International Journal of Botany

ISSN: 1811-9700

science alert

ANSInet
an open access publisher
http://ansinet.com

International Journal of Botany 4 (4): 456-460, 2008
ISSN 1811-9700

Effect of Various Hormones on the Germination of Fonio-*Digitarie exilis* L.

[1]M. Idu, [2]J.U. Chokor and [1]O. Timothy
[1]Department of Botany,
[2]Department of Soil Science, University of Benin, P.M.B. 1154, Benin City, Nigeria

Abstract: The present study embodies data on the seed morphometrics and effect of five hormones viz., thiourea, gibberellin, coumarin, 1-naphthalene acetic acid and Indole butyric acid on the germination of *Digitaria exilis*. The hormonal treatment was carried out under different concentrations, time regimes and continuous light and dark conditions. The highest percentage germination (78%) was recorded in seeds treated with Thiourea (0.01 mg L^{-1}) for 15 min and 0.0001 mg L^{-1} for 60 min under continuous dark condition while lowest percentage germination (25%) was recorded in seeds treated with 1-naphthalene acetic acid (0.001 mg L^{-1}) for 60 min under continuous light condition.

Key words: Hormones , germination, fonio, *Digitaria exilis*

INTRODUCTION

Fonio (*Digitaria exilis* L). commonly known as hungry rice is a small grain cereal of ancient cultivation in Africa. It is considered as a diversified African food (Konkobo-Yaméogo *et al*., 2004). It was identified with early crop domestication in Western Sudan zone. It became one of the integral cereals in the savanna area with the emergence of agriculture. The center of origin of fonio is around the central delta of the Niger. Porteres (1955) recognized three different types of pattern of diversity. In Nigeria, cultivation is much more limited, found mainly in the middle belt of the northern region and scattered elsewhere. It is currently almost certainly a relic of former wider cultivation (Porteres, 1976).

Digitaria exilis has erect or ascending culms, nearly simple, over 45 cm high, leaf sheath smooth, linear leaf blade, 5-15 cm long and 4-9 mm wide and glabrous. Racemes are 2-4 digitate, sessile and slender 5-12 cm long and pedicel of spikelets without hairs, nearly smooth. Fruits are much narrow at the base and acute. The caryopsis is tightly enclosed within the brown hurks.

Germination as defined by the International Seed Testing Association (ISTA) is the emergence and development from the seed embryo of those essential structures, which for the kind of seed being treated indicates the ability to develop into normal plants under favorable condition in the soil. Seed dormancy and germination are complex traits of higher plant that are influenced by a large number of genetic and environmental factors. Studies of genetics and physiology have shown important roles of plant hormones, abscisic acid and gibberellins in the regulation of dormancy and germination (Koornneef *et al*., 2002).

The idea that growth substances serve to regulate the germination of seeds emanated from the early observation of Kockemann (1934). Seeds have been shown to differ in their response to growth regulatory compounds; thus applied both to hormonal and non-hormonal compounds. Likewise, these growth chemicals, whether applied exogenously or naturally occurring, exert either stimulatory or inhibitory effects under different conditions and concentrations, either as germination stimulators or germination inhibitors (Idu and Omonhinmin, 1998).

Studies have revealed that seed dormancy and germination are under hormonal control (Black and Naylor, 1959; Frankland, 1961; Paleg, 1962). Growth regulators (stimulators and inhibitors) commonly occur naturally and interact in seeds to effect dormancy or germination together with other germination mechanisms present in the seeds or its environment (Kelly *et al*., 1992). They can be synthesized and exogenuously applied to achieve the same effect as the endogenuously present ones. Most often, these interactive regulators acts antagonistically; a commonly known interaction pair is the GA_3/ABA complex, which occurs in growth region of plant components (Idu and Omonhinmin, 1998).

