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A COMPARATIVE STUDY OF THE EFFECTS OF CLUMPING, SUBSTRATE, LIGHT, DEPTH OF BURIAL AND SOIL MOISTURE UPON THE GERMINATION OF SEEDS OF WEEDS AND CROPS GROWN IN THE SUDAN GEZIRA.

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ABSTRACT

The influence of the number of seeds per clump upon germination of *oryza sativa* L., *Gossypium hirsutum* L., *Brachiaria eruciformis* (Sm.) Griseb, *Dinbera retroflexa* (Vahl) Panz. and *Echinochloa colonum* (L.) Link was investigated on filter paper and in sand and clayey soil. The substrates did not affect the germination or the seeds of the crops of the weeds. Neighbour effects and interference were examined between rice and *B. eruciformis* and between cotton and *E. colonum* seeds sown at different densities and clumps in the clayey soil. Germination of seeds of crops was not affected by increasing density, while that of the weeds was affected by diversity and increasing density. The germination of seeds of crops was not affected by light. The weed seeds were light sensitive and only germinated on the surface of the soil, under a wide range of moisture levels. The implications of the results are discussed in relation to weed control in the Gezira.

INTRODUCTION

It is well known that the growth of weeds is one of the most important limiting factors in crop production. Sagar (1982) pointed out that experimental work on the population dynamics of weeds must examine three parameters: the theoretical potential for increase, the real rates of increase or decrease and the factors which must be responsible for the rate of change in the population size.

Although the status of various weeds in the Gezira has been documented for many years (Crowther, 1943; Ishag, 1968; Thomas, 1970; Beshir, 1970; Hamdoun, 1976; Drennan and Jennings, 1977; Hamdoun and Babiker, 1978; Ismail, 1979; Jennings and Drennan, 1979; Babiker and Hamdoun, 1982), little is known concerning their competitive ability during the germination phase. *Brachiaria eruciformis, Echinochloa colonum and Dinbera retroflexa,* which belong to the family Poaceae, are noxious weeds growing luxuriantly with crops in the Sudan Gezira. They are annuals and

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reproduce only by seed which enables them to invade new areas and perpetuate their population. One of the weeds under investigation (*E. colonum*) has been described hy Holm *et al.* (1977) as one of the world's worst weeds.

The present study examines aspects of germination which have to do with both physiology and ecological strategy, i.e. how the rate of seed germination of both weed and crop is affected by clustering of seeds sown contiguously in clumps of different sizes and whether this is modified by changing external parameters, e.g. substrate or light regime. The responses of germination to greater density have included both increases (Ballard, 1958; Palmblad, 1968; Linhart & Pickett, 1973; Linhart, 1976; Waite & Hutchings, 1978) and decreases (Palmblad, 1968; Linhart, 1976) or neither decreases or increases (Waite & Hutchings, 1979, Soetono & Puckrifdge, 1982). Plants at high densities interfere with each other earlier in their development than those at lower densities and plants do not react to density *per se* but to the proximity and behaviour of neighbours (Harper, 1977). The three weeds under investigation here show adaptability to a wide range of agricultural environments (Ishag, 1979) and crops and, therefore, the study was further extended to investigate the effects of depth of burial and frequency or irrigation on their seed gremination. *Dinbera retroflexa* was excluded from the diversity experiment because of insufficient germination which occurred on all substrates.

MATERIALS AND METHODS

General

Seeds of the weeds, *Brachiaria eruciformis, Echinochloa colonum* and *Dinbera retroflexa* and of the the crops *Gossypium hirsutum* variety Acala 44, 48 and *Oryza sativa* variety IR 2053, 306, 1. 3 and 6 which were collected during 1980 - 1981, were kindly provided by the Agricultural Research Corporation, Gezira Station and stored in paper envelopes in the laboratory at temperatures rangning from 23° to 32° C. Gezira clayey soil, which was heat-sterilized at 360°C to destroy any variable seed, was used. The soil consisted of montmorillonitic clay, 0.4% organic carbon, pH of 8.5 — 9.5 and a high cation exchange capacity.

