.01)

Table 2: The effect of some growth hormones on seedling growth of *Senna siamea*: Data are mean ± SE of 5 replicates

Hormone treatments (%)	Dry weight ($x10^2$gm)	Leaf No.	Height (cm)
Control	1.68 ± 9.2	14	7.0 ± 2.4
IAA			
0.01	2.53* ± 15.6	10	19.5* ± 3.6
0.02	3.56* ± 2.70	12	25.3* ± 6.5
0.03	5.30* ± 17.4	13	15.5* ± 4.3
0.04	1.55 ± 9.2	10	15.2* ± 6.2
0.05	1.48 ± 12.4	10	18.1* ± 3.4
IBA			
0.01	2.51** ± 12.6	11	18.1* ± 3.4
0.02	9.33** ± 24.6	14	33.2* ± 3.4
0.03	3.71** ± 9.4	13	21.7* ± 2.6
0.04	1.51 ± 3.4	10	13.6* ± 1.7
0.05	1.39 ± 5.6	12	13.4* ± 1.9
KINETIN			
0.01	1.40 ± 0.74	90	14.2* ± 2.4
0.02	3.48** ± 1.16	10	15.6* ± 2.6
0.03	5.57** ± 2.24	12	19* ± 3.2
0.04	1.30 ± 0.46	12	14.3* ± 1.7
0.05	1.26 ± 0.84	12	13.6* ± 1.6
Gibberellic Acid			
0.01	9.6 ± 0.64	8	8.2 ± 0.9
0.02	7.4 ± 0.23	60	8.6 ± 0.7
0.03	4.6 ± 0.17	8.0	9.0 ± 1.2
0.04	3.6 ± 0.26	6.0	13.4* ± 2.1
0.05	2.1 ± 0.13	60	14.5* ± 3.2

* Significant; ** Highly significant (P = 0.01)

Table 3: The effect of some growth hormones on seedling growth of *Albizia lebbeck*. Data are mean ± S.E of 5 replicates

Hormone treatments (%)	Dry weight ($x10^2$gm)	Leaf No.	Height (cm)
Control	8.3 ± 6.2	14	12.3 ± 2.3
IAA			
0.01	14.5* ± 0.93	12	17.3* ± 4.6
0.02	13.5* ± 0.84	14	18.2* ± 3.4
0.03	16.7* ± 0.72	18	15.7 ± 3.1
0.04	19.1* ± 0.91	13	17.3 ± 2.7
0.05	15.8* ± 0.53	15	17.7 ± 3.1
IBA			
0.01	25.0** ± 6.8	16	18.0* ± 2.4
0.02	6.3 ± 1.3	13	11.3 ± 0.9
0.03	41.0** ± 15.4	18*	22.5* ± 1.7
0.04	29 ± 0.9	7	13.5 ± 1.8
0.05	26 ± 1.2	9	11.7 ± 0.2
KINETIN			
0.01	9.7* ± 0.64	17	14.0 ± 1.3
0.02	6.2 ± 0.34	10	9.33 ± 1.1
0.03	7.5 ± 0.52	15	9.63 ± 1.2
0.04	6.7 ± 0.64	22*	11.0 ± 2.1
0.05	6.4 ± 0.54	14	9.24 ± 0.8
Gibberellic Acid			
0.01	1.81* ± 0.92	19*	18.3* ± 0.8
0.02	6.4 ± 0.17	20*	15.7 ± 1.7
0.03	7.8 ± 0.34	13	16.4 ± 2.4
0.04	5.9 ± 0.21	8.0	13.9 ± 1.2
0.05	6.9 ± 0.40	8.4	12.7 ± 0.8

* Significant; ** Highly significant (P = 0.01)

Table 4: The effect of some growth hormones on seedling growth of *Prosopis africana*. Data are means ± SE of 5 replicates

