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Section 1. Biology

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ANTIBIOTIC RESISTANCE AND XENOBIOTIC BIODEGRADATION CORRELATION IN NATIVE SOIL *PSEUDOMONAS CHLORORAPHIS* GROUP

Abstract. *Pseudomonas chlororaphis* are widely represented in nature, as common habitant of wet surfaces. These non-pathogenic Gram-negative microbes are able to synthesize the range of compounds with antimicrobial, plant growth stimulative and other positive effects. Some representatives are able to biodegradation of xenobiotics. Thus, *P. chlororaphis* are being considered as positive for agriculture. Besides, they are often resistant to antibiotics and able to stable replication of exogenous antibiotic plasmids. The main aim of current research was to study the correlation between the properties of degradation of various natural and synthetic substances and the ability to stable replicate plasmids of antibiotic resistance, as well as the transmission of it to other bacteria. As a result of experiments, it was found out, that for 3 subspecies and 2 species of this group the resistance is related with the degradation genes plasmid localization in case of lipases, and polyphenol oxidases (PPO), which are being encoded by genes of nucleoid. The tartaric acid derivatives degradation is related to PPO presence in *P. chlororaphis* representatives.

Keywords: Polyphenol oxidases, lipases, plasmids, PCR, antibiotic resistance, tartaric acid derivatives, *Pseudomonas chlororaphis*.

Introduction

Pseudomonas chlororaphis is a group of bacteria from *Pseudomonas*, which are common for practically every place world around. The wide diversity of metabolic pathways led to adaptation high level, antimicrobial resistance and biodegradation high potential [1; 2]. The other property which is very common *Pseudomonas* is an ability to transfer genetical properties by mobile genetic elements, such as like plasmids to other Gram-negative bacteria. Thus, *Pseudomonas* different species are very

important component in chains of intraspecific gene horizontal transfer. These bacteria are mostly presented by opportunistic pathogens of human and animals. Moreover, this genus includes phytopathogen representatives, such as like *P. syringae* [3; 4; 5; 6]. *P. chlororaphis*, are mostly non-pathogenic soil bacteria with the range of positive agricultural characteristics. They include some species, with the abilities of various bioactive molecule synthesis, such as like intracellular and extracellular enzymes of adaptation, plant growth regulators, antimicrobial

phenazine-like substances, etc. *P. chlororaphis* sometimes are being used as biocontrol agents for some phytopathogenic fungi, and other agricultural pests and some species of fishes. Moreover, *P. chlororaphis* are good models for antimicrobial resistance spread research of toxigenic *Pseudomonas*, due to metabolic similarities of them [7; 8; 9].

According to WHO recent reports, the problem of antimicrobial resistance spread is very actual and it is being considered as the one of the most prospective directions of research for upcoming century [10; 11; 12]. In current paper there are being discussed the range of extracellular enzymes of *P. chlororaphis* 2 species and 3 subspecies (polyphenol oxidases (PPO), lipases, caseinase, etc.), there were being researched the antibiotic resistance, the genes of it as well as the potential of spread of resistance in aspect of correlation with biodegradative properties of multi-drug resistant strains.

Materials and methods

For current research, non-pathogenic and opportunistic pathogenic strains of *Pseudomonas* and *E. coli* from NCCM, MDC, "Armbiotechnology" SPC NAS RA were used. For the cultivation of bacteria, the various selective cultural media with containing 13 antibiotics of different classes and generations, according to standard protocols [13]. There selective cultural media with 50 mg/ml of antibiotic

(β -lactamic (Pen/Penicillin, Amp/ampicillin, Amx/Amoxicillin, Amc/Augmentin, Cfx/Cefixime, Cro/Ceftriaxone), aminoglycoside (Gen/Gentamicin, Kan/kanamycin, Str/Streptomycin, Gnc/Gentamycin) fluoroquinolone (Cip/Ciprofloxacin), Tcn/Tetracycline, macrolide (Azm/azithromycin), amphenicol (Chl/Chloramphenicol). All the used antibiotics were produced by "Astoria") were used. For the resistance and biodegradation potential registration there were used the standard protocols [14]. As chemically differing natural and synthetic compounds examples there were used the following substances: L-Tyrosine (L-Tyr), tannin, casein of cow milk, polysorbates with different length of fatty acids (Polysorbate-20, Polysorbate-40, Polysorbate-60, Polysorbate-65, Polysorbate-80, Polysorbate-85), α -naphthol, as well as synthetic derivatives of tartaric acid: benzyl-, cyclohexyl-, phenyl- imides and their complex salts, with higher hydrophilic properties [15]. The genetical (DNA isolation, purification, PCR, transformation) and the statistical analysis were done due to standard methods [16; 17].