All the experiments were conducted in an environmental growth chamber at a 13-h photoperiod (about 9000 lx from white fluorescent tubes at the level of the seeds) and an 11-h darkness, at alternating temperature regimes of 32±0.5°C during the day and 18+0.5° when dark. The relative humidity in the chamber was about 40-60%. These conditions were meant to approximate those prevailing in the fields of the Gezira during the period of July-August (main crop sowing period).

The effect of the size of seed clump upon germination

The effect of the size of seed clump upon germination was investigated on three different substrates moistened with distilled water. The basic method was the same in all experiments. Seeds were placed singly at least 0.5 - 1 cm apart and in clumps of four, ten and twenty, each clump being at least 1 - 2 cm distance from other clumps, in 9 cm diameter glass Petri dishes with lids. Seeds within clumps were in contact with each other and in monolayers, in order to ensure firm contact with the substrate. Germination was recorded daily and the germinated seeds were not removed. The experiments were each of a randomized block design with three replicates of a total of forty seeds (twenty for cotton seeds because of their size and weight, Table 1) per treatment. The arrangement is similar to that used by Linhart & Pickett (1973), Linhart (1976) and Waite & Hutchings (1978). Three germination substrates were used : (i) Whatman's No. 1 filter paper, (ii) washed sand and (iii) Gezira soil.

Table 1
Weight of seed of crops and weeds

Species	Mean weight/seed(mg)
Gossypium hirsutum. L. var. Akala, 44, 48	6.5900±0.85
Oryza sativa L. var. IR 2053, 306, 1. 3 and 6	1,9400±0.18
Echinochloa colonum (L) Link	0.0080 ± 0.0009
Brachiaria eruciformis (Sm.) Griesb	0.0027 ± 0.0002
Dinbera retroflexa (Vahl) Panz.	0.0014 × 0.0001

The effect of interaction of a weed and a crop seed

In order to study the effect of interaction of a weed and a crop. seeds of rice and *Brachiaria*, and cotton and *Echinochloa* were sown in monoculture and in association (polyculture) in the Gezira clayey soil (Table 2).

The effect of light

For all the above experiments, the following treatments were imposed and germination tests were carried out in the growth chamber. One set of seeds was exposed to alternating light and dark; one set was exposed to complete darkness. Dishes for the dark treatment were wrapped individually in black plastic sheets. To avoid contamination by micro-organisms during germination tests, treatment of the

Table 2

Sowing densities and types of experiments. Numbers are the total number of seeds per Petri dish.

Clump Size	Diversity	Gossypium	Oryza	*Brachiaria*	*Echinoc-hloa*	*Dinbera*	Total
1	Monoculture	20	0	0	0	0	20
4	Monoculture	20	0	0	0	0	20
10	Monoculture	20	0	0	0	0	20
20	Monoculture	20	0	0	0	0	20
1	Polyculture	20	0	0	20	0	40
4	Polyculture	20	0	0	20	0	40
10	Polyculture	20	0	0	20	0	40
20	Polyculture	20	0	0	20	0	40
1	Monoculture	0	40	0	0	0	40
4	Monoculture	0	40	0	0	0	40
10	Monoculture	0	40	0	0	0	40
20	Monoculture	0	40	0	0	0	40
1	Polyculture	0	20	20	0	0	40
4	Polyculture	0	20	20	0	0	40
10	Polyculture	0	20	20	0	0	40
20	Polyculture	0	20	20	0	0	40
1	Monoculture	0	0	40	0	0	40
4	Monoculture	0	0	40	0	0	40
10	Monoculture	0	0	40	0	0	40
20	Monoculture	0	0	40	0	0	40
1	Monoculture	0	0	0	40	0	40
4	Monoculture	0	0	0	40	0	40
10	Monoculture	0	0	0	40	0	40
20	Monoculture	0	0	0	40	0	40
1	Monoculture	0	0	0	0	40	40
4	Monoculture	0	0	0	0	40	40
10	Monoculture	0	0	0	0	40	40
20	Monoculture	0	0	0	0	40	40

cotton seeds with 1% sodium hypochlorite for 5 minutes was essential. Seeds were considered germinated when their radicle had emerged. Germination was determined in the light daily for 17 days. Seeds germinated in darkness were counted only on the last day of observation.

