BIOLOGICAL ACTIVITIY ASSESMENT OF FERTILISER *AGROVIT-KOR*

Alsina I., Dubova L. and Krulikovskis J.
Latvia University of Agriculture, Strazdu iela 1, Jelgava, Latvia

Abstract

Experiments are carried out to investigate biological activity of fertiliser *Agrovit-kor.* Plant biotests, pot and small-scale field experiments were conducted at the Department of Plant Biology and Protection, Latvia University of Agriculture. Maize and wheat coleoptiles were used for determination of preparation auxin activity. The effect of preparation on vegetable seed germination was tested. Vegetable growth as well as soil biological activity was studied in the pot culture. Tests with coleoptiles showed that *Agrovit-kor* hadn't auxin activity. Germination of seeds depended on preparation's concentration and seeds weight. Large seeds were less sensitive to preparation. 100 g L^{-1} and 5 g L^{-1} solutions of *Agrovit-kor* inhibited seed germination. Positive correlation is found between preparation's concentration and soil biological activity. The pot experiments with different vegetables showed that the recommended doses of preparation were lower than plants needs for their growth. The decrease of plant length, weight and number of leaves was observed in comparison with variants where mineral fertilisers were used. Small-scale field experiments did not prove the advantage of *Agrovit-kor* in comparison with mineral fertiliser.

Key words: *Agrovit-kor*, biotests, seed germination, vegetables, soil biological activity

Introduction

The use of organic fertilizers to improve soil is very old. Theophrastus (372–287 B.C.) pointed out the importance of legumes and grasses used as mulches. Other common organic fertilizers included dung of birds and bats (guano), fish fertilizer, dry blood, and dry meat. All these organic compounds help improve the soil by increasing water retention capacity, thus impeding nutrient loss by leaching, by decreasing erosion and surface drainage, and by helping control weeds and other pests (J. A. Caamal-Maldonado *et al.*, 2001).

Lot of different organic fertilisers are recommended for farmers today. Producers advertise their products stimulating plant growth, increasing yield, improving plant quality and resistance to environmental stresses and diseases.

The aim of the work was to test biological activity of the organic fertiliser *Agrovit-kor*.

Materials and Methods

Experiments were carried out in 2002 and 2003 at the Department of Plant Biology and Protection, Latvia University of Agriculture for investigation of effect of the preparation *Agrovit-kor,* AVK, on cultures. It is produced in Russia as an organic fertilizer prescribed for improvement of soil structure and increase of yields in organic farming. It is made from soil, poultry manure, and peat and contains: organic matter 68–74%, N – 1.35%, P – 1.45%, K – 1.07%, Ca – 0.64%, Mg – 0.96%, microelements Fe, Mn, Zn, Cu and bio active compounds according to the specifications (declaration) of the producer. Biotests, vegetation (pot) and small-scale field experiments were designed for determination of the effect of AVK.

Activity of auxins was determined with the growth of wheat and maize coleoptiles. Seeds of the grains were germinated in a thermostat, at 25 ºC. When the coleoptiles were approximately 2 cm long, the middle part, precisely 1.0 cm, was cut with 2 parallel blades fixed in a cork. The pieces of the coleoptiles were put in a 100 ml weighing glasses with 20 ml of 100, 50, 10, 5, 1, 0.5 or 0.1 g L^{-1} solution of AVK, and incubated for 24 hours in a thermostat at 25 ºC. Simultaneously, pieces of coleoptiles were incubated in water and in solutions of indolylacetic acid, IAA, 1, 0.1 and 0.01 mg L^{-1}. After the incubation the increase of the length of each piece of coleoptile was determined. Five coleoptile pieces were put in each weighing glass. Experiments were done in three replications (Гродзинский А. М. *et al.*, 1973).