Results

The majority of the studied strains are resistant, and plasmid containing. 3 subspecies small percentage are non-plasmid, resistant strains and 4 researched resistance genes are detected only in nucleoid of *P. chlororaphis* (tables 1–4).

Table 1.– The resistance of *P. chlororaphis*, *subsp. chlororaphis*, to 13 different antibiotics

Strain	Kan	Stp	Gen	Cam	Amc	Amx	Amp	Pcn	Cfx	Ctx	Tcn	Azm	Cip	C
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9329	–	–	–	–	–	–	–	–	–	–	–	–	+	+
9159	–	–	–	–	–	–	+	+	–	–	–	–	–	+
9190	–	–	–	–	+	+	+	+	+	+	–	–	–	+
9157	–	–	–	–	–	–	–	–	–	–	–	–	–	+
9158	–	–	–	+	–	+	–	–	+	–	–	–	–	+
9167	–	–	–	–	–	–	+	+	–	+	+	–	+	+
9165	–	–	–	+	+	+	+	–	+	–	–	–	–	+
9164	–	–	–	–	–	+	+	–	–	–	–	–	–	+
9163	–	–	–	–	–	–	+	–	–	–	–	–	–	+
9330	–	–	–	–	+	+	+	–	–	–	–	–	–	+
9171	–	–	–	–	+	–	+	+	+	+	–	–	–	+

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9172	-	-	+	-	+	+	+	+	+	+	-	-	-	+
9174	-	-	-	-	+	-	+	+	-	-	-	-	-	+
9175	-	-	-	-	+	+	+	+	+	-	+	-	-	+
9177	-	-	-	+	-	+	+	+	-	-	-	-	-	+
9178	-	-	-	-	+	+	+	+	-	-	-	-	-	+
9156	-	-	-	+	-	-	+	+	-	+	-	-	-	+
9189	-	-	-	-	+	-	+	+	-	-	-	-	+	+
9168	-	-	-	+	+	+	+	+	+	-	+	-	-	+

50 mkg/ml, S – Subspecies (A – subsp. chlororaphis, B – subsp. aureofaciens, C – subsp. aurantiaca, 1 – Pcn, 2 – Amp, 3 – Amx, 4 – Amc, 5 – Cfx, 6 – Ctx, 7 – Stp, 8 – Gnc, 9 – Kan, 10 – Cam, 11 – Tcn, 12 – Azm, 13 – Cip, C – control on nutrient agar media, “+” – growth indication, “-” – the absence of growth)

Table 2. – The genetical research of *P. chlororaphis* subsp. *chlororaphis* soil strains

Strain	Pl	PCR analysis				+/-	Strain	Pl	PCR analysis				T+/-
		1	2	3	4				1	2	3	4	
9163	+	-	-	-	-	+	9329	+	-	-	-	-	-
9330	-	-	-	-	-	-	9159	+	-	-	-	-	+
9171	+	-	C+	-	-	+	9190	+	-	-	-	-	+
9172	+	-	C+	-	-	+	9157	-	-	-	-	-	-
9174	-	-	-	-	-	-	9158	+	-	-	-	-	-
9175	-	-	-	-	-	-	9167	-	-	-	-	-	-
9177	-	-	-	-	-	-	9165	-	-	-	-	-	-
9178	+	-	-	-	-	-	9164	+	-	-	-	-	-
9156	+	-	-	-	-	-	9168	+	-	-	-	-	-
9189	+	-	-	-	-	-							

“Pl” – plasmid, “+” – plasmid/gene/transformation presence, “c+” – gene localization on bacterial chromosome, “p+” – gene plasmid localization, “T+/-” – transformation; genes: 1 – aph(3')IV, 2 – aac(6')II, 3 – catB7, 4 – blaOXA-10