Similarly, the pair thiourea and coumaria have been reported for seeds, where they control the germination growth of such seeds. Coumarin at different concentrations added to nutrient solutions inhibited root length, but effects differed depending on root types. Concentration of 0.25 μM sufficiently reduced the radical, seminal and nodal root length by 50% (Williams *et al*., 2005). Abenavoli *et al*. (2004) also found coumarin decreased the number of lateral roots and ranching density more in the seminal roots than in the

Corresponding Author: Macdonald Idu, Department of Botany, University of Benin, P.M.B. 1154, Benin City, Nigeria

radical roots of maize seedlings. In the case of lettuce seeds, while thiourea effectively stimulated germination to as high as 100%, coumarin reduced germination from 50% level (control) to zero. Such interactions are light, temperature and respiration linked (Mayer and Poljakoff-Mayber, 1989).

The present study gets to determine the effect of exogenously applied Gibberellinic acid (GA_3), indole butyric acid (IBA), 1-naphthalene acetic acid(1-NAA), thiourea and coumarin on the germination growth of *D. exilis*.

MATERIALS AND METHODS

The seeds of *D. exilis* were obtained from Jos mains market, Plateau State. Seeds were then kept in an airtight screw cap glass vials.

The seed outline was examined under a dissecting Leitz ortholuse stereoscopic microscope and a magnifying lens, each equipped with a fluorescent light. The terminologies used for describing the seed morphology were adapted after that of Gun and Barners (1977) and Gill *et al*. (1993). Twenty seeds were examined for each sample; seed size and volume were determined using ocular micrometer. Seeds shape was determined by examining the seeds under the microscope. The colour of the seed was determined by comparing the seed colour with colour of specific purpose.

The seeds for the hormone experiment were first of sterilized with 0.1% mercuric chloride solution for one minute and rinsed thereafter with several changes of distilled water. Set of one hundred seeds with five replicates were used per treatment: GA_3, IBA, thiourea, coumarin, 1-NAA for 5, 10, 15, 30, 60 min at different concentrations of 10, 1, 0.1, 0.01, 0.001, 0.0001 mg L^{-1}. Seeds were then transferred to a 9 cm diameter petri-dishes lined with Whatman No. 1 filter paper and set at bench level under continuous fluorescent light at room temperature while the other sets were in a dark cupboard. In each case, control experiment of untreated seeds was set up. Water was added to experiment as and when needed. The emergence of a radicle of 5 mm was used as criterion for germination.

RESULTS AND DISCUSSION

Seed morphology: The seed of *D. exilis* is a smooth, glossy, monochromatic brown with an oblong to woody ellipsoid shape, sculptured radially by low ridges and grooves ranging from 3 to 9, sizes ranging from 0.07 mm to 1.07. Halos not apparent, helium recessed, no funicular margin, slight funicular overlay, lotoid split and rim-aril absent, lens not apparent, size not applicable, micropylar pit not applicable.

Table 1: Percentage germination of *Digitaria exilis* seed treated with gibberellin grown in both light and dark

Concentration (mg L^{-1})	Time (min)	Germination (%) Light	Dark
10	5	63.0±0.2	40.0±0.1
	10	52.5±0.4	40.0±0.4
	15	64.0±0.3	55.0±1.1
	30	55.5±0.3	43.0±0.3
	60	54.0±0.5	5.0±1.2
1	5	64.5±0.2	46.0±0.3
	10	60.0±0.3	55.0±0.3
	15	60.5±0.2	58.0±0.2
	30	57.0±0.5	50.0±1.2
	60	60.0±0.2	48.0±0.4
0.1	5	53.0±0.1	37.0±2.3
	10	64.0±1.1	45.0±0.7
	15	57.5±0.3	48.0±0.4
	30	60.5±1.4	56.0±0.2
	60	63.0±1.2	40.0±2.1
0.01	5	58.5±1.2	43.0±0.3
	10	53.5±0.2	45.0±0.6
	15	54.0±0.3	50.0±0.4
	30	59.0±0.3	52.0±0.1
	60	51.0±0.2	41.0±0.6
0.001	5	59.0±0.2	41.0±0.7
	10	55.5±1.3	55.0±0.3
	15	62.0±0.3	53.0±1.4
	30	58.0±0.5	40.0±0.4
	60	49.0±1.1	65.0±0.3
0.0001	5	56.5±1.4	37.0±0.1
	10	58.5±0.8	45.0±0.4
	15	62.5±0.3	48.0±0.4
	30	57.5±0.2	56.0±0.2
	60	54.5±1.0	40.0±0.8
Distilled water	Control	60.5±0.3	50.0±0.2