The effects of depth of showing and frequency of irrigation

The effect of seed burial (for weeds only) and frequency of irrigation was examined in a second experiment, by sowing 4 seeds at a depth of 0, 2, 4 and 6 cm in slightly conical free-draining black plastic pots (8 × 6 × 5 cm) filled with a known weight of the

Gezira soil. Different levels of moisture classified as low, moderate and high (Idris, 1979) were provided by giving irrigation (usually 50 ml of distilled water was given at the first time for each pot, so that the soil was maintained close to the field capacity in order to establish a common start) water (30 ml) at a frequency of 2, 4 and 6 day intervals. The experiment included 3 weeds × 4 sowing depths × 3 levels of watering × 3 replicates arranged in a randomized block design.

Seedling emergence was recorded daily and seedlings were counted till no further emergence occurred. The term emergence here is used to mean the appearance of parts of the seedling above the soil surface (Harper & Obeid, 1967). The experiment lasted for one month.

The percent germination and emergence data were transformed to arc sines, as in binomial distribution, the variance would be a function of the mean. The arc sine transformation prevents this. Differences between total germination on the three substrates were tested for each plant and density (degree of clumping) by $\times^2$ test (2 d.f.). The effect of the different factors (plant density, plant diversity monoculture. v. polyculturel, replication, interaction between density and diversity, interaction between light and dark) on germination and (burial depth, frequency of irrigation) on emergence were compared by analysis of variance.

RESULTS

The effect of substrate on germination

Comparison between germination of the two crops and the three weedy species at all clumping levels and various densities on different substrates under light or dark conditions gave no statistically significant results, except in the case of seeds of *Dinbera retroflexa* in the clayey soil. With this weed, germination on all substrates in light of darkness was either low or prevented (Table 3), despite viability (as shown by a tetrazolium chloride test) of 85 — 95%.

The effects of diversity, density and light on germination.

Oryza sativa: The final percentage germination was not significantly affected by density, clum sizes, light or dark; monoculture or polyculture treatments (Table 4).

B. eruciformis: Consistently, the final percentage germination of the seeds sown in monoculture and under light conditions was substantially higher ($P = 0.1$) than seeds sown in polyculture under the same light regime. At all clumping levels there was no significant difference in germination for monoculture and polyculture seeds when sown in the dark. At all clumbing levels for monoculture, germination was 90% in the light regime ($P=0.01$) compared to 23-30% in the dark. In monoculture and in the

Table 3

Final percentage germination of seeds (monoculture) on different substrates and increasing densities.