Table 3. – *P. chlororaphis* genetical analysis

Strain A	Pl	PCR analysis				T+/-	Strain A	Pl	PCR analysis				T+/-
		1	2	3	4				1	2	3	4	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
9195	-	c+	-	-	-	-	9060	+	-	-	-	-	-
9196	+	-	-	-	-	-	9192	+	-	-	-	-	-
9199	-	c+	-	-	-	-	9197	-	-	-	-	c+	-
9200	+	-	-	-	-	+	9026	-	-	-	-	-	-
Strain B						Strain C							
9064	Pl	PCR analysis				T+/-	9246	+	-	-	C+	-	-
		1	2	3	4		9243	+	-	-	-	-	-
	+	-	-	-	-	+	9244	+	-	-	-	-	-
9061	+	-	-	-	-	-	9242	+	-	-	-	C+	-

1	2	3	4	5	6	7	8	9	10	11	12	13	14
9062	+	-	-	-	-	-	9240	+	-	-	-	-	-
9065	-	-	-	-	-	-	9241	+	-	-	-	-	-
9066	+	-	-	-	-	-	9248	+	-	-	C+	C+	-

“Pl” – plasmid, “+” – plasmid/gene /transformation presence, “c+” – gene localization on bacterial chromosome, “p+” – gene plasmid localization, “T+/-” – transformation; genes: 1 – *aph(3')IV*, 2 – *aac(6')II*, 3 – *catB7*, 4 – *blaOXA-10*, “Strain A” – *P. chlororaphis*, subsp. *aureofaciens*, “Strain B” – *P. chlororaphis*, subsp. *aurantiaca*, “Strain C” – *P. taetrolens*

Table 4. – *P. chlororaphis* antibiotic resistance test

Strain A	Kan	Stp	Gen	Cam	Amc	Amx	Amp	Pcn	Cfx	Ctx	Tcn	Azm	Cip	C
9195	-	-	-	+	-	-	+	+	-	-	-	-	-	+
9196	-	-	-	-	-	-	+	+	-	-	-	-	-	+
9199	-	-	-	-	+	-	+	+	-	-	-	-	-	+
9200	+	-	-	-	-	-	-	-	-	+	-	-	-	+
9060	-	+	-	+	+	+	+	-	+	-	+	-	+	+
9192	-	-	-	-	-	-	-	-	-	-	-	-	-	+
9197	-	-	-	-	-	-	-	-	-	-	-	-	-	+
9026	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Strain B	Kan	Stp	Gen	Cam	Amc	Amx	Amp	Pcn	Cfx	Ctx	Tcn	Azm	Cip	C
9246	+	+	-	+	+	+	+	-	+	-	-	-	-	+
9243	-	-	-	-	-	-	-	-	+	-	-	-	-	+
9244	-	-	-	+	+	+	+	-	+	-	-	-	-	+
9242	-	-	-	-	-	-	-	-	+	+	+	-	-	+
9240	-	-	-	+	+	+	+	-	+	+	+	+	+	+
9241	-	-	-	-	+	+	-	-	+	+	-	+	+	+
9248	-	-	-	+	-	-	-	-	-	+	-	+	+	+
Strain C	Kan	Stp	Gen	Cam	Amc	Amx	Amp	Pcn	Cfx	Ctx	Tcn	Azm	Cip	C
9066	-	+	-	+	+	+	+	+	+	+	-	+	+	+
9065	-	+	-	+	+	+	+	+	+	+	-	-	-	+
9064	-	+	-	+	-	+	+	+	+	+	+	+	+	+
9061	-	-	-	+	+	+	+	+	+	+	+	-	-	+
9062	-	-	-	-	-	-	-	-	-	-	-	-	-	+

50mg/ml, S – Subspecies A – subsp. *chlororaphis*, B – subsp. *aureofaciens*, C – subsp. *aurantiaca*, 1 – Pcn, 2 – Amp, 3 – Amx, 4 – Amc, 5 – Cfx, 6 – Ctx, 7 – Stp, 8 – Gnc, 9 – Kan, 10 – Cam, 11 – Tcn, 12 – Azm, 13 – Cip, C – control on nutrient agar media, “+” – growth indication, “-” – the absence of growth, Strain A – *P. chlororaphis* subsp. *aureofaciens*, B – *P. taetrolens*, C – *P. chlororaphis* subsp. *aurantiaca*

All *P. taetrolens* are plasmid-containing, but they are not related with the resistance to these 13 antibiotics (tables 5–7). Nucleoid localized *blaOXA-10* and *catB7* are detected in 4 strains. Then all

the strains of *P. chlororaphis* group were tested in experiments with different substrates degradation for the detection of PPO, lipases, caseinase activity (tables 8, 9).