A seed germination test was designed for investigation of the biological activity of AVK. Ten seeds of different vegetables were placed in Petri dishes with filter papers moistened with 10 ml of: 100, 50, 10, 5, 1, 0.5 or 0.1 g L^{-1} AVK, and placed in the thermostat. The control was germinated with water only. Vegetables, their varieties, temperature and time of incubation are presented in Table 1. After the incubation time, the length of the primary roots was determined. Experiments were done in 3 replications (Гродзинский А.М. *et al.,* 1973).

Vegetation experiments were placed in pots with neutralized peat in 4 replications. Three variants and 2 controls were chosen:

Control 1 (c1) – neutralised peat;
Variant 1 (v1) – 1 g of AVK per 1L of peat;

Variant 2 (v2) – 2 g of AVK per 1L of peat;
Variant 3 (v3) – 3 g of AVK per 1L of peat;
Control 2 (c2) – 1 g of KEMIRA 10:10:20 per 1L of peat.

Table 1. Vegetables, varieties, temperatures and time of incubation for germination of seeds

Vegetable	Variety	Temperature of incubation, ºC	Time of incubation, days
Cucumber	'Grīva'	25	8
Cabbage	'Amager red'	20	10
Carrots	'Amsterdam'	20	14
Radish	'Žara'	20	10
Lettuce	Novogodnij'	20	7
Maize		25	7

The volume of pots varied depending on culture and number of plants. 10 radishes were grown in 6 L pots, 4 lettuces in 400 mL pots, and single cabbage and cucumbers in 400 mL pots, all placed in a greenhouse. The weight, the length, the number of leaves, and dry matter content were determined after one month of vegetation. The pH and the biological activity of the soil were determined at the harvest time. The activity of catalase in the soil was used as a measure of the biological activity in the soil. The activity was determined as follows: 10 g of soil and 30 mL distilled water were put in a Bunsen flask and mixed. A small beaker with 1.0 ml of 3% hydrogen peroxide was then carefully put in the flask and the flask was closed with a stopper. The side tubing was connected with rubber tubing to a gas burette. After three minutes the temperature and pressure were equalised and the hydrogen peroxide was poured out and mixed with the soil slurry. Readings of the volume of evolved oxygen were taken after 1, 3 and 5 minutes (Klāsens *et al.*, 1987).

Field experiments were conducted on a loamy sand soil with the following parameters: pH_{KCl}-7.4, P – 270 mg L^{-1}, K – 273 mg L^{-1}, Ca – 19625 mg L^{-1}, Mg – 3075 mg L^{-1}, Fe – 1455 mg L^{-1} in four replications. The vegetation experiments showed that the recommended doses of AVK were too small, therefore doses for field experiments were calculated using the recommendations given by V. Nollendorfs (V. Nollendorfs, 1998) and the nitrogen content in AVK. Three different fertiliser programmes were used:

1) Mineral fertilising with KEMIRA 10:10:20 with microelements, 50 g m^{-2} and twice dressed with 25 g of fertiliser, i.e. 50+25+25 g m^{-2}.
2) Fertilising with *Agrovit-kor*, AVK – 370+185+185 g m^{-2}.
3) Mixed fertilising – half mineral, half AVK.

The experiments were carried out with the cucumber variety *Pioneer* and cabbage *Amager Red*. Four cabbage or three cucumber plants were grown per square meter.

Results and Discussion

The experiments with the wheat and the maize coleoptiles showed different sensitivity of the cultures to AVK. The highest concentration of AVK (100 g L^{-1}) inhibited the growth in length of the pieces of wheat coleoptiles. Lower concentrations did not significantly affect the length. There was no significant effect of AVK on the maize coleoptiles. All used concentrations of IAA showed stimulating effect (Fig. 1).

