

Test of Toxicity of Different Concentrations of Phenol on Seed Germination of Some Cultivated Plants

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Abstract: In this paper we have studied seed sensitivity to different concentrations of phenol of some grain and vegetables. During their vegetation these plants are irrigated mostly from natural water currents where, undoubtedly phenol can be found. The results of the test will be shown by numerical and descriptive parameters: acceptable dose, harmful dose and lethal dose of phenol.

Key words: polluted water, phenol, cultivated plants.

Introduction

Phenol waste water is produced in vast quantities in Coal and Gas Industry, Oil Refineries, wood distillation and chemical industry. Often, unrefined waste waters get into the water currents, even in the water-supply systems. Phenol compounds are of course toxic and most dangerous matter for plants, animals and man. Phenol greatly disrupts plant's germination phase. It reduces percentage of germination and totally changes relation between the lengths of radicle and hypocotyl. Besides, it prolongs time of germination.

This paper deals with the degree of sensitivity of the seeds to different concentrations of phenol of vegetables and grains such as *Sinapis alba*, *Capsicum annum*, *Brassica oleracea*, *Zea mays* and *Pisum sativum* which are most often watered during droughty period of vegetation with the water from natural water currents most likely to contain phenol.

Materials and Methods

A well-known method of seed germination was applied to test toxicity of phenol to germination of the cultivated plants: *Sinapis alba*, *Capsicum annum*, *Brassica oleracea*, *Zea mays* and *Pisum sativum*. The essence of this method is to dauly monitor the number of germinated seeds of each species. The samples contained 100 seeds of every species in accordance to the low for seeds and agricultural practice. Seeds were watered with distilled water (control samples) and with different concentrations of phenol: 1ml of phenol per 1l of water, 2ml of phenol per 1l of water, 3ml of phenol per 1l of water, etc got by dilutting basic 1N solution of phenol. The test was repeated three times looking for concentration of phenol which completely blocks germination, seeds in adequate petri disk were put in thr hotbad and kept at the temperature of 22°C. every day the number of germinated seeds was noted and the length of radicle and hypokotil was measured by milimeter paper. The obtained results are shown in the tables and described by using terms: acceptable, harmful and lethal dose.

Results and Discussion

The results of the tested species: *Sinapis alba*, *Capsicum annum*, *Brassica oleracea*, *Zea mays* and *Pisum sativum*. Are given in the tables including : percentage of germination of the seeds (table 1), length of radicle (table 2) and length of hypocotil(table 3).

Comparative analysis of the obtained results for the listed plant species seed germination in distilled water (as the control sample) and in different concentrations of phenol clearly shows that *Sinapsis alba* is the most sensitive species. Acceptable concentration of phenol is under 1ml of phenol per 1l of water (43% of germinated seeds to 84% in the control sample). Very harmful concentration is from 2.3 to 4ml of phenol per 1l water. While lethal concentration of phenol for this species is 5ml of phenol per 1l of water when there is no germination.

Capsicum annum is very sensitive species to phenol. Acceptable concentration of phenol is under 1ml of phenol per 1l of water (83% of the germinated seeds to 91% in the control sample. Very harmful doses of phenol are 5,6,7 and 8ml of phenol per 1l of water since small percent of the seeds germinates than (38%,17%,10%,27%). Lethal concentration for this species is 9ml of phenol per 1l of water.

Brassica oleracea is sensitive species to phenol Acceptable concentration is unders 1ml of phenol per 1l of water. Than 72% of the seeds germinate in relation to 86% in the control sample. Water which contains phenol in concentrations. From 8ml per 1l of water to 16 ml of phenol per 1l of water must not be used because the abrupt fall in percentage of seed germination from 49% to 2% was noted. At the concentration of 17ml of phenol per 1l of water the seed of *Brassica oleracea* species does not germinate.

Zea mays is tollerant species to phoenol. At the concentration of 1ml pf phenol per 1l of water 98% of the seedgerminate to 100% in the control sample. Relatively acceptable doses of phenol are 2, 3, 4, 5, 6 and 8ml of phenol per 1l

of water when the percentage of germination varies from 94% to 64%. Waters containing phenol in concentrations from 14 to 18 ml of phenol per 1l of water may be considered harmful. Very harmful waters contain 19, 20, 21, 22 and 23 ml of phenol per 1l of water where the percentage of germination falls to symbolic 9% and 6%. Lethal dose is 24 ml of phenol per 1l of water.