Number of seeds/ clump	Plant		Filter paper	Sand	Clayey soil	X^2
1	*Oryza sativa*	L	84.57	85.67	81.86	0.10 NS
1		D	87.29	90.00	87.29	0.07 NS
1	*B. eruciformis*	L	84.85	90.00	90.00	0.28 NS
1		D	38.33	23.33	23.00	5.08 NS
1	*Gossypium hirsutum*	L	61.33	73.85	68.45	1.74 NS
1		D	79.52	90.00	70.47	2.40 NS
1	*E. colonum*	L	90.00	90.00	90.00	0.00 NS
1		D	57.33	53.33	47.67	1.09 NS
1	*D. retroflexa*	L	26.00	26.67	30.33	0.43 NS
1		D	0.00	0.00	8.67	17.33***
4	*Oryza sativa*	L	77.84	77.71	76.19	0.06 NS
4		D	90.00	87.29	78.62	0.86 NS
4	*B. eruciformis*	L	83.85	90.00	83.24	0.35 NS
4		D	36.33	27.67	36.33	1.65 NS
2	*Gossypium hirsutum*	L	75.19	75.59	75.19	0.08 NS
2		D	81.33	83.85	79.52	0.12 NS
4	*E. colonum*	L	90.00	90.00	90.00	0.00 NS
4		D	60.00	56.00	50.33	0.84 NS
4	*D. retroflexa*	L	28.00	29.33	33.33	0.66 NS
4		D	0.00	0.00	12.67	29.60***
10	*Oryza sativa*	L	81.33	76.19	77.84	0.18 NS
10		D	85.67	73.37	87.29	1.40 NS
10	*B. eruciformis*	L	90.00	90.00	90.00	0.00 NS
10		D	48.33	29.33	38.00	4.72 NS
5	*Gossyium hirsutum*	L	79.52	78.07	63.55	2.14 NS
5		D	90.00	79.52	77.00	1.16 NS
10	*E. colonum*	L	90.00	90.00	90.00	0.00 NS
10		D	55.67	55.00	40.00	3.14 NS
10	*D. retroflexa*	L	26.67	26.00	41.67	4.96 NS
10		D	0.00	0.00	11.67	23.34***
20	*Oryza sativa*	L	84.88	80.24	76.22	0.48 NS
20		D	85.67	73.37	87.29	1.41 NS
20	*B. eruciformis*	L	90.00	90.00	82.40	0.49 NS
20		D	49.33	36.33	36.67	2.89 NS
10	*Gossypium hirsutum*	L	72.78	90.00	73.74	2.37 NS
10		D	77.00	85.67	81.33	0.48 NS
20	*E. colonum*	L	90.00	90.00	90.00	0.00 NS
20		D	58.33	49.33	41.67	2.81 NS
20	*D. retroflexa*	L	30.33	26.00	30.33	0.48 NS
20		D	0.00	0.00	6.67	13.37**

NS = Not significant; *P<0.05; ** P < 0.01; *** P < 0.001 L = Light D = Dark

light regime, increasing density had no effect on germination; in the dark, the final percentage germination increased with an increase in density (P=0.5) only from 1-4 clump size. In polyculture, there was no difference in the final percentage germination between seeds sown in the light regime or under dark conditions in low and modertae densities (Table 4). In the higher and highest densities, the germination under light conditions was significantly higher than under dark conditions (P=0.01), and in one case (highest density of monoculture and polyculture of seeds sown under light) the final percentage germination was similar. Under dark conditions and in polyculture, increased density significantly increased (P = 0.05) the final percentage germination only from 1-4 clump size.

Gossypium hirsutum: The final percentage germination was not significantly affected by density, clump sizes, light or dark, monoculture or polyculture treatments (Table 4).

E. colonum: Generally, the final percentage germination at various densities and clumping levels and under light conditions in monoculture was significantly higher than that (P = 0.01) of polyculture under the same conditions, except for the high and highest density, where they were similar (Table 4). In monoculture and at all clumping levels, the final percentage germination was 90% in the light regime (P = 0.01) compared to 41.67 - 50.33% in the dark. At all various densities and clumping levels in polyculture, germination was higher in the light than under dark conditions (P = 0.01). In monoculture, whether under light conditions or dark, increasing density had no effect on the final percentage germination. In polyculture, increasing density increased the final percentage germination from 61.92% at low density to 90% at high density (P = 0.01) for light and dark conditions respectively.

The effect of depth of sowing and frequency of irrigation on the emergence of the weedy species seeds.

Table 5 shows the percentage emergence of the weedy species in response to the interaction of the various depths of burial and watering frequencies. It can be seen that the final percentage emergence was drastically reduced (P = 0.1) by increasing the depth of sowing from 0 - 2 cm for *B. eruciformis,* and prevented for *E. colonum* and *D. retroflexa.* Different regimes of water did not affect the final percentage emergence, but the three weedy species were different (P = 0.5) in their response to the three regimes of water (Table 5).

Table 4

Final percentage germination of seeds of *Oryza sativa, Brachiaria eruciformis, Gossypium hirsutum* and *Echinochloa colonum* (monoculture versus polyculture) sown in the clayey soil (data transformed to arc sine).

