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Response of seeds of four tropical weed species to some herbicides and gibberellic acid during germination

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ABSTRACT: The responses and viability of acid scarified seeds of four tropical weeds to gibberellic acid and seven herbicides including Galex, Gramoxone, 2,4-D, Atrazine, Simazine, Round Up amd Primextra in the laboratory were investigated. The weeds used are *Cassia occidentalis, Cassia obtusifolia, Cassia hirtusa* and *Calapogonium mucunoides.* 100 ppm solutions of the herbicides inhibited germination of seeds in the four weed species. 50 ppm of 2,4-D, Atraxime and Primextra inhibited seed germination in *C. occidentalis.* 100 ppm of Galex and Atrazine reduced the viability of seeds of *C. hirtusa* to 0%. The germination rate was increased by 100 ppm gibberellic acid. Total percentage seed germination in herbicide-free seeds ranged between 75 and 90 percent.

Key Words: Weed control; Herbicides; Gibberellic acid.

Introduction

The four tropical weeds *Cassia obtusifolia, Cassia occidentalis* Linn., *Cassia hirtusa* and *Calapogonium mucunoides* are weeds of field crops, cultivated fields, bush regrowths, road sides and waste places. They are widespread in West Africa, especially in areas where the annual rainfall exceeds 1000 – 1250 mm with optimum temperatures of 25 – 35^{o}C (Olaoye, 1974). The cassia weeds are shrubs while *C. mucunoides* is a creeping and rarely climbing plant.

Cassia hirtusa (stinking cassia) is an erect, hairy, perennial plant up to 2.5m high while *C. occidentalis* (coffee senna) is an erect, hairless under-shrub, annual or biennial, growing to about 100 cm high. *C. mucunoides* is a creeping hairy annual plant that spreads fast covering the land during the rainy season in Nigeria (Marc – October) (Akobundu and Agyakwa, 1987). These weeds propagate by means of seeds and in the dry season they shed many seeds from their pods some of which may germinate sporadically in the field (Etejere and Ajibola, 1990). Most of the seeds remain dormant within the soil for many years. This condition thus makes the eradication or control of the plant difficult.

Weed control in the field can be achieved by the stimulating or inhibitory effect of herbicides on the germination of seeds. The increased field emergence of seedlings, obtained by stimulating germination, makes it possible to reduce the content of soil-borne viable weed seeds (Kolk, 1979). The emerged seedlings can subsequently be destroyed by mechanical or chemical weed control measures. Soil-borne viable seeds can also be destroyed directly by using herbicides of a suitable concentration and dosage. The stimulating effect of Carbamate herbicides on germination and field emergence of different weed seeds was

shown by Fawcett and Stife (1975). The inhibitory or eliminating effect of herbicides such as 2,4-D (2,4-dichloro phenoxy acetic acid) and 2,4,5-T (2,4,5-trichloro phenoxy acetic acid) on the viability of soil-borne weed seeds, especially *Psoralis caryfolia*, has been demonstrated by Shukla (1972). DNOC-4,6, dinitrocresol, MCPA-chloro-2-methyl phenoxy acetic acid and Calcini cyanamide have been used to control weeds such as *Veronica persica, Sinapsis arvensis, Rumes crispus* and *Stellaria media* through destruction of the soil-borne seeds (Hurle, 1974).

The present investigation examines the viability and responses of scarified seeds to gibberrelic acid and some herbicide formulation. This is with a view to knowing more about the measures needed to control the spread of these weeds.

Materials and Methods

Seeds were collected in November and December, 1998, during the early periods of the dry season. Seeds were processed from their pods manually with hand. Seeds were sundried for 2 weeks. The seeds were then scarified with concentrated sulphuric acid for 15 min, washed several times in distilled water and sundried for 3 days according to the method of Agboola (1995). The dried, scarified, seeds were stored in glass bottles with a pack of silica. Seeds for the experiment were taken when needed from these. The seeds were divided into lots. Four concentrations were prepared from 7 commecially formulated herbicides including Galex, Gramoxone, 2,4-D, Atrazine, Simazine, Roundup and Primextra, as well as gibberellic acid. The concentrations used were 0 (water), 10, 50 and 100 ppm. Twenty millilitres of the various concentrations of herbicide solution was added to each of the seed lots, mixed thoroughly and left for 4 – 5h according to the method of Etejere (1980). The herbicide-treated seeds were then sundried for 2 – 3h and stored for use.

In a separate experiment, 100 ppm solution of gibberellic acid was used as bath solution when the seeds were prepared for germination. Water served as the control. Seeds were sampled from the specimen bottles where they were stored for germination tests.