Tab. 1. Percentage of germinated seeds in distilled water and in phenol

Concentration phenol in ml/l	Plant species				
	<i>Sinapis</i>	<i>Capsicum</i>	<i>Brassica</i>	<i>Zea</i>	<i>Pisum</i>
	<i>alba</i>	<i>annum</i>	<i>oleracea</i>	<i>mays</i>	<i>sativum</i>
	percentage of germination in control sample				
	84	91	86	100	100
	percentage of germination in phenol				
1	43	83	72	98	100
2	30	80	70	94	100
3	22	74	68	80	100
4	3	59	67	82	100
5	0	38	64	77	100
6		17	58	73	100
7		10	54	69	100
8		2	49	60	100
9		0	48	58	92
10			21	55	73
11			17	53	71
12			12	52	69
13			11	50	69
14			10	48	67
15			9	46	63
16			2	42	60
17			0	40	57
18				36	43
19				28	38
20				26	34
21				12	31
22				9	26
23				6	17
24				0	11
25					7
26					3
27					0

Pisum sativum is highly tolerable species to phenol compounds. Water containing from 1ml to 8ml of phenol per 1l of water can be used in intensive

cultivation of this vegetable culture without any serious damage. In these cases the percentage of germination is the same as in the control sample 100%. Concentrations of 9 to 16 ml of phenol per 1 l of water may be considered acceptable since the percentage of germination slightly falls from 92% to 60%. Harmful concentrations of phenol are 17, 18, 19, 20, 21, 22, 24 ml of phenol per 1 l of water and especially harmful are 24, 25 and 26 ml of phenol per 1 l of water when only 11%, 7% and 3% of the *Pisum sativum* seed germinate. Lethal dose is 27 ml of phenol per 1 l of water.

Tab. 2 The average length of radicle in distilled water and in phenol

Concentration phenol in ml/l	Plant species				
	<i>Sinapis</i>	<i>Capsicum</i>	<i>Brassica</i>	<i>Zea</i>	<i>Pisum</i>
	<i>alba</i>	<i>annuum</i>	<i>oleracea</i>	<i>mays</i>	<i>sativum</i>
	The average length of radicle in the control sample in mm				
	57.5	23.7	43.2	30.5	62.4
	The average length of radicle in phenol in mm				
1	25	19.6	38.7	25.5	60.9
2	12.5	15.7	31.3	25	59.3
3	9	13.2	26.8	24.7	58.6
4	3.5	10	19.43	23.2	58
5	0	6.2	9.6	26.3	41.7
6		5	7.5	20.75	38.5
7		4.2	7.1	19.3	33
8		2.6	7	18.15	32.8
9		0	6.8	18.2	32
10			5.8	17.5	30.5
11			5.8	17.58	30
12			5.75	16.3	29
13			5.73	16.25	28.75
14			5.6	16	28.4
15			4.2	15.15	28.2
16			4	15.05	17.3
17			0	14.15	17
18				14.5	16.3
19				9.75	14.2
20				3.1	11
21				2.8	9.5
22				1.3	8
23				1	6.3
24				0	4.2
25					3
26					2.5
27					0

Table 3 The average length of hypokotil in distilled water and in phenol

Concentration phenol in ml/l	Plant species				
	<i>Sinapis alba</i>	<i>Capsicum annum</i>	<i>Brassica oleracea</i>	<i>Zea mays</i>	<i>Pisum sativum</i>
	The average length of hypokotil in control sample in mm				
	25	8.1	11.5	22.5	13.4
	The average length of hipokotila in phenol in mm				
1	27.50	8.20	12.50	23.23	16.50
2	29.00	9.20	12.70	23.20	19.90
3	31.40	10.00	13.10	23.60	17.30
4	0.00	10.80	14.70	24.52	18.00
5	0.00	11.50	16.20	28.70	18.30
6		15.20	17.50	29.00	18.90
7		15.60	18.00	30.80	19.30
8		17.80	19.50	31.20	22.80
9		0.00	19.70	31.40	23.50
10			19.90	35.20	23.90
11			20.00	37.80	24.50
12			21.20	37.00	28.20
13			21.80	95.00	29.00
14			22.30	40.90	29.30
15			24.50	40.75	30.50
16			25.60	43.10	31.00
17			0.00	43.50	31.00
18				43.50	32.30
19				45.10	33.25
20				47.60	33.00
21				48.50	35.50
22				48.50	37.00
23				49.00	38.20
24				0.00	38.70
25					38.60
26					39.00
27					0.00

Phenol compounds not only interfere with the proces of germination and decrease percentage of germination but greatly disruct relation between the lenghts of radicle and hypocotil. Hamwly, the length of radicle almost proportionally shartens with the increase in concentration of phenol in waterand hypocotil in the same way lenghtensThis corelation is shown in table 2 and table 3.