		Percentage germination in clumps of			
		1* (40) L	4 4 × (10) M	10 10 × (4) Hr	20 20 × (2) Hs
			O. sativa		
Light	M	81.86[a]†	76.19[a]	77.84[a]	76.22[a]
Dark		87.29[a]	78.62[a]	87.29[a]	84.57[a]
Light	P	79.52[a]	81.33[a]	75.19[a]	74.92[a]
Dark		77.71[a]	75.19[a]	79.52[a]	78.62[a]
			B. eruciformis		
Light	M	90.00[a]	83.24[a]	90.00[a]	82.40[a]
Dark		23.00[d]	36.33[c]	38.00[c]	36.67[c]
Light	P	26.56[d]	34.78[c]	66.17[b]	75.19[a]
Dark		21.33[d]	33.85[c]	36.22[c]	37.20[c]
			G. hirsutum		
		1* (20)	2 2 × (10)	5 5 × (4)	10 10 × (2)
Light	M	78.45[a]	75.19[a]	73.55[a]	73.44[a]
Dark		79.52[a]	79.52[a]	77.00[a]	81.33[a]
Light	P	81.33[a]	81.33[a]	77.00[a]	74.81[a]
Dark		75.19[a]	73.37[a]	77.00[a]	79.52[a]
			E. colonum		
		1* (40)	4 4 × (10)	10 10 × (4)	20 20 × (2)
Light	M	90.00[a]	90.00[a]	90.00[a]	90.00[a]
Dark		47.67[c]	50.33[c]	45.00[c]	41.67[c]
Light	P	61.92[b]	63.48[b]	73.37[a]	90.00[a]
Dark		45.00[c]	50.77[c]	53.85[c]	60.00[b]

* In case of polyculture 20 seed of the weed + 20 seed of the crop.
M = monoculture, P = polyculture, L = Low, M = Moderate,
Hr = Higher and HS = Highest
† For each species, means within columns followeds by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

Table 5

The percent emergence of seedlings of *B. erucuformis, E. colonum* and *D. retroflexa* sown at different depths and subjected to 3 regimes of watering frequency (mean of 3 replicates).

Frequency of Irrigation	Sowing Depth (cm)				
	0	2	4	6	Mean
Brachiaria eruciformis					
High watering	44.99	10.00	0.00	0.00	13.74
Moderate watering	55.00	10.00	10.00	10.00	21.25
Low watering	75.00	10.00	10.00	10.00	26.25
Mean	58.33	10.00	6.66	6.66	20.41
Echinochloa colonum					
High watering	64.96	0.00	0.00	0.00	16.24
Moderate watering	55.00	0.00	0.00	0.00	13.75
Low watering	50.00	0.00	0.00	0.00	12.50
Mean	56.65	0.00	0.00	0.00	14.16
Dinbera retroflexa					
High watering	20.00	0.00	0.00	0.00	5.00
Moderate watering	40.00	0.00	0.00	0.00	10.00
Low watering	20.00	0.00	0.00	0.00	5.00
Mean	26.66	0.00	0.00	0.00	6.66

DISCUSSION

In the present investigation, the micro-environment presented by the substrates from filter-paper to sand to soil providing substrates more like those available in natural conditions (Waite & Hutchings, 1978) had no effect on the final percentage germination of four of the five species (two crops and two weeds) studied. The behaviour of *Dinbera retroflexa* seeds sown in the clayey soil in light compared to the other two substrates remains obscure and needs more investigation.

The experimental evidence shows that germination of seeds of both crops (rice and cotton) in monoculture was affected neither by intraspecific competition nor by light or darkness. The results also show that under the conditions of the experiment with equal crop and weed densities, the germination of seeds of both crops was unaffected by increasing density at all clumping levels in monoculture or polyculture, i.e. there was no response to density stress at the densities used. Waite and Hutchings (1979), experimenting with *Plantago coronopus L.* at a range of densities found that the chance of a seed forming an etablished seedling was not increased when seeds were grown in clumps.