For the germination tests, 50 seeds in each case were sterilized with 5% sodium hypochlorite solution for 5 minutes and rinsed in several changes of distilled water. The herbicide treated seeds were placed in 9cm Petri-dishes containing filter paper and moistened with 10 ml of distilled water. Water treated seeds served as the control. In the case of the set up on GA_3 treatment, 10 ml of the 100 ppm solution of the hormone was used to moisten the seeds instead of distilled water. The set up was maintained at 30 ± 1^{o}C under a light intensity of 2000 Lux. Five replicates of the set up were made while germination counts were recorded daily for 8 days.

The experimental design was a randomized one. Mean germination percent values from 5 replicates were calculated. Data were also subjected to analysis of variance (ANOVA). The treatment means were also compared by the least significance difference test (LSD).

Results

The results on the responses of scarified seeds to herbicide treatment after 7 days of germination in the laboratory showed that 100 ppm of the seven herbicides used were effective in inhibiting the germination in seeds of the four weed species. For example, 0% germination was obtained for all the species after 8 days of germination (Tables 1 – 4). Fifty ppm Roundup and Primextra were most effective in checking germination in *C. occidentalis* as this gave 0% germination. These are followed by Atrazine and Galex which gave 25 – 35% germination after 7 days (Table 1). It was observed that only 100 ppm solutions of the herbicides completely inhibited germination of seeds in *C. obtusifolia*. Galex, Atrazine and Primextra reduced the viability by 55 – 65% in this weed specie (Table 2). Seeds of *C. mucunoides* treated with 50 ppm of 2,4-D, Atrazine and Primextra showed 0% germination while 100 ppm of the 7 herbicides also gave 0% germination. Ten ppm solution of 2,4-D, Atrazine and Primextra reduced viability of the seeds by 50 – 65% (Table 3). Only 100 ppm Galex and Atrazine reduced the viability of seeds to 0% in *C. hirtusa* (Table 4). However, it was observed that reduction of viability by 60 – 80% was brought about by 50 – 100 ppm

Table 1: Percentage germination of untreated and herbicide treated seeds of Cassia occidentalis after 7 days

	Percentage germination			
	Concentration (ppm)			
Treatment	0	10	50	100
2 – 4D	75±3	70±7	45±3	0±0
GALEX	75±3	65±5*	35±5*	0±0
GRAMAXONE	75±3	75±3*	60±4	0±0
ATRAZINE	75±3	65±14	25±5*	0±0
SIMAZINE	75±3	60±6	45±3	0±0
ROUND UP	75±3	55±3*	0±0*	0±0
PRIMEXTRA	75±3	45±2*	0±0*	0±0

*Significantly different from control at 95% probability level.

Table 2: Percentage germination of untreated and herbicide treated seeds of Cassia obtusfolia

	Percentage germination			
	Concentration (ppm)			
Treatment	0	10	50	100
2 – 4D	90±4	75±3	75±2	0±0
GALEX	90±3	65±5*	35±5*	0±0
GRAMAXONE	90±14	70±3*	55±5*	0±0
ATRAZINE	90±14	65±7*	45±6*	0±0
SIMAZINE	90±14	80±10	60±2*	0±0
ROUND UP	90±14	70±5	65±3	0±0
PRIMEXTRA	90±14	80±3	45±7*	0±0

*Significantly different from control at 95% probability level

Table 3: Percentage germination of untreated and herbicide treated seeds of Calapogomum mucunoides

	Percentage germination			
	Concentration (ppm)			
Treatment	0	10	50	100
2 – 4D	80±6	40±3*	0±0	0±0
GALEX	80±6	65±7	45±4*	0±0
GRAMAXONE	80±6	70±3	55±3	0±0
ATRAZINE	80±6	45±2*	0±0	0±0
SIMAZINE	80±6	65±3	40±7	0±0
ROUND UP	80±6	50±12*	24±5*	0±0
PRIMEXTRA	80±6	35±3*	0±0*	0±0

*Significantly different from control at 95% probability level

Table 4: Percentage germination of untreated and herbicide treated seeds of Cassia hintusa

	Percentage germination			
	Concentration (ppm)			
Treatment	0	10	50	100
2 – 4D	86±4	72±6*	43±2	31±3
GALEX	86±4	64±7	22±3*	0±0
GRAMAXONE	86±4	56±2*	25±3*	25±2*
ATRAZINE	86±4	60±5	42±4	0±0
SIMAZINE	86±4	74±5	35±1	24±7*
ROUND UP	86±4	66±1	45±2	15±6*
PRIMEXTRA	86±4	70±1	36±3*	16±4*