% Germination±SE

Seed germination: The highest percentage germination of 64.5, 64 and 64% in seeds treated with GA_3 were recorded in seeds treated with 1 mg L^{-1} (5 min), 10 mg L^{-1} (15 min), and 0.1 mg L^{-1} (10 min), respectively of continuous light. These readings were higher than those recorded for the corresponding dark phase (Table 1).

Seeds treated with 10 mg L^{-1} (60 min), 0.1 mg L^{-1} (60 min) and 1 mg L^{-1} (60 min) of IBA recorded percentage germination of 60, 59 and 58%, respectively under dark condition while lower values (38.5, 41.5 and 41.5%, respectively) were observed in seeds grown under continuous light. Control recorded 59 and 54% under light and dark respectively (Table 2).

Seeds treated with 1-NAA recorded highest percentage germination of 57% at 10 mg L^{-1} (30 min) and 0.1 mg L^{-1} (5 min) under dark condition. On the other hand, lowest percentage germination of 25% was recorded in seeds treated with 1 mg L^{-1} (15 min), 0.001 mg L^{-1} (15 min) and 0.0001 mg L^{-1} (15 min) under continuous light, while percentage germination recorded in the control was 56 and 59% under light and dark conditions, respectively (Table 3).

Table 2: Percentage germination of *Digitaria exilis* seed treated with IBA grown in both light and dark

Concentration (mg L^{-1})	Time (min)	Germination (%) Light	Dark
10	5	45.5±1.3	45.0±0.4
	10	32.5±1.5	49.0±0.5
	15	44.0±0.2	45.0±0.1
	30	47.0±0.5	54.0±0.2
	60	38.5±0.5	60.0±0.4
1	5	46.5±2.0	46.0±0.9
	10	37.5±1.2	48.0±0.5
	15	43.5±0.2	49.0±0.4
	30	43.5±0.1	55.0±0.3
	60	41.5±0.4	58.0±0.5
0.1	5	46.5±1.6	47.0±0.3
	10	37.5±0.4	44.0±0.8
	15	43.5±0.3	50.0±0.4
	30	43.0±2.1	52.0±0.6
	60	41.5±0.4	59.0±1.7
0.01	5	31.5±2.8	38.0±0.2
	10	46.5±0.3	40.0±2.0
	15	42.5±0.7	52.0±0.6
	30	43.0±2.3	55.0±0.4
	60	51.5±0.3	54.0±0.2
0.001	5	45.0±0.3	43.0±0.2
	10	43.0±0.2	49.0±0.2
	15	35.0±0.2	46.0±0.4
	30	43.5±0.4	48.0±0.9
	60	51.0±1.8	45.0±1.3
0.0001	5	46.0±0.4	49.0±0.5
	10	39.5±0.3	41.0±0.5
	15	35.5±1.2	52.0±0.2
	30	44.5±0.2	43.0±0.1
	60	48.5±0.6	40.0±0.3
Distilled water	Control	59.0±0.2	54.0±0.1

% Germination±SE

Table 3: Percentage germination of *Digitaria exilis* seed treated with 1-Naphthalene acetic acid grown in both light and dark