The results also shows that the seeds of rice and of *B. eruciformis* when are sown together, the seeds of rice out-germinated those of the weed under both light and dark conditions. The experiments also indicate that the seeds of *B. eruciformis* were light sensitive, i.e. positively photoblastic (Batanouny & Ziegler, 1971). During the same germination period, *E. colonum* behaved similarly to *B. eruciformis*. For example, when the seeds of cotton and *E. colonum* were sown together, the cotton seeds germinated far better than the weed seeds under the same light and dark conditions. *E. colonum* seeds were found to be light sensitive. *Dinbera retroflexa* seeds sown only in monoculture were also found to be (Table 3) light sensitive.

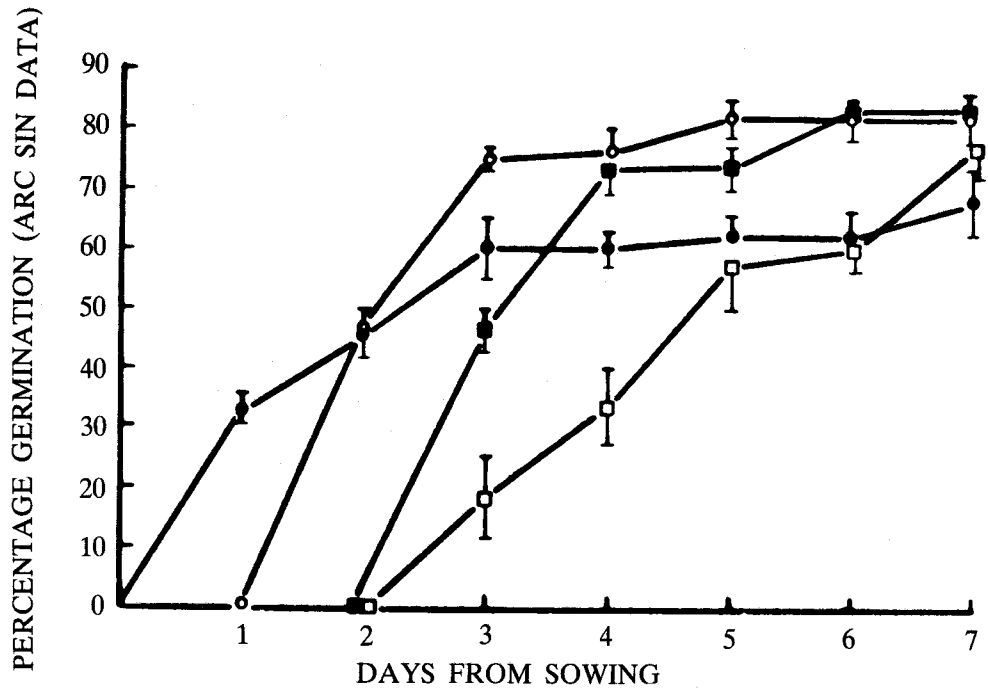

Figure 1. Time sequence of the germination of seeds of cotton●———●; rice ○———○; *B. eruciformis* □———□ *E. colonum,* ■———■ sown in monoculture in light on the clayey soil (± SE given).

Factors such as seed size (Table 1), time of emergence (Fig. 1) and the density, position and size of neighbours have all been identified as influencing the rate of growth of a young plant (Watkinson, Lonsdale & Firbank, 1983). Fig. 1 shows that the seeds of the two crops germinated faster than the seeds of the weeds when sown in

monoculture. This difference (which was also true in the case of polyculture) in speed of germination was observed on the third day of the test, but by the seventh day the ultimate percentage germination of the four plants was almost similar. One would therefore expect that plants derived from the smaller seeds of *B. eruciformis. and* E. colonum would not germinate and grow as well as plants derived from heavier seeds (cotton and rice) because the light seeds start with initially smaller resources (Harper, Lovel & Moore, 1970; Cideciyan & Malloch, 1982). This delay in the germination of these two weedy species was also observed in the field (Gezira) by Idris (1979), who showed that after rain or irrigation the weed flora was dominated by broadleaved species for 4 - 5 weeks. Thereafter, their population number decreased, the broadleaved species were totally superseded and dominated by grass species like *Brachiaria, Dinbera* and Echinochloa, presumably because these broad leaves emerging first capture a disproportionate share of the environmental resources, i.e. light (Harper, 1977, p. 166).