*Significantly different from control at 95% probability level

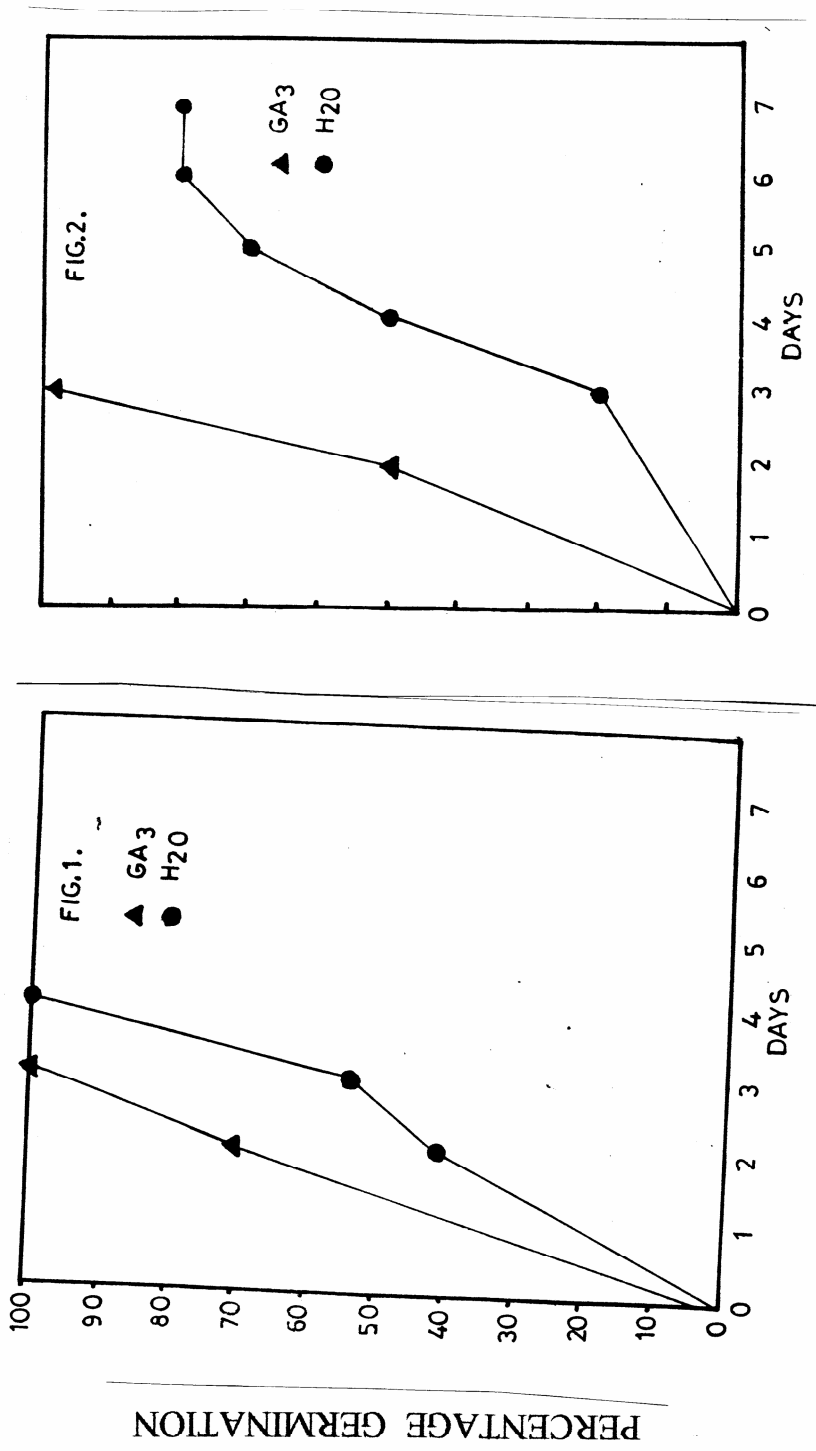

Fig. 1: Germination in *C. occidentalis* treated with gibberellic acid.

Fig. 2: Germination in *C. obtusifolia* treated with gibberellic acid.

