Effect of Water Extract of Sugarbeet on the Germination of Other Crop Seeds[1]

S. Abu-Shakra and B. A. Aqil[2]

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The presence of germination inhibitors in seeds and fruits has been reviewed (2)[3]. The water extract of sugarbeet seed balls was found to retard the germination of sugarbeet seed and kill the radicles of emerged seedlings (5). Stout and Tolman (4) reported that the toxicity of the water-extract of sugarbeet was not specific to sugarbeet seed but also totally inhibited or retarded the germination of other seeds.

The present study was conducted to investigate further the effect of sugarbeet seed water-extracts of different dilutions on the germination of crop seeds and subsequent growth of seedlings.

Materials and Methods

Water extract of sugarbeet (*Beta vulgaris* L.) variety Maribo autopoly, lot number 7015, was prepared by soaking 10 g of the whole seed balls in 100 ml distilled water. The soaking was done in the dark at 10°C for a period of 24 hours. The leachate was then filtered through Whatman filter paper No. 4 and was referred to as the whole seed ball extract of 100% concentration. Sugarbeet seed balls were also crushed by means of a small hand mill and the true seed separated from the pericarp tissue. The water extract of each part (crushed seed balls, pericarp tissue and true seed) was prepared in the same manner as mentioned above and the effect of each was then tested on the speed of germination of true (excised) sugarbeet, alfalfa and sorghum seeds. The effect of the whole seed ball extract was tested on the initial germination and radicle length of sunflower (*Helianthus annus* L.), sugarbeet (*Beta vulgaris* L.), cabbage (*Brassica oleracea* L.), cotton (*Gossypium herbaceum* L.), alfalfa (*Medicago sativa* L.), vetch (*Vicia sativa* L.), rice (*Oryza sativa* L.), barley (*Hordeum vulgare* L.), perennial rye grass (*Lolium perenne* L.), sorghum (*Sorghum vulagre* Pers.), wheat (*Triticum vulagre* L.), and oats (*Avena sativa* L.). Dilutions of 50% and 75% of the extract were prepared and their effect was compared with that of the undiluted extract on seed germination and subsequent seedling growth of alfalfa, sorghum and oats.

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[1] Authorized for publication on June 1968 as Journal No. 229 by the Faculty of Agricultural Sciences, American University of Beirut, Beirut, Lebanon.

[2] Assistant Professor of Agronomy, American University of Beirut, Beirut, Lebanon and Instructor of Agronomy, West Pakistan Agricultural University, Lyallpur, West Pakistan, respectively.

[3] Numbers in parentheses refer to literature cited.

For each test duplicates of 20 seeds were germinated on two filter papers in petri dishes. Three ml of solution was added to each dish. Germination was done in a Stults seed germinator at alternating temperature of 20-30°C. Germination in distilled water was used in each test to serve as the check. At an arbitrary time that was specific to each crop, seeds that produced radicles of one or more cm in length were considered germinable. Growth of ten seedlings was determined by measuring the fresh weight of radicles and hypocotyls or plumules after pressing the seedlings gently between two filter-papers to remove any surface water. Where the effect of the extract on subsequent growth of seedlings was studied, 200 seeds of the crop tested were germinated between blotters in distilled water and 2 samples of 20 germinated seeds with radicles one cm in length were selected for the test. All the data reported in this paper are the means of four replicated experiments.

Results and Discussion

Results (Table 1) indicate that the water extract depressed the germination percentage and the average radicle length of all the crop seeds tested. The extract affected germination of barley, alfalfa, sunflower, perennial ryegrass, cabbage, rice, and sugarbeets more than sorghum, oats, vetch, cotton, and wheat. The results are in agreement with Stout and Tolman (4) who reported that the toxicity of the water extract from sugarbeet seed balls was not specific to sugarbeet but also affected the germination of several other seeds.

The origin of the inhibitory material in the aqueous extract was found to be in the pericarp tissue (Table 2). The water extracts of the pericarp tissue and the crushed seed balls inhibited to the same magnitude the radicle development of sugar-

Table 1.—Effect of the water extract of sugarbeet seed on the germination percentage and radicle length of different crop seeds.

Crop seed	Germination period (hr)	Germination (% of check)	Radicle length (% of check)
Barley	84	1.7	18.2
Alfalfa	72	3.3	12.0
Sunflower	96	4.2	28.6
Perennial rye grass	144	4.2	11.4
Cabbage	84	10.3	12.9
Rice	204	19.8	14.3
Sugar beet (inhibitor-free)	96	35.4	36.1
Sorghum	72	53.2	17.1
Oats	132	66.7	6.7
Vetch	84	78.4	52.2
Cotton	96	79.5	42.5
Wheat	72	90.9	25.3

Table 2.—Effect of different extracts on the speed of germination of true sugarbeet, alfalfa and sorghum seeds.

Extract	Fresh weight 10 radicles after 72 hrs germ. (mg)		
	Sugar beet true seed	Alfalfa	Sorghum
Control (Dist. H_2O)	20.71	55.69	118.50
Sugarbeet true seed	19.39	49.69	118.19
Pericarp tissue	2.35	13.75	38.13
Crushed seed balls	1.40	10.69	33.75

beet, alfalfa, and sorghum. The extract of the sugarbeet true seeds did not show any inhibitory properties when compared to distilled water.

The effect of different dilutions of the whole seed ball extract on seed germination of alfalfa, sorghum and oats is given in Table 3. The extract did not inhibit the germination at a dilution of 75%. The full strength of the extract (zero dilution), on the other hand, significantly decreased the germination percentage of all the seeds tested. The effect, however, was differential at 50% dilution since it significantly decreased the germination of alfalfa and oats but not of sorghum.