Table 5. – Caseinase activity precipitation in 3 subspecies of *P. chlororaphis* on solid cultural media during the cultivation within 5 days

Strain of <i>subsp. chlororaphis</i>	Day 1		Day 5		C ⁺	C ⁻	Strain of <i>subsp. chlororaphis</i>	Day 1		Day 5		C ⁺	C ⁻
	G	A	G	A				G	A	G	A		
9178	-	-	2+	-	15+	-	9189	-	-	3+	-	15+	-
9329	-	-	2+	-	15+	-	9174	-	-	2+	-	15+	-
9157	-	-	-	-	15+	-	Strains of <i>subsp. aurantiaca</i>	Day 1		Day 2		C ⁺	C ⁻
9158	-	-	-	-	15+	-		G	A	G	A		
9164	-	-	-	-	15+	-	9061	-	-	-	-	15+	-
9165	-	-	-	-	15+	-	9062	2+	3+	3+	10+	15+	-
9168	-	-	-	-	15+	-	9064	2+	3+	3+	8+	15+	-
9171	2+	10+	3+	12+	15+	-	9066	-	-	2+	-	15+	-
9159	-	-	-	-	15+	-	Strains of <i>subsp. aureofaciens</i>	Day 1		Day 2		C ⁺	C ⁻
9172	2+	2+	3+	10+	15+	-		G	A	G	A		
9177	-	-	-	-	15+	-							
9330	-	-	2+	3+	15+	-	9197	-	-	3+	-	15+	-
9156	-	-	-	-	15+	-	9199	-	-	3+	-	15+	-
9163	-	-	-	-	15+	-	9195	3+	10+	3+	15+	15+	-

G – growth, A – activity precipitation, “+” – growth intensity detection correspondently form single colonies (+) up to cultural growth zone 1–5mm, “-” – the absence of growth or precipitation zone 1–5mm correspondently, C⁻ negative control on mineral cultural media, C⁺ – the positive control on nutrient agar media)

The proteolytic activity is not directly related to antibiotic degradation activities enzymes, but the presence of it is often related with the infection processes of pathogen representatives of *Pseudomonas*, as well as this type of enzymes presence is one of the main metabolic characteristics of non-pathogenic and opportunistic pathogenic *Pseudomonas* [18; 19]. Thus, the

caseinase activity precipitation could be related with the resistance stability of *P. chlororaphis*. According to results, which are presented on (table 8), not all the researched strains of *P. chlororaphis* are caseinase-positive. The growth level of caseinase containing strains is three times lower, than in control samples, which were cultivated on nutrient agarised cultural media.

 Table 6. – Polyphenol oxidase activity precipitation in different soil representatives of *P. chlororaphis* group

Strain of <i>P. chlororaphis</i>	I		II		III		C ⁻	C ⁺
	G	A	G	A	G	A		
I	2	3	4	5	6	7	8	9
<i>subsp. chlororaphis</i> 9330	-	-	3+	4+	+	-	-	5+
<i>subsp. chlororaphis</i> 9168	-	-	3+	-	-	-	-	5+
<i>subsp. chlororaphis</i> 9329	-	-	3+	4+	3+	-	-	5+
<i>subsp. chlororaphis</i> 9168	-	-	3+	-	2+	-	-	5+
<i>subsp. aurantiaca</i> 9062	+	-	3+	-	2+	-	-	5+
<i>subsp. aurantiaca</i> 9061	-	-	3+	3+	-	-	-	5+
<i>subsp. aureofaciens</i> 9200	-	-	3+	2+	2+	-	-	5+

1	2	3	4	5	6	7	8	9
<i>P. taetrolens</i> 9246	2+	2+	3+	5+	+	-	-	5+
<i>P. taetrolens</i> 9243	2+	-	2+	-	+	+	-	5+
<i>P. taetrolens</i> 9241	+	-	3+	5+	+	-	-	5+
<i>P. taetrolens</i> 9242	-	-	3+	5+	-	-	-	5+

G – growth, A – activity precipitation, I – L-tyrosine, II – tannin, III – α -naphthol, “+” – growth intensity detection correspondently form single colonies (+) up to cultural growth zone 1–5mm, “-” – the absence of growth or precipitation zone 1–5mm correspondently, C⁻ – negative control on mineral cultural media, C⁺ – the positive control on nutrient agar media