Radicle of the *Sinapis alba* species at the concentration of 1ml of phenol per 1l of water is shaitened by half (25mm to 57mm in control sample). At the concentration of 3 and 4ml of phenol per 1l of water the length of radicle is

almost minimal 9mm and 3.5 mm. At the same time hypocotil of this species lengthens proportionally to the increase of phenol concentration, so that of the concentration of 3ml of phenol per 1l of water, it reaches maximal length of 31.4mm.

Radicle of the *Capsicum annum* species slowly and gradually decreases its length up to concentration of 4ml of phenol per 1l of water and then rapidly shortens to the minimal length of 6.2 mm to 2.6 mm as the concentration of phenol increases from 5 to 8 mm of phenol per 1l of water. As hypocotilis concerned, it lengthens more or less regularly from 3.1 mm in the control sample up to 13.8 mm at the concentration of 8ml of phenol per 1l of water.

Decrease in the of *Brassica oleracea* species radicle occurs in two phases. In the first phase it shortens gradually from 43.2 mm in the control sample to 19.43 mm at the concentration of 4ml of phenol per 1l of water. At the concentration of 5ml of phenol per 1l of water decrease in length is drastic. Length of the radicle is 9.6 mm down to the radical length of only 4 mm at the concentration of 16ml of phenol per 1l of water. As far as hypocotil is concerned, it slowly and gradually lengthens as the concentration of phenol rises from 11.5 mm in the control sample to 25.6 mm at the concentration of 16 ml of phenol per 1l of water. Almost insignificant decrease in radicle length of *Zea mays* species up to the concentration of 5ml of phenol per 1l of water (30.5 mm in the control sample and 26.3 mm in phenol) is another evidence that this is a tolerant to phenol. Further increase in concentration of phenol almost proportionally results in decrease of radicle length down to 1mm when concentration of phenol is 23 ml of phenol per 1l of water. *Zea mays* species hypocotil gradually changes its length from 22.5mm in the control sample to 45mm at the concentration of 23 ml of phenol per 1l of water.

Judging by symbolic decrease in radicle length of 4 mm at the concentration of 4 ml of phenol per 1l of water, *Pisum sativum* is highly tolerant species to phenol with the increase in concentration of phenol radicle abruptly shortens down to the minimal length of 2.5 mm. *Pisum sativum* hypocotil regularly and almost proportionally lengthens with the increase in concentration of phenol from 13.4 mm in the control sample to 39 mm at the concentration of 26ml of phenol per 1l of water.

Conclusion

Based on the performed research founded on our immediate experimental evidence as well as on already known characteristics of phenol from literary sources the following has been undoubtedly proved:

Phenol is very harmful chemical compound for all of the tested plant species *Sinapis alba*, *Capsicum annum*, *Brassica oleracea*, *Zea may* and *Pisum sativum*;

Sinapis alba is the most sensitive species to presence of phenol in polluted water. Acceptable concentration of phenol is under 1 ml of phenol per 1l of water and lethal concentration is 5 ml of phenol per 1l of water;

Capsicum annum is very sensitive species to phenol, limit of harmfulness is under 1ml of phenol per 1l of water, while lethal concentration is 9ml of phenol per 1l of water;

Brassica oleracea is sensitiv species to the toxic characteristics of phenol. Phenol izs harmful at the concentration of 1 ml of phenol per 1l of water while lethal concentration is up to 17 ml of phenol per 1l of water;

Zea may is tolerant species. Harmful effect of phenol is noted at the concentration of 4 ml of phenol per 1l of water and lether dosa is 24 ml of phenol per 1l of water;

Pisum sativum is very tolerant species. No harmful effect was noted compared to the control sample up to the concentration of 8ml of phenol per 1l of water.. Lthal concentration is very high 27 ml of phenol per 1l of water.

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TEST TOKSIČNOSTI RAZLIČITIH KONCENTRACIJA FENOLA NA KLIJAVOST SEMENA NEKIH GAJENIH BILJAKA

-originalni naučni rad-

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Rezime

U ovom radu ispitivan je stepen osetljivosti semena na različite koncentracije fenola kod povrtarskih i ratarskih biljaka *Sinapis alba*, *Capsicum annum*, *Brassica oleracea*, *Zea may* i *Pisum sativum*. koje se najčešće i navodnjavaju tokom vegetacione periode vodom iz prirodnih tokova u kojima ima, to je sasvim izvesno i fenola. Dobijeni rezultati pokazuju da ja vrsta *Sinapis alba* najosetljivija na prisustvo fenola u zagađenim vodama, dok je *Capsicum annum* vrlo osetljiva vrsta, *Brassica oleracea* je osetljiva vrsta dok je *Zea mays* tolerantna a *Pisum sativum* veoma tolerantna vrsta u odnosu na količinu fenola u vodi.