Hormone treatments (%)	Dry weight ($x10^2$gm)	Leaf No.	Height (cm)
Control	2.4 ± 0.28	23	13.5 ± 0.9
IAA			
0.01	2.7 ± 0.11	11	12.4 ± 1.2
0.02	5.6* ± 0.26	19	21.5* ± 2.4
0.03	7.2** ± 0.34	14	18.4* ± 3.6
0.04	2.4 ± 0.13	18	17.6 ± 2.8
0.05	2.6 ± 0.16	16	12.4 ± 1.2
IBA			
0.01	2.5 ± 0.11	11	9.4 ± 0.3
0.02	2.4 ± 0.12	12	8.16 ± 0.7
0.03	2.41 ± 0.11	10	8.5 ± 1.2
0.04	6.6 ± 0.42	25*	18.8* ± 3.4
0.05	2.7 ± 0.13	12	11.6 ± 2.6
KINETIN			
0.01	2.4 ± 0.12	21	11.4 ± 0.2
0.02	3.2* ± 0.13	7	8.0 ± 0.09
0.03	1.3 ± 0.09	6	6.0 ± 0.14
0.04	3.3* ± 0.34	17	12.9 ± 2.0
0.05	1.4 ± 0.06	15	11.6 ± 0.19
Gibberellic Acid			
0.01	2.8 ± 0.12	15.0	10.8 ± 0.02
0.02	2.8 ± 0.12	17.0	15.0* ± 0.64
0.03	3.5* ± 0.34	20.0	17.5* ± 1.2
0.04	2.2 ± 0.30	13.5	12.5 ± 0.9
0.05	1.0 ± 0.40	8.0	9.5 ± 0.7

* Significant; ** Highly significant (P = 0.01)

Discussion

Some concentrations of IAA and GA_3 enhanced seed germination in *A. lebbeck* and *P. biglobosa* and to some extent in *P. africana* and S. *siamea*. Kinetin and IBA retarded seed germination in the four tree species. Bachelard (1967) found that Gibberellic acid up to a concentration of 50mg/l, markedly stimulated germination of *Eucalyptus pauciflora* seeds while kinetin inhibited it.

The promotion of germination by various compounds has been demonstrated a great number of times on many different seeds. Such compounds include Potassium nitrate (KNO_3), thiourea, ethylene, Gibberellin, Kinetin and IAA in some cases (Kozlowski 1972; Bewley and Black, 1994; Bewley, 1997; Agboola and Adedire, 1998). These compounds function via activation of enzymes, mobilisation of food materials leading to cell division, cell elongation and successful embryo growth and hence germination in viable seeds (Maguire, 1975; Khan, 1980).

Gibberellic Acid (GA_3) enhanced leaf number and plant height in *A. lebbeck* and *P. biglobosa* while IAA enhanced plant height and dry weight. Kinetin and IBA enhanced leaf number. Dybing and Lay (1982) found that application of growth regulators on plant improves the plant quality in *Hibiscus sabdarifa*. El-sharkawi and Springuel (1979) found that IAA influences the elongation phase more than emergence phase of both plumule and the radicle of germinating seeds of wheat, sorghum and Barley. Gibberellic acid (GA_3) has been found to stimulate the growth of stems particularly those of rosette plants. GA_3 also stimulated leaf disks by a combination of cell division and expansion (Jones, 1973). Omran *et. al.* (1980) also found that soaking seeds of Okra (*Abelmoschus esculentus* (Linn) Moench) in different concentrations of GA_3, IAA and IBA increased the plant height and dry matter content. The reason for the possible role of IAA and kinetin in enhancing leaf number and plant height is their ability to induce cell division, cell elongation, and chlorophyll synthesis (Mukaila *et al.*, 1997). There was enhancement of germination by gibberellic acid (GA_3) and Indole-Acetic-Acid in the tree species. The growth promoters are well known for their stimulation of lettuce seed germination (Sankhla and Sankhla, 1968).

Stimulation of plant height, dry weight and leaf number by plant growth regulators such GA_3, kinetin and IAA, at low concentration has also been shown in some vegetables similar to the results observed in the four tree legumes. (Mukaila *et al.*, 1997). The possible reason for this could be that plant hormones such as GA_3, Kinetin and IAA induce cell division, Cell-elongation and hence the enhancement of growth.

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