The reduction in germination percentage was due mainly to the inhibtory effect of the extract on radicles. The fresh weights of radicles of alfalfa and sorghum were not reduced by the 75% dilution but were significantly reduced by the 50% dilution. Reduction in the fresh weight of oat radicles was obtained only when the oat seeds were germinated in the undiluted extract. These results indicate that a minimum concentration of the extract is needed to cause radicle inhibition and that this minimum concentration is not the same for all seeds. Oat radicles were stimulated by 75% dilution of the extract (Table 3).

The undiluted extract significantly reduced the development of the sorghum plumule at 1% level, of the alfalfa hypocotyl at 5% level and had no significant effect on the oat plumule. No inhibition of the plumules was produced by the diluted extracts. Instead, at 75% dilution the plumules of oats and sorghum were significantly stimulated at 1% level. No significant stimulation of the hypocotyls of alfalfa was observed. This stimulation effect of the extract on the plumules of sorghum and oats might be due to the presence of growth-promoting substances in the extract that are stimulatory only when present at low concentrations.

The influence of the dilutions of the whole seed ball extract on the growth of seedlings of alfalfa, sorghum, and oats is shown in Table 4. The radicles of sorghum were significantly inhibited

Table 3.—Effect of various dilutions of the sugarbeet seed ball extract on seed germination and seed vigor[1] of alfalfa, sorghum and oat.

% dilution of extract	Alfalfa observed after 144 hrs			Sorghum observed after 120 hrs			Oats observed after 120 hrs		
	% germ.	Fresh weight 10 radicles	Fresh weight 10 hypocotyls	% germ.	Fresh weight 10 radicles	Fresh weight 10 plumules	% germ.	Fresh weight 10 radicles	Fresh weight 10 plumules
		Mg	Mg		Mg	Mg		Mg	Mg
Control[2]	90.2	67.1	144.5	95.0	122.8	73.6	63.9	62.5	60.1
75	89.4	63.0	173.5	97.5	137.8	100.9	55.0	81.6	96.1
50	75.6	26.1	163.6	90.0	87.4	57.7	46.0	61.5	71.1
0[3]	8.1	9.6	93.4	41.3	30.8	48.0	39.6	39.6	58.0
LSD 5%	12.0	22.7	43.8	13.9	34.7	17.7	11.1	11.0	16.0
LSD 1%	17.3	32.6	63.1	20.1	49.9	25.4	15.9	15.8	23.0

[1] Seed vigor was determined by measuring the fresh weight of radicles and plumules or hypocotyls.
[2] Distilled water.
[3] Whole seed ball extract of 100% concentration.

Table 4.—Effect of various dilutions of sugarbeet seed extract when applied on seedlings of alfalfa, sorghum and oats.

% dilution of extract	Alfalfa observed after 48 hrs		Sorghum observed after 72 hrs		Oats observed after 72 hrs	
	Fresh weight 10 radicles	Fresh weight 10 hypocotyls	Fresh weight 10 radicles	Fresh weight 10 plumules	Fresh weight 10 radicles	Fresh weight 10 plumules
	Mg	Mg	Mg	Mg	Mg	Mg
Control[1]	53.1	99.0	114.4	54.8	94.1	187.8
75	49.6	111.6	88.8	46.9	113.6	247.8
50	30.9	130.6	75.9	76.5	105.9	252.0
0[2]	13.5	98.5	48.8	93.2	68.3	241.3
LSD 5%	13.4	23.3	12.5	10.1	5.4	17.6
LSD 1%	19.3	33.4	18.9	15.2	7.8	25.4

[1] Distilled water.
[2] Whole seed ball extract of 100% concentration.

by the extract diluted to 75%. The magnitude of inhibition increased with the decrease in dilution. The growth of alfalfa radicles was reduced significantly (1% level) when the seedlings were allowed to grow in the 50% dilution of the extract. In contrast, the growth of radicles of oats was stimulated at the 75% and 50% dilutions. Radicle development of alfalfa, sorghum and oats was seriously inhibited by the original concentration of the extract.

The growth of plumules of sorghum and oats and hypocotyls of alfalfa was not inhibited by any concentration of the extract. Instead, the plumules of oats were significantly stimulated at 75%, 50% and zero dilutions, of sorghum at 50% and zero dilutions, and the hypocotyls of alfalfa at 50% dilution.

DeKock et al. (1) reported that the germination of cress seeds was inhibited by the water extract of the seed balls of sugarbeet. But, if the seeds treated with the inhibitor were washed and then put to germinate, the speed of germination was more rapid and the hypocotyls were much stronger than those of the controls. The authors concluded that some phase of the growth process is being retarded whereas other phases may proceed normally or be stimulated. Snyder (3) reported that the whole seed balls from two progenies of the sugarbeet variety US 401 germinated more rapidly than the naked seeds obtained from the same plants indicating a stimulating effect of the seed balls. Also, the growth of seedlings was found to be stimulated by the seed balls. In the present investigation the stimulating effect of the seed ball extract on other crop seeds appeared to be due to the presence of growth promoting substances in the extract that is stimulatory only when present at low concentrations.

Summary

The effect of the water extract of sugarbeet seed was studied on the speed of germination and seedling growth of different crops.

The water extract of the whole seed balls inhibited the germination and radicle development of many crop seeds. The degree of inhibition varied with seeds of different varieties.

The origin of the inhibitory material was found to be concentrated in the pericarp tissue and absent from the true sugarbeet seeds.

Extracts of the whole seed balls apparently contained substances that stimulated seedling growth of alfalfa, sorghum and oats. Stimulation was more prominent on plumules and hypocotyls than on radicles.

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