SHAPING AND DEVELOPMENT OF PLANTS IN CONDITIONS OF RADIOACTIVE CONTAMINATION OF SOIL WHEN USING THE POTASSIUM FERTILIZERS

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ABSTRACT

The studies on the influence of KCl on harvest of winter wheat, grown on radioactive contamination territory, were carried out. Specific activity of soil on ^{137}Cs has compose 1343 Bq/kg. KCl was applied in concentrations 90, 190, 390 kg per ha (accordingly - control, K_{100}, K_{300}). In is set that grain harvest in K_{100} variant was above than in the control, a ^{137}Cs concentration in experienced variants has reduced in contrast with the control level. However, growth of harvest was stipulate by increasing an amount of formed grain, rather then its weigh. It was noted inverse dependence between the weight of grain and dose KCl, contributed in soil, and positive relationship between the germination of wheat and concentration of ions K^+ in soil. These results indicative of the twofold action this salts on plants, on the one hand, as a saline factor of soil, on the other hand, as macroelement required for developments of plants. Experiments with plants grown from grains of these three variants showed, that dependence is track between the weight of grain and height, contents in acrospire of chlorophyll and protein. Additional gamma-irradiating of grains within the range of doses 5,0 - 10,0 Gy has reveal a change of radioresistance of seedlings.

INTRRODUCTION

Study of the behavior of Chernobul origin ^{137}Cs is of great importance for the Belarus Polesye. The method of the non-isotopic dilution (a contributing on the high dose of the potassium fertilizer) the most is often used for the reduces an arrival of the radionuclides in plants. The KCl contributing on the one hand reduces an accumulation of ^{137}Cs in plants but on the other hand – increases a productivity of the agricultural cultures. Using of the potassium fertilizers in high doses ensures an antagonism an K^+ with respect to ^{137}Cs, that reduces its accumulation in plants, on this poor potassium soils particularly. Simultaneously, potassium fertilizers reduce an accumulation of ^{90}Sr in plants. The contributing of the increased doses of KCl under perennial herbs is particularly effectively [1]. However high doses of potassium fertilizers in soil cause a saline stress beside plants, which can

influence on their development. Particularly this effect is intensify at arid years and in the second half vegetative period, when goes a shaping seeds.
The aim of the present research was a study of influence of KCl in high doses on plants, growing on the polluted with radionuclides territories .

MATERIALS AND METHODS

The studies was carried winter wheat (Triticum aestivum), which grew on the mineral soil of the "Sydkovo" collective farm, Hoyniki District, Gomel Region. Specific activity (SA) of soil has form 1343 Bq/kg, density of contamination - 282 kBq/m^2 (7,5 Ku/km^2). The exposure dose rate formed 26,8 mkR/h on soil level and 22,7 mkR/h on the height 1 m from the soil. Agricultural chemistry background of control plot has form $N_{60}P_{60}K_{90}$. The KCl-fertilizer doses – 100 and 300 kg K_2O per ha - were applied on experimental plots in the april in addition to available background (accordingly, variants - K_{100} and K_{300}). Plant selections were conducted in the july month on the stage of ripeness.
The ^{137}Cs concentration was determined by the gamma-spectrometer LP-4900B company "Afora" with the semiconductor Ge-Li detector (DGDK-80B).
Air-dry seeds of winter wheat were irradiated one-shot by ^{137}Cs gamma-rays on installation "Иryp" Institute of radiobiology NASB (power of irradiating 15,2 R/min. Plants were provided a 12-h photoperiod and temperature 22 $\pm$ 2 ^0C. Photosynsetical pigments concentration was determined using spectrophotometer [2]. Separation of protein was carried out at method [3]. Protein concentration defined on the Loyry method [3]. For the feature of level of radioactivity of plants and soils were used a value of specific activity (SA, Bk/kg), of coefficient of accumulation of ^{137} Cs in plants (CA, ratio: SA plant / SA soil) and of coefficient of transition (CT, ratio: SA plant / density of contamination of soil).

RESULTS AND DISCUSSION

Conducted studies have show that the additional contributing of the potassium fertilizers under sowing of winter wheat reduces a ^{137} Cs accumulation of the plants (non-isotopic dilution) and gives rise to its redistribution on organs of plants (table.1). It is set that the ^{137} Cs concentration increases in the spike and simultaneous reduces in grain and straw and. The effect of biological dilution (increasing a general phitomass by plants) presents by second factor of agency of fertilizers reducing SA of the plant. In our experiment this effect has not revealed that was connected with the drought of per annum of undertaking of the experience. KCl in high doses renders a twofold influence upon plants. On the one hand, it is an element, necessary plants. On the other hand, when plants are exposed to excess of salt they suffer both an ionic stress resulting from the high concentration of potentially toxic salt ions and an osmotic stress by limiting the absorption of water from the soil. The action of salinity results in reducing total productivity of plants, number of the *spicans* plants, weight of grain (table 1, 2). Particularly powerfully this effect is show in the variant K_{300}. If in the variant K_{100} gain of grain has

form 49 % (KCl – macroelement), in the variant K_{300} the yield grain had reduced on 5 % (KCl – salinity) with respect to control.