Table 7. – Biodegradation of different polysorbates

Strain of <i>P. chlororaphis</i> group representatives		Polysorbates												C ⁺	C ⁻
		20		40		60		65		80		85			
		G	A	G	A	G	A	G	A	G	A	G	A		
<i>P. taetrolens</i>	9240	3+	-	+	-	3+	-	+	-	3+	-	3+	+	5+	-
	9241	3+	2+	-	-	2+	-	+	-	-	-	3+	+	5+	-
	9242	3+	+	3+	2+	+	2+	+	+	-	-	2+	+	5+	-
	9243	3+	-	3+	-	3+	-	+	-	3+	-	3+	+	5+	-
	9246	3+	-	3+	-	3+	-	2+	-	3+	-	3+	+	5+	-
	9248	3+	-	+	-	+	-	+	-	3+	-	+	+	5+	-
<i>P. chlororaphis</i> , subsp. <i>au-reofaciens</i>	9200	3+	5+	3+	5+	3+	-	+	-	3+	-	3+	+	5+	-
	9197	3+	-	-	-	3+	-	+	-	3+	-	3+	+	5+	-
<i>P. chlororaphis</i> , subsp. <i>aurantiaca</i>	9062	3+	+	3+	3+	3+	-	+	-	3+	-	3+	+	5+	-
	9061	3+	5+	3+	5+	3+	-	+	-	3+	-	3+	+	5+	-
	9064	3+	-	-	-	3+	-	2+	-	3+	-	3+	+	5+	-
	9196	3+	+	-	-	3+	+	2+	+	2+	+	3+	+	5+	-
<i>P. chlororaphis</i> subsp. <i>chlororaphis</i>	9156	3+	-	+	-	-	-	-	-	-	-	3+	+	5+	-
	9158	3+	-	2+	-	3+	-	3+	-	3+	-	3+	+	5+	-
	9165	2+	-	-	-	-	-	-	-	+	-	+	+	5+	-
	9163	+	+	2+	2+	3+	+	2+	+	2+	+	+	+	5+	-
	9159	3+	-	3+	-	3+	-	-	-	3+	-	3+	+	5+	-
	9329	3+	5+	3+	5+	3+	-	2+	-	+	-	3+	+	5+	-
	9330	3+	-	3+	-	3+	-	2+	-	3+	-	3+	+	5+	-

Polysorbates 20, 40, 65, 80, 85 by *P. chlororaphis* 30 °C mineral cultural media M9, after 5 days; G – growth, A – activity; “+” – growth (in cm) /lipase activity presence different intensity; “-” – growth/lipase activity absence, C⁺ – the positive control on nutrient agarised cultural media, C⁻ – the negative control on mineral cultural media

Table 8. – The transformation of *P. chlororaphis* 9330 recipient strain by plasmids from different *Pseudomonas* and *Stenotrophomonas* which are able to polysorbates biodegradation

Donor	P1							Control	P2							Control	St. (%)
	Polysorbates								Polysorbates								
	20	40	60	65	80	85	C1 ⁺	C1 ⁻	20	40	60	65	80	85	C2 ⁺	C2 ⁻	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
C39330	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	-	0
9061	-	-	-	-	+	-	+	-	-	+	-	-	-	-	+	-	0

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
9241	-	-	-	-	-	+	+	-	+	-	-	-	-	+	+	-	0
9242	-	+	-	-	-	-	+	-	-	-	-	-	+	-	+	-	0
9329	+	+	-	-	-	-	+	-	+	+	-	-	-	-	+	-	0
9196	-	-	-	-	+	+	+	-	-	-	-	-	+	+	+	-	0
9164	-	-	-	-	-	+	+	-	-	-	-	-	-	+	+	-	0
9163	-	-	+	+	+	+	+	-	-	-	+	+	+	+	+	-	0

T – transformants; “C⁺” – the positive control on solid nutrient cultural media M9, “C⁻” – the negative control on mineral cultural media without carbon source; “+” – the growth of bacteria, “-” – the absence of bacterial growth,

P1 – mineral cultivation media with appropriate polysorbate 20, 40, 60, 80, 85 for transformants selection;

P2 – cultivation of transformants on different selective media containing appropriate polysorbates – 20, 40, 60, 80, 85; *St* – transformation stability percentage; *C3* – recipient control

During the experiments with transformation of sensitive strains without the biodegradation activity it was demonstrated nucleoid localization of PPO and both nucleoid and plasmid localization diversity in lipases. Lipases of plasmids are not able to stable replication on non-selective cultural media in recipients from differing species, while in same species cells, the replication is stable and not always is related with re-

sistance. The resistance tests of transformants showed, that not all biodegradation plasmids can carry resistance some genes. In a majority of strains, β -lactam resistance, including full diapason transmission or the transfer of part of it, up to clavulanic acid resistant β -lactamases transmission, is being detected. In both cases the resistance of recipient is not decreasing the external genetical element presence.