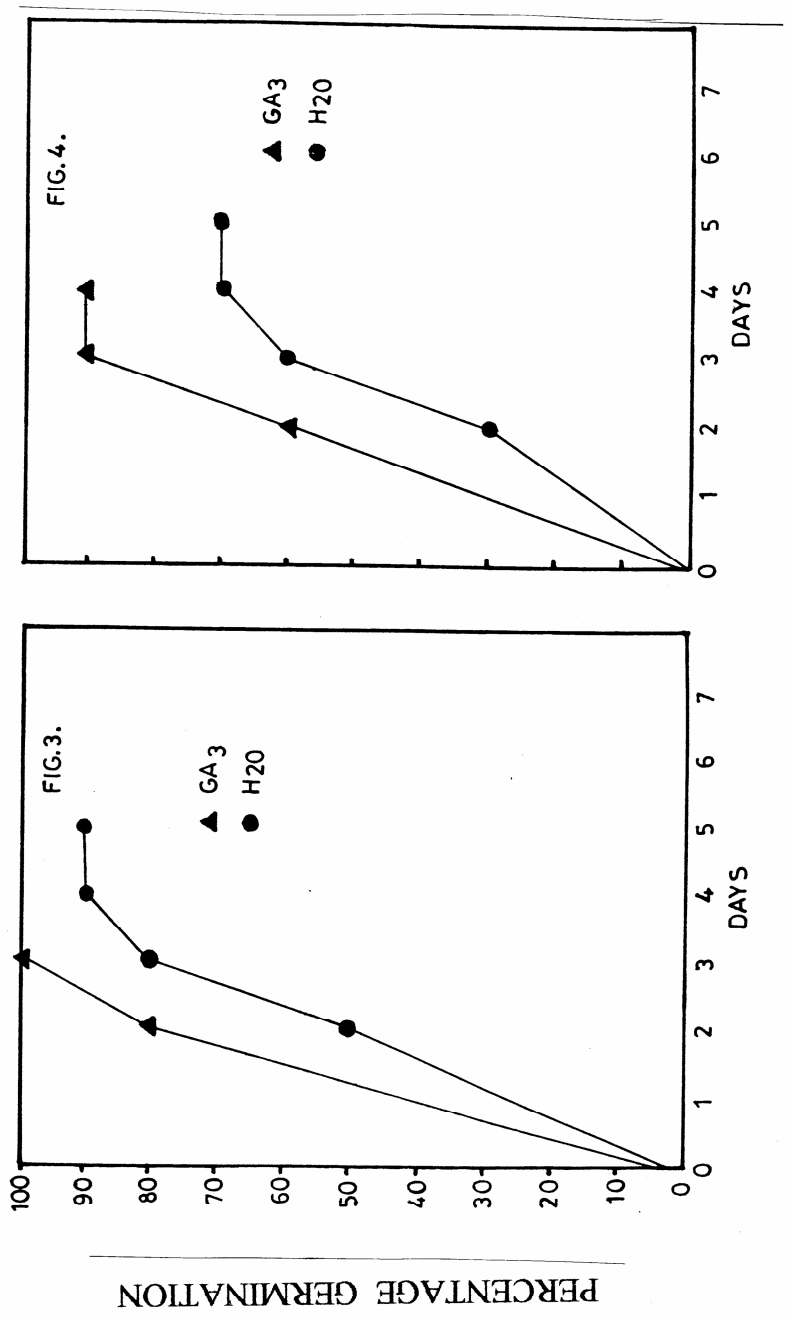

Fig. 3: Germination in *C. mumucoides* treated with gibberellic acid.

Fig. 4: Germination in *C. hirtusa* treated with gibberellic acid.

solution of Galex, Gramoxone, Simaxine and Promextra in *C. hirtusa* (Table 4). Germination of herbicide-free scarified seeds of the four species ranged between 75 and 90% (Tables 1 – 4).

The result of the gibberellic acid treatment showed 40 – 50% germination within 2 – 4 days in the untreated seeds compared to 70 – 100% germination observed for the GA_3-treated scarified seeds for the same period in *C. occidentalis* (Fig. 1). Germination in *C. obtusifolia* seeds showed 50 – 80% within 4 – 7 days in the untreated seeds compared to 50 – 100% in the treated seeds within 2 – 3 days (Fig. 2). Percentage germination of 80 – 100% was shown by hormone-treated seeds of *C. mucunoides* within 2 – 3 days while 50 – 80% was given by the untreated seeds (Fig. 3). The results in *C. hirtusa* showed 30 – 70% germination at the 2^{nd} and 4^{th} day respectively in the untreated seeds compared to 60 – 90% in the hormone-treated seeds for the period (Fig. 4).