Table 1: The ^{137}Cs accumulation and distribution in plant of the wheat depending on dose of KCl-fertilizer contributed in soil.

Variant	Part of plant	SA plant	CA	CT *E-04	Distribution of ^{137}Cs, %	Weigh, g/m^2
Control	Grain	117,0	0,087	0,80	4,20	193,8
	Spike	212,0	0,16	1,56	8,14	207,5
	Straw	307,5	0,23	7,05	36,81	646,9
	Root	999,0	0,74	9,74	50,85	275,0
K_{100}	Grain	65,0	0,048	0,67	4,07	289,4
	Spike	350,0	0,26	1,68	10,21	135,0
	Straw	284,8	0,21	4,87	29,70	482,5
	Root	997,0	0,74	9,19	56,02	260,0
K_{300}	Grain	86,0	0,064	0,57	3,84	186,9
	Spike	415,0	0,31	1,82	9,50	123,8
	Straw	119,6	0,09	2,02	10,53	475,6
	Root	804,0	0,60	10,04	85,13	365,6

Table 2: Morphological characteristic of plants and grains of the winter wheat depending on dose of KCl-fertilizer contributed in soil.

Variant	*Ramificatio basalis* of plants	Number of the *spicans* plants	Weigh of grain, g/1000	Quantity of grain in spike	Germination of grains, %
Control	1,69	1,51	27,16	8	86,7
K_{100}	1,83	1,15	20,45	21	96,8
K_{300}	2,06	1,06	16,84	17	97,2

Besides necessary to note the positive effect of KCl-fertilizers on plants. *Ramificatio basalis* of plants, quantity of grain in the ear on experienced plots was above than on control (table 2). Increasing of the concentration of ions K^+ in soil promoted the shaping of more viable fetus, that was note on the germinating ability of grain. It has form for variants K_{100} and K_{300} - 111,7 and 112,2 %, accordinly, with respect to control.

Reduction of weight of grain in experienced variants is negative is say on the development of acrospire (table 3). Height and concentration of chlorophylls (***a***+***b***) beside 7-day acrospire had a direct dependency from the weight of grain, that is connected with insufficient shaping of endosperm of grain. Additional irradiating of grains had revealed the change of their radioresistance for variants K_{100} and K_{300}. If for plants of the control variant was observed maximum positive effect at the dose 5.0 Gy

(height, Chl (***a***+***b***) and carotinoids), that for plants of the variant K_{100} – 10.0 Gy. Irradiating of grains of the variant K_{300} has bring about arrest of developments of acrospires, which depended on increasing of dose. Necessary to note that concentration of the protein when γ-irradiating falls with plants of all variants with simultaneous change of its breakup. The share of the light-coherent proteins-ferments (albumin and globulin) decreases with increasing of the dose of irradiating. Reduction of share of glutenin is note in the plants of the variant K_{100}. Increasing of share this protein was revealed in the variant K_{300}. Changes of breakup of the protein in the plants either of three variants (control, K_{100}, K_{300}) are the case different with action of the γ-radiation. It is due to that, that metabolic processes in plants go fine friend from friend in each variant

Table 3: Physiology-biochemical parameters of 7-day acrospire of wheat, grown from irradiated and non-irradiated grains

Variant	Dose, Gy	Height of acrospire, cm	Chl (***a***+***b***), mg/g	Carotinoids, mg/g	Total protein, mg/g	Distribution of protein, %		
						albumin + globulin	gliadin	glutenin
Control	0.0	12,12 ± 0,041	1,310 ± 0,013	0,240 ± 0,017	97,42 ± 0,45	23.23	8.06	68.68
	5.0	12,43* ± 0,047	1,363 ± 0,012	0,292 ± 0,016	88,85* ± 0,27	23.17	5.67	71.16
	10.0	12,09 ± 0,048	1,310 ± 0,011	0,224 ± 0,024	86,72* ± 0,54	17.22	11.98	70.80
K_{100}	0.0	11,51 ± 0,044	1,202 ± 0,013	0,288 ± 0,013	99,79 ± 0,61	18.86	6.06	75.08
	5.0	11,61 ± 0,048	1,268 ± 0,014	0,364 ± 0,020	89,73* ± 0,46	18.01	9.15	72.84
	10.0	12,08* ± 0,051	1,338* ± 0,025	0,403* ± 0,018	80,32* ± 0,54	17.24	9.87	72.89
K_{300}	0.0	11,37 ± 0,048	1,190 ± 0,012	0,284 ± 0,018	80,28 ± 0,74	23.91	7.03	69.06
	5.0	11,04* ± 0,039	1,170 ± 0,014	0,264 ± 0,014	78,65* ± 0,41	18.21	10.15	71.64
	10.0	10,96* ± 0,032	1,024* ± 0,017	0,260 ± 0,013	71,60* ± 0,39	16.20	7.61	76.19

*- the differences are reliable relating to non-irradiating variants (P< 0.05)

**- the differences are reliable relating to non-irradiating variants (P< 0.01)

CONCLUSION

So the studies conducted that dose KCl-fertilizers (190 per ha) contributed under winter wheat is greatly high dose that it is possible concerning "clean" and normal formed grain. Increasing of the dose of this fertilizer brings about of effect of salinity of soil, that exerts negative action on development of plants.

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