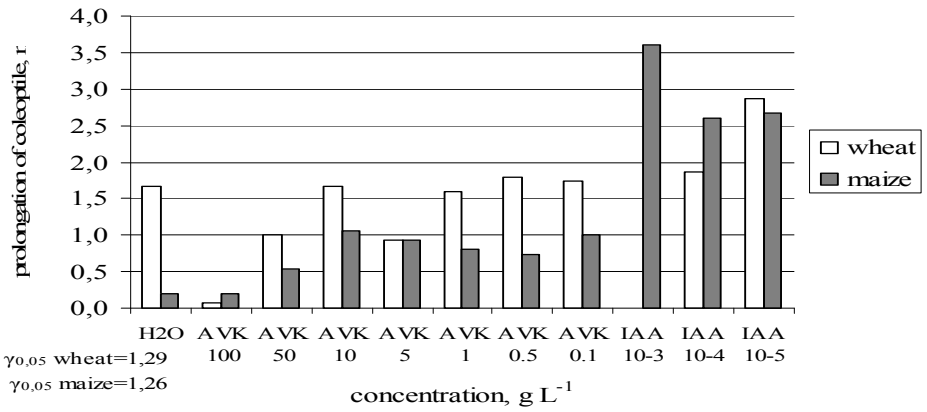

Figure 1. Effect of AVK on coleoptiles growth given as increase in length in mm

The germination experiments showed that seeds of different cultures had different germination ability and sensitivity to AVK, as shown in Table 2. Cabbage and lettuce seeds had the lowest germination. Radish, maize and cucumbers germinated well. The effect of AVK on the seeds was related to the seed weight. There wasn't observed effect on large seeds as on those of maize.

Table 2. The effect of AVK on vegetable seed germination as % of germinated seeds

Culture	Concentration of preparation, g L^{-1}							
	H_2O	100	50	10	5	1	0.5	0.1
Cucumber	87.5	62.5*	75.0	75.0	87.5	87.5	100.0#	75.0
Radish	100.0	30.0*	95.0	100.0	100.0	95.0	100.0	95.0
Lettuce	10.0	0.0	0.0	30.0#	40.0#	50.0#	45.0#	40.0#
Maize	90.0	95.0	85.0	95.0	90.0	100.0	100.0	95.0
Cabbage	10.0	0.0	5.0	20.0	35.0#	15.0	40.0#	45.0#
Carrot	60.0	0.0*	10.0*	55.0	65.0	50.0	65.0	65.0

γ0.05 between concentrations 10.4;
γ0.05 between varieties 14.7;
*Result is significantly lower than control (H_2O);
#Result is significantly higher than control (H_2O);
Concentration 100 g L^{-1} was too high for germination of cucumber and radish seeds.

Lettuce, carrot and cabbage seeds were significantly inhibited by concentrations higher than 50 g L^{-1}. Lower concentrations stimulated the germination. The largest effect was observed on seeds of low germination ability (cabbage and lettuce). The experiments showed that for seed treatment, concentrations of AVK of more than 10 g L^{-1} were not acceptable. The stimulating effect was found in the concentration range 0.1–10 g L^{-1}.

At concentrations 100 and 50 g L^{-1} of AVK a decrease of the length of the primary roots was observed, but at 1–10 g L^{-1} a significant increase was observed (Table 3).

Table 3. The effect of preparation *Agrovit-kor* on the length of primary root, cm

Culture	Concentration of AVK, g L^{-1}							
	H_2O	100	50	10	5	1	0.5	0.1
Radish	1.2	0.2*	0.7	2.3#	2.4#	1.5	0.9	1.3
Maize	3.0	0.6*	7.0#	7.0#	6.9#	4.0#	2.7	3.3
Cucumber	4.9	0.2*	1.4*	4.6#	5.5#	4.7#	3.7#	4.1#
Lettuce	0.6	0.0	0.0	1.7#	1.7#	1.4#	1.3#	0.8
Carrot	2.1	0.0*	1.2*	2.3	2.6	3.2#	1.6	2.4
Cabbage	4.6	0.0	0.0	6.2#	4.0	6.5#	3.8*	3.6*
Mean	2.7	0.5*	2.1*	3.7#	3.9#	3.5#	2.6	2.5

$\gamma_{0.05}$ between concentrations 0.6;
$\gamma_{0.05}$ between varieties 0.6;
* Result is significantly lower than control (H_2O);
#Result is significantly higher than control (H_2O).