Table 9. – The antibiotic resistance tests of transformed strains

A	B	1	2	3	4	5	6	7	8	9	10	11	12	C	St
9056	<i>pUC18</i>	+	-	-	-	-	-	-	-	-	-	-	-	+	100
<i>E.coli</i>	<i>VOG16</i>	-	-	-	-	-	-	+	-	-	-	-	-	+	100
9329	<i>VOG16</i>	-	-	-	-	-	-	+	-	-	-	-	+	+	0
9243	<i>pUC18</i>	+	-	-	-	+	-	-	-	-	-	-	-	+	0
9243	9242	-	-	-	-	+	-	-	-	-	-	-	-	+	100
<i>E.coli</i>	9242	-	-	-	-	+	-	-	-	-	-	-	-	+	0
9329	9241	-	-	-	-	-	-	-	-	-	-	-	+	+	100
9330	9243	-	+	+	-	-	-	-	-	-	-	-	-	+	0
9243	9061	+	+	+	+	-	-	-	-	-	-	-	+	+	100
<i>E.coli</i>	9061	+	+	+	+	-	-	-	-	-	-	-	+	+	0
9330	9061	+	+	+	-	-	-	-	-	-	-	-	-	+	100
9330	9200	-	+	+	-	-	-	-	-	-	-	-	-	+	0
9329	9164	-	+	+	-	-	-	-	-	-	-	-	+	+	100
9329	9163	-	+	-	-	-	-	-	-	-	-	-	+	+	100
9329	9196	+	+	-	-	-	-	-	-	-	-	-	+	+	100

1 – *Amp*, 2 – *Pcn*, 3 – *Amx*, 4 – *Amc*, 5 – *Cfx*, 6 – *Ctx*, 7 – *Kan*, 8 – *Stp*, 9 – *Cam*, 10 – *Tcn*, 11 – *Azm*,

12 – *Cip*, C – positive control on nutrient agar media, the negative control of antibiotics – *pUC18* (*Amp* resistance plasmid) and *VOG16* (*Kan* resistance plasmid), which are being considered as the transformation positive control, recipient strains – *E. coli* DH5a and *P. aeruginosa* 9056, which are sensitive to all the mentioned antibiotics, A – recipient strain, B – donor strain, St – stability in%

During the experiments, 3 types of PPO were detected, with the predominance of tyrosinase in correlation to tetracycline resistance and an ability of tartaric acid benzyl- and cyclohexyl- mono amino salts degradation [20]. Transformations with caseinase containing strains showed the negative results. The isolated plasmids are stable even after the multiple cultivations on non-selective cultural media in same genus recipients [21; 22]. Probably this effect is caused by the features of genetical apparatus and nucleoid encoded plasmid replication control mechanisms.

Conclusion

The prevailing percentage of studied strains of *P. chlororaphis subsp. aureofaciens*, *P. chlororaphis subsp. aurantiaca*, *P. chlororaphis subsp. chlororaphis*, *P. taetrolens*, are antibiotic resistant. The majority of them are resistant to more than one antibiotics or antibiotics of different classes, such as like β -lactams and aminoglycosides or amphenicoles and tetracyclines. There are strains with resistance to 5 β -lactams simultaneously with the resistance to 2 aminoglycosides. Among the resistant strains, there is the dominance of plasmid-containing strains. But the genes of antibiotic modification (such as like β -lactamases, acetyltransferases, etc.) are observing in both nucleoid (bacterial chromosome) and plasmid localization. Thus, these microbes can participate to their intraspecific transfer processes.