Concentration (mg L^{-1})	Time (min)	Germination (%) Light	Dark
10	5	41.0±2.3	54.0±1.1
	10	35.5±0.3	51.0±0.8
	15	33.0±1.0	50.0±0.4
	30	33.0±0.5	57.0±1.3
	60	31.5±0.1	43.0±0.2
1	5	31.5±1.1	40.0±0.7
	10	31.5±0.2	49.0±0.2
	15	25.5±0.1	50.0±1.4
	30	35.5±0.3	49.0±2.1
	60	35.5±0.2	46.0±1.7
0.1	5	30.0±0.7	57.0±0.4
	10	35.5±0.2	48.0±2.3
	15	32.0±0.3	43.0±0.6
	30	29.0±2.0	45.0±0.4
	60	35.5±0.5	47.0±1.1
0.01	5	35.5±0.6	42.0±0.7
	10	29.5±0.2	45.0±0.2
	15	33.5±0.4	44.0±0.6
	30	32.0±0.4	41.0±0.3
	60	32.0±0.1	48.0±1.6
0.001	5	28.5±0.6	40.0±0.2
	10	25.5±0.3	32.0±0.9
	15	28.5±0.8	42.0±0.3
	30	32.0±0.4	43.0±0.4
	60	25.0±0.2	95.0±0.4
0.0001	5	30.0±0.2	46.0±1.5
	10	27.0±0.4	39.0±1.7
	15	25.5±0.3	49.0±1.2
	30	32.5±0.6	51.0±0.4
	60	29.0±0.3	53.0±1.4
Distilled water	Control	56.0±0.1	59.0±0.3

% Germination±SE

For thiourea, highest percentage germination was observed in seeds treated with 0.1 mg L^{-1} (15 min) and 0.0001 mg L^{-1} (60 min) at 78% each under dark condition while lowest percentage germination was recorded in 0.0001 mg L^{-1} (30 min) at 48% in the dark. Control under dark condition recorded 64% germination (Table 4).

Highest percentage germination for seeds treated with coumarin was recorded in 0.0001 mg L^{-1} (60 min) at 74% under dark condition. The lowest percentage germination was observed in 0.1 mg L^{-1} (10 min) at 41%. Control under dark condition recorded 68% germination (Table 5).

Generally, the highest percentage of germination (78%) was recorded in the seeds treated with thiourea at 0.0001 mg L^{-1} (60 min) and 0.1 mg L^{-1} (15 min) under continuous dark condition while lowest percentage germination (25%) was recorded in seeds treated with 1-NAA in 0.001 mg L^{-1} (60 min) under continuous light condition.

Jarvis *et al*. (1968) reported 85% germination in seeds of hazel treated with gibberellins (GA_3), also Bryant (1985) reported 97% germination in lettuce seeds treated with 10^{-5} M GA_3 and Idu (1994) reported 67.3% germination in seeds of *Bixa orellana* treated with 10^{-3}M GA_3 under continuous light and 57% under dark condition. The result obtained in this study on *D. exilis* seeds confirmed the improvement of germination by GA_3 as shown in the high percentage germination (64.5%) when the seeds were treated with 1 mg L^{-1} concentration of GA_3 for 5 min under continuous light and 58% in dark condition, both being higher than the respective controls (Table 1) Thus, it is possible that the applied GA_3 promotes germination by raising the effective gibberellin level in the seeds, which was more effective under continuous light.

Auxins have been known to give both positive (stimulatory) and negative (inhibitory) results; this is also seen in the present work. Seeds germinated were either slightly different from the control or were stimulated or inhibited by higher concentrations under continuous light and dark conditions. The present study showed that IBA at low concentration (0.01-0.001 mg L^{-1}) promoted germination under continuous light conditions and at high concentration (10-0.1 mg L^{-1}) under continuous dark condition (Table 2). It can thus be said that IBA has no regulatory role in the germination of *D. exilis*.

Table 4: Percentage germination of *Digitaria exilis* seed treated wit h Thiourea grown in both light and dark