Table 4. The effect of preparation AVK on the parameters of radish

Variants	Weight of leaves, g	Weight of radish, g	Length of leaves, cm	Dry matter content in leaves, %	Dry matter content in radish, %
Control 1	0.5	1.0	5.5	8.45	11.70
Variant 1	1.4	4.5	9.8	8.04	10.72
Variant 2	1.3	4.6	9.8	10.73	10.68
Variant 3	2.7	7,6	12.9	6.65	8.78
Control 2	7.7	17.9	19.3	5.00	5.71
$\gamma_{0,05}$	2.4	5.6	3.4	1.95	3.28

Pot experiments showed that AVK significantly influenced the growth of radish (Fig. 2). The recommended doses were too small in relation to the requirement of the plants. Therefore the best results were obtained with mineral fertilisers (control 2). As it is shown in Table 4 the roots of the fertilized variant were 2.4 times, but leaves 2.9 times heavier than in the best variant of AVK. The average length of leaves increased with the dose of fertiliser. The dry matter content in radishes significantly decreased with the dose of fertiliser (coefficient of correlation is –0.98). It shows that the recommended doses could not meet the plant requirements for nutrients.

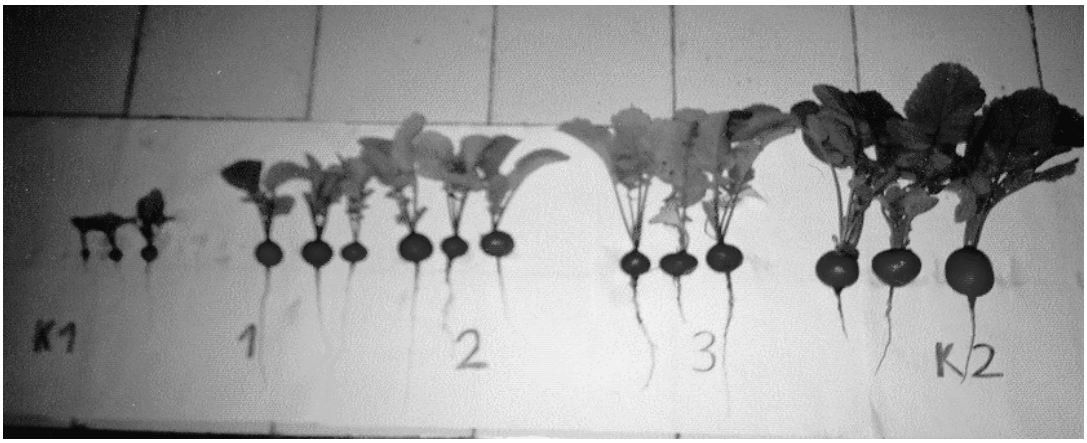

Figure 2. Effect of AVK on the growth of the radish in pot experiments
K1 – control 1, 1, 2 and 3 – variants 1, 2 and 3 respectively, and K2 – control 2

Similar results were obtained with cabbage and cucumber seedlings as shown in Table 5. Plants with mineral fertilizers were approximately 2 times larger; they had more leaves, the weight of a leaf increased according to the used dose of fertiliser. The plants fed with mineral fertilizer had less dry matter in comparison with those fed with AVK.

Table 5. The effect of AVK on the cabbage and cucumbers

Variants	Cabbage				Cucumbers			
	length of leaves, cm	number of leaves	dry matter content, %	weight of a leaf, g	length of leaves, cm	number of leaves	dry matter content, %	weight of a leaf, g
Control 1	9.7	2,2	16.1	0.097	8.1	3.8	16.2	0.21
Variant 1	11.2	2.0	18.2	0.126	8.0	4.0	18.2	0.23
Variant 2	10.7	2.3	18.5	0.125	8.5	4.0	18.5	0.24
Variant 3	13.5	3.8	18.5	0.210	10.2	4.0	18.5	0.30
Control 2	15.1	4.5	9.1	0.303	17.5	5.6	6.1	0.51
$\gamma_{0.05}$	4.4	1.0	3.4	0.035	3.5	0.2	3.4	0.15

As presented by Table 5, AVK at recommended doses could not meet the plant requirements for nutrients at early stages of growth.
At the end of experiments the soil acidity and biological activity was measured. Non-significant effect of the used fertilizer on the soil pH was observed.