Discussion

The seeds of the four weed species lost their viability in 100 ppm solution of the seven herbicides tested. Germination of the seeds whose dormancy was broken by scarification with concentrated sulphuric acid was also variously inhibited by the herbicides. These is in agreement with the results of some other workers on herbicides and weeds. For example, reduction in the viability of seeds of *Eupatorium odoratum* (*Chromolaena odoratum*) up to 0% by 2,4-D, Diuron, Daconate and Simazine has been reported by Etejere (1980). The inhibitory or eliminating effect of herbicides on viability of weeds has been indicated in some work on *Psoralis caryfolia* (Shuka, 1970) and *Parthenium hysteroplus* (Dagar, 1977).

Some stages of germination prior to seedling emergence include mobilization of food materials in the endosperm or cotyledons after inhibition of water, resumption of growth by the embryo and consequent development and emergence of the radicle. Each of these stages require metabolic energy produced during the metabolic processes involved in the oxidation of carbohydrates, proteins and fats. Since many pre-emergence herbicides are known to affect these processes, the absorption of any of these herbicides by germinating seeds of plants sensitive to them is bound to disrupt one or more of the stages in germination (Akobundu, 1987). For example, Chloramben and the carbamate herbicides inhibit early germination. The mechanism of this action is the inhibition of amylase activity in the endosperm of those germinating seeds that depend on carbohydrate mobilization in their endosperm (Delvin and Cunningham, 1970; Penner, 1968).

The germination rate of scarified seeds of the four weed species was increased by 100 ppm gibberellic acid. Similar effect of GA_3 on the rate of germination in seeds of *Crotalaria juncea* has bee established by Prasad et al. (1976). Low levels of GA_3 has also been found to promote and accelerate germination in seeds of *Barbarea vulgaris* (Taylorson, 1976).

Gibberellic acid is one of the major plant hormones involved in the control processes for mobilization of food reserve from the endosperm of cotyledons, especially enzyme production (Black, 1972). Hence, acceleration of the rate of germination by 100 ppm GA_3 in scarified seeds is due to the fact that there is an unhindered entry of GA_3 solution, the seed coat barrier having been reduced and softened by acid scarification.

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References

Agboola, D. A. (1995) Studies on dormancy and germination of seeds of *Prosopsis africana*. Nig. J. Bot. 8, 45 – 56.

Akobundu, I. O. and Agyakwa, C. W. (1987) A Handbook of West African Weeds. International Institute of Tropical Agriculture (IITA), Ibadan, pp. 214 – 221.

Black, M. (1972) Control processes in germination and dormancy. Oxford Biology Readers Series. pp. 1 – 7.

Dagar, J. C. (1977) Effect of some growth regulators and chemicals on seed germination of *Parthenium hyarweophrus.* Geobios 4(3), 87 – 88.

Delvin, R. M. and Cunningham, R. P. (1970) The inhibition of gibberellic acid induction of - amylase activity in barley endosperm by certain herbicides. Weed Research (10): 316 – 320.

Etejere, E.O. (1980). Viability of herbicide-treated seeds of *Eupatorium odoratum.* Weed Research 20: 361 – 363.

Etejere, E.O. and Ajibola, I.O. (1990). Studies on seed germination and Domancy of Itch grass *Rottboellia cochinchinensis*. 3: 19 – 28.

Fawcett, R.S. and Slife, F.W. (1975). Germination stimulation properties of Carbamate herbicides. Weed Science 23(5): 419 – 424.

Hurle, K. (1974). Effect of long-term weed control measures on viable weed seeds in the soil. 12th British Weed Control Conference 3: 1145 – 1152.

Kolk, H. (1979). Weed seeds. Advances in research and technology of seeds Pudoc – CTA Wagenigen 4: 9 – 21.

Olaoye, S.O.A. (1974). Studies on the ecology and control of *Eupatorium odoratum* (Siam weed) in Nigeria. M.Sc. Thesis, University of Ibadan, Ibadan, Nigeria.

Penner, D. (1968). Herbicidal influence as amylase in Ibarley and squash seedlings. Weed Science. 16: 519 – 522.

Prasad, K.; Shrimal, S.K. and Drasad, T. (1976). Effect of gibevberellic acid, thiourea and bork acid on germination and seedling growth of *Crotolaria juncesa*. Biochemie und physiologie der Pflanzen 170(4-5): 293 – 300.

Shukla, S.P. (1972). The effects of some chemicals on the germination of a weed *Psoralea coryfolis* L. Weed research 12(4): 293 – 300.

Taylorson, R.B. (1976a). Responsiveness of intact and scarified seeds of *Babarea vulgaris* to gibberellic acid and changes in Phytochrome: Physiologica Plantarium 38(3): 196 – 200.