Concentration (mg L^{-1})	Time (min)	Germination (%) Light	Dark
10	5	59.0±0.7	60.0±0.2
	10	58.0±0.1	65.0±0.5
	15	61.5±0.2	54.0±0.3
	30	57.0±0.8	49.0±0.1
	60	62.5±1.3	62.0±0.7
1	5	58.0±0.5	56.0±0.2
	10	54.5±0.2	59.0±0.9
	15	61.5±0.6	64.0±1.0
	30	57.5±0.1	54.0±1.3
	60	62.5±1.4	59.0±0.3
0.1	5	56.5±1.6	55.0±0.6
	10	56.0±0.3	58.0±0.8
	15	60.0±0.2	53.0±0.5
	30	52.5±1.1	50.0±0.4
	60	60.5±0.9	49.0±1.6
0.01	5	58.5±2.5	50.0±1.1
	10	53.5±0.3	65.0±0.6
	15	61.0±1.7	78.0±0.5
	30	56.0±0.5	48.0±1.1
	60	60.0±1.1	63.0±0.8
0.001	5	56.5±0.8	55.0±2.4
	10	55.5±0.4	58.0±0.2
	15	62.5±0.1	55.0±1.2
	30	60.0±0.3	55.0±0.2
	60	53.0±0.6	58.0±0.7
0.0001	5	58.5±2.2	54.0±0.3
	10	53.0±0.3	62.0±2.1
	15	59.5±1.9	63.0±0.5
	30	54.0±1.2	48.0±0.3
	60	55.0±0.8	78.0±2.2
Distilled water	Control	58.0±0.1	64.0±0.7

% Germination±SE

Table 5: Percentage germination of *Digitaria exilis* seed treated with Coumarin in both light and dark

Concentration (mg L^{-1})	Time (min)	Germination (%) Light	Dark
10	5	43.5±1.0	49.0±0.7
	10	47.5±1.2	51.0±1.8
	15	50.5±0.4	64.0±1.6
	30	48.5±0.1	52.0±0.1
	60	49.5±0.4	64.0±0.9
1	5	44.0±1.1	57.0±0.4
	10	49.0±0.8	55.0±0.3
	15	47.0±0.7	59.0±1.6
	30	47.5±0.4	62.0±2.0
	60	50.5±0.1	60.0±1.3
0.1	5	51.5±1.0	46.0±0.2
	10	41.0±0.3	50.0±0.7
	15	45.0±0.8	61.0±0.3
	30	54.0±2.6	55.0±0.3
	60	53.0±0.3	63.0±2.2
0.01	5	50.0±0.4	49.0±1.4.
	10	53.5±0.6	61.0±0.5
	15	45.5±0.9	51.0±0.6
	30	46.0±0.4	59.0±2.1
	60	49.5±0.7	57.0±0.4
0.001	5	52.5±1.1	59.0±0.9
	10	44.5±1.3	50.0±1.2
	15	48.0±0.5	57.0±0.5
	30	49.5±1.5	67.0±0.3
	60	53.5±2.4	69.0±1.4
0.0001	5	55.0±1.2	52.0±0.2
	10	46.5±0.4	60.0±0.2
	15	49.0±0.1	49.0±0.6
	30	53.5±1.8	55.0±0.7
	60	45.0±0.4	74.0±0.1
Distilled water	Control	68.0±1.6	68.0±2.3

% Germination±SE

In the case of 1-NAA, at low concentration of 0.01-0.001 mg L^{-1}, there was an inhibitory effect on germination under continuous light condition (25%) but under continuous dark condition, had a stimulatory effect (57%) which was however lower than the control result (Table 3). Thus it can be said that 1-NAA had no regulatory effect on *D. exilis*.

Thiourea and coumarin have been used over the years to influence germination of seeds. Generally, it is known that thiourea enhances germination while coumarin inhibits germination (Mayer and Poljakoff-Mayer, 1989). This pattern of response however does not agree with this present work. From Table 4, thiourea recorded the highest percentage germination of 75% at 0.0001 mg L^{-1} (60 min) under dark condition; this was higher than that recorded for light condition (62.5%) in 0.001 mg L^{-1} (15 min) treatment. Both values were higher than for their respective controls.

Germination percentage recorded for the coumarin treatment was also high with the highest percentage germination of 74% at 0.0001 mg L^{-1} (60 min) under dark condition and lowest germination percentage of 41% under light condition at 0.1 mg L^{-1} (10 min) (Table 5) compared to that of the control of 68% both under light and dark conditions.