Table 6. The effect of AVK on the soil parameters

	pH_{KCl}			Soil activity, cm^{-3} O_2 min^{-1} (100g dry soil)$^{-1}$		
	radish	cabbage	cucumbers	radish	cabbage	cucumbers
Control 1	6.5	6.5	6.6	35.5	29.5	39.3
Variant 1	6.6	6.2	6.4	27.5	35.6	31.0
Variant 2	6.5	6.2	6.4	45.3	33.8	30.8
Variant 3	6.5	6.2	6.5	33.3	39.1	32.7
Control 2	6.6	6.4	6.6	24.0	36.2	48.8
	$\gamma_{0.05}$= 0.3			$\gamma_{0.05}$= 9.8		

Soil biological activity was significantly influenced by the grown culture, type and the dose of fertilizer used. The highest activity was observed in cucumber soil fertilized with Kemira 48.8 cm^3 O_2 100g of air-dry soil, but the lowest (24.0 cm^3 O_2 per 100g of soil) was observed in the same variant, but on soil sown to radish. The lowest average soil activity was observed in the 1st variant using 1g of *Agrovit-kor* per 1L of soil.

Field experiments showed that cabbage fertilised with AVK were 5% taller, but the diameter of the canopy decreased by 9.6%, the average number of leaves by 4.7%, and the weight of cabbage-heads by 10.1%. The visual differences were observed as well. The cabbage grown with AVK had steeper foliage. Results of mathematical data processing do not show significant differences between fertilisers.

Table 7. The effect of AVK on the parameters of cabbage in field experiments

Variants	Weight of cabbage heads, kg	Plant height, cm	Diameter of canopy, cm	Number of leaves per plant
Agrovit-kor	3.21	29.2	82.6	14.3
Mineral fertiliser	3.57	27.8	91.4	15.0
$\gamma_{0,05}$	1.07	3.3	8.9	0.9

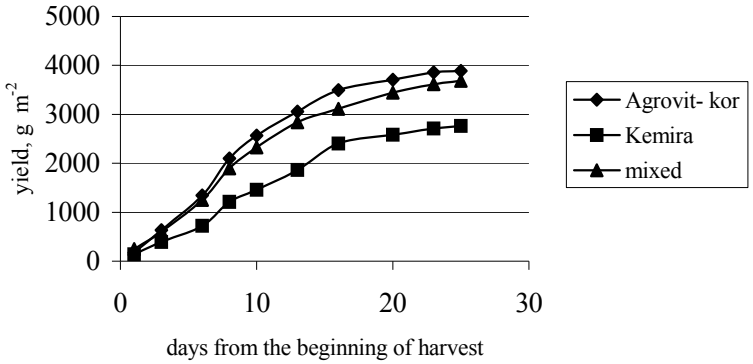

Figure 3. The effect of fertiliser on the cucumber yield formation

The activity of AVK was tested also on cucumbers (Fig. 3). The best results were obtained with AVK on average 3.89 kg per square meter, with mixed fertilisers 3.69 kg, with mineral fertilizer – 2.76 kg, i.e., the cucumber yield with organic fertiliser was 1.5 times higher, but great differences between replications were observed as well, therefore statistically significant differences were not observed.

Conclusions

Preparation *Agrovit-kor* did not show auxin activity.

The effect of preparation on the germination of vegetable seeds depended on culture and concentration of *Agrovit-kor*. The stimulating effect could be expected if the doses of preparation were 0.1–10 g L^{-1}.

The recommended doses (1–3 g per L of peat) for the growth of vegetables and their seedlings were too low.

The advantage of mineral fertiliser or *Agrovit-kor* was not verified in field trials with cabbage and cucumbers.

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