Changes in the position of seeds in the soil are mainly brought about by cultivation activities (Wesson & Wareing, 1967, 1969) and the depth of distribution of weed seeds in arable land is partly determined by the soil inversions involved in cultivation (Harper, 1977). In the Sudan Gezira, poor soil cultivation and frequency of irrigation and the use of high rates of nitrogen increase the weed problem (Babiker, 1982).

The results show that sowing at a depth of 0 cm afforded the best germination for the three weedy species. These results suggest that in the field, these light sensitive seeds of the three weedy species enter into enforced dormancy, thus making a seed bank, which can be considered as an essential survival mechanism.

This argument finds support from Wesson & Wareing (1967), Cresswell & Grime (1981) and Grime *et al.* (1981), who reported that seeds may acquire dormancy in the absence of light, and germination is only initiated when the seed is eventually unearthed by some form of disturbance, e.g. ploughing and cultivation practices.

From the present study on the frequency of irrigation, it could be concluded that, although the seeds of the three weedy species have preference for certain levels of moisture, as they only germinate on the soil surface which is exposed to direct sun and dry air, they would receive alternating periods of wetness and dryness. They are, therefore, adapted to a wide range of moisture levels, consequently showing adaptability to a wide range of agricultural environments and crops in the Sudan (Ishag, 1979). Ishag (1982) reported that more frequent watering in the Northern part of the Sudan resulted in the growth of *Thunbergia annua* Hochst ex Hees, a weed with a shallow root system, which also grows with crops in the Sudan Gezira.

The results of these studies should contribute to a better understanding of the population biology of these weedy species in the Gezira, which in turn, will allow better planning for control measures. Harper (1958) pointed out that ecological studies of weeds may often expose an *Achilles Heel* in the life cycle of the plants and may, therefore, improve the chances of designing efficient control measures.

The practice of using only pre-emergence and post-emergence herbicides for restricted periods of the season in the Gezira (Hamdoun & Babiker, 1978, 1979; Babiker, 1982) cannot reduce a severe infestation in a short time. This can only be achieved by using herbicides to restrict the production and entry of new spikelets and seeds into the soil, coupled with cultural measures which encourage mortality of seeds produced by any survivors. Peter & Wilson (1979) described such an approach to control as necessary for at least 3 -4 years, to allow for the loss of dormancy and depletion of the reserve of old seeds in the seed bank.

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دراسة مقارنة لتأثير بعض العوامل في إنبات بذور الأعشاب والمحاصيل في الجزيرة بالسودان

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يتضمن البحث دراسة تأثير منابت مختلفة (ورقة ترشيح ورمل وتربة طينية) على إنبات بذور كل من الأرز والقطن وثلاثة من الحشائش الضارة عندما وضعت في كثافات مختلفة .

أوضحت النتائج عدم وجود أثر واضح للمنبت على إنبات بذور المحاصيل والحشائش .

كذلك أوضحت نتائج تجارب التدخل والمناقشة مع زيادة عدد البذور ، أن إنبات بذور المحاصيل لم يتأثر بزيادة عدد البذور في المجموعة الواحدة ، ولكن كان لهذه المعاملة أثر جوهري على إنبات بذور الحشائش .

وفي تجارب أخرى ، وجد أن إنبات بذور الحشائش إزداد زيادة جوهرية في وجود الضوء في حين لم تتأثر بذور المحاصيل بذلك . كما أوضحت التجارب أن بادرات الحشائش نمت بطريقة أفضل على سطح التربة ، تحت درجات متفاوتة من الرطوبة .

نوقشت نتائج هذه التجارب في ضوء مكافحة الحشائش في منطقة الجزيرة بالسودان .