From the foregoing, it is apparent that thiourea irrespective of the illumination condition stimulated germination to a high level while coumarin exhibited a slight inhibitory effect under light condition but not under dark condition. These stimulatory/inhibitory effects of thiourea and coumarin may have been due to their action on the storage materials of the seeds, the oxidative phosphorylation (phosphate/oxygen ratio) and the coupling action in germinating seeds either directly or indirectly (Mayer and Poljakoff-Mayber, 1989).

In conclusion, light improves the germination of seeds of *Digitaria exilis* treated with gibberellin while dark conditions improves the germination of seeds treated with thiourea and coumarin at low concentration of 0.001 mg L^{-1} (15 min) and 0.0001 mg L^{-1} (60 min), respectively.

REFERENCES

Abenavoli, M.R., A. Songona, S. Albano and G. Cacco, 2004. Coumarin differentially affects the morphology of different root types of maize seedlings. J. Chem. Ecol., 30: 1871-1883.

Black, M. and J.M. Naylor, 1959. Prevention of the onset of seed dormancy by gibberellinic acid. Nature, 184: 468-469.

Bryant, J.A., 1985. Seed Physiology. The Institute of Biology's Studies in Biology 165. 1st Edn., Edward Arnold, London.

Frankland, B., 1961. Effect of gibberellic acid, kinetin and other substances of seed dormancy. Nature, 192: 678-679.

Gill, L.S., H.E. Okoh and S.W.H. Husaini, 1993. Morphometric studies of some Nigerian leguminous seeds. J. Plant Morphol., 6: 106-119.

Gun, C.R. and D.E. Barnes, 1977. Seed morphology of *Erythrina* (Fabaceae). Liogida, 40: 454-470.

Idu, M., 1994. Effect of gibberellic acid (GA3) and Indole acetic acid (IAA) pre-treatment on the germination of *Bixa orellana* L. seeds. Organism Interaction Environ., 1: 1-3.

Idu, M. and C.A. Omonhinmin, 1998. Germination control of *Helianthus annus* L. using two growth regulators thiourea and coumarin. Compositae Newsletter, 32: 37-38.

Jarvis, B.C., B. Frankland and J.H. Cherry, 1968. Increased nucleic acid synthesis in relation to the breaking of dormancy of hazel seed by gibberellic. Planta, 83: 257-266.

Kelly, K.M., J. Van Stades and W.E. Bell, 1992. Seedcoat structure and dormancy. Plant Growth Regulator, 11: 201-209.

Kockemann, A., 1934. Uber eine keimungshemme-nede substanz in frleischigen fruchten. ber dtsn. Botany Ges., 52: 523-526.

Konkobo-Yaméogo, C., Y. Chaloub, A. Kergna , N. Bricas and R. Karimou *et al*., 2004. Urban consumption of fonio, a traditional cereal in West Africa. Cahiers Agric., 13: 125-128.

Koornneef, M., L. Bentsink and H. Hilhorst, 2002. Seed dormancy and germination. Curr. Opin. Plant Biol., 5: 33-36.

Mayer, A.M. and A. Poljakoff-Mayber, 1989. The Germination of Seed. 4th Edn., Pergamon Press, Oxford .

Paleg, L.G., B.G. Coombe and M.S. Buttrose, 1962. Physiological effects of gibberellic acid. V. Endosperm responses of barley, wheat and oats. Plant Physiol., 37: 798-803.

Porteres, R., 1955. Les céréales mineurs du genre digitaria en Afrique et Europe. J. Agric. Trop. Bot., 2: 41-53.

Porteres, R., 1976. African Cereals, Eleusine, Fonio, Black Fonio, *Braciaria, Paspalum, Pennisetum* and African Rice. In: Origin of African Plant Domestications, Harland, J.R., J.M. De Wet and A.B.L. Stemler (Eds.). Mouton Publishers, Hague, pp: 409-452.

Williams, P.R., R.A. Congdon, A.C. Grice and P.J. Clarke, 2005. Germinable soil seed banks in a tropical savanna: Seasonal dynamics and effects of fire. Aust. Ecol., 30: 79-90.