Biodegradation potential different levels were discovered in various strains of *P. chlororaphis* and *P. taetrolens*. There were precipitated different species-specific

and non-specific extracellular enzymes of xenobiotic biodegradation. The genes of biodegradation PPO are localized only in nucleoid of researched strains, and they are encoding extracellular active lakase, tyrosinase, etc. The activity of lipases was differing in other strains in gene localization scope. Plasmid localized lipases of the majority of *P. chlororaphis* subspecies strains are being transferred by plasmids. This process is related to antibiotic resistance transfer and stability too, because of localization of both properties genes on same plasmid. In *P. taetrolens* the antibiotic resistance is not related with the plasmids, but they can transfer lipase activity to different species recipients. The stability of this process is not high, and they are being eliminated after the cultivation on non-selective cultural media. The resistance to antibiotics from lactams is correlating with this property of tartaric acid cyclic derivatives degradation in both cases of plasmid and chromosomal localization of lactamases genes, such as like the presence of tetracycline resistance and nucleoid localized PPO activity. It's very important in case of forming of resistance to tartaric acid derivatives. The relation of nucleoid localized degradation genes with the degradation can potentially decrease the frequency of resistance occurrence.

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Section 2. Information Technology

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ARP ATTACK IN KALI LINUX FOR PENTESTING SECURE TRANSMISSION OF PACKETS

Abstract. In the study it is considered the classification of the data transfer methods, the method of packet interception in the network and the transmission pentesting is given.

Keywords: ARP, pentesting, Kali Linux, sniffer, Wireshark, spoofing, ataks, data interception.

The Internet is the global system of interconnected computer networks that uses the Internet protocol suite (TCP/IP) to link devices worldwide. It is a network that consists of private, public, academic, business, and governmental networks of local to global scope, linked by a broad array of electronic, wireless, and optical networking technologies. The Internet carries a vast range of information resources and services, such as the inter linked hypertext documents and applications of the World Wide Web (WWW), electronic mail, telephony, and file sharing [9]. It is impossible to imagine our lives without Internet, it has entered our lives that we can say “without it there will be no life” and introduced itself as a vital function in the life of modern society. “Information”, which belongs to the most important place in the development stages of human life, has preserved its value as one of the biggest factors affecting the thinking, living, actions of people in the history of the world. The desire of people to obtain information anywhere at any time, regardless of space, has led to great achievements and rapid development in the field of technology. In modern society, it is impossible to imagine life without the

internet. Information technology, which already has its own place in every sphere of our lives, allows us to carry out our work faster and more accurately, but in addition to this it brings with it some dangers. Every day, the number of users on the network increases, which tells us how much it is in great demand. All information on the internet is not transmitted intact, but by malicious attackers can capture, store, modify, combine or use this information in the form of packets. Therefore, it is worth thinking about the safety of the transmitted data. The fact that information, which seems unnecessary, has great importance to other people, has made data systems vulnerable to attack by malicious people. For this reason, it is very important to predict the attacks on data systems and learn about them and take the necessary measures to protect the privacy and integrity of data, so that useful information does not fall into the hands of other people or malicious people. Data security refers to the Prevention of unauthorized access to data systems, their interference and failure to comply fully.

Short for Address Resolution Protocol, ARP is a used with the IP for mapping a 32-bit Internet Pro-

protocol address to a MAC address that is recognized in the local network specified in RFC826. Once recognized, the server or networking device returns a response containing the required address.

Let's consider the situation where the computers A and B are in different LANs and linked to each other through the Internet. To transmit data, the computer A uses B PC IP-address as the destination address and sends the packet to the Internet. After going through a series of routers, it hits the network gateway, which belongs to the computer B. The local B PC network address used for 6-byte MAC address, and when the package reaches the gateway, a further delivery on the LAN data is only possible if you know the MAC-address computer B. If the gateway MAC-address is not known, it sends a network broadcast ARP-request, the essence of which is as follows: "The computer with the IP-address B, let me know (lock) your MAC-address". Because broadcast request, it reaches the computer B, and in response it sends ARP-reply with its MAC-address. The rest of the computers on the network does not send any packets on the gateway ARP-request, because have IP-addresses that are different from the computer IP-addresses B. Gateway, receiving MAC-address of the computer B, enters into its ARP-table (cache) compliance with the IP-address and the MAC-address of the computer B, and then sends the data to it, obtained via the Internet from the computer A. at the same time, the computer enters B in its ARP-table match the gateway IP and MAC addresses to be able to send data to computer A. At first glance, everything should work easily and reliably, if not for one feature – ARP does not authenticate-ARP requests and ARP responses-and allows you to send ARP-replies network nodes at random, ie, even if the node is not sent on the network no ARP-requests. Spontaneous answers are needed, for example to identify IP-address conflicts in the network.

ARP spoofing attack

Let's assume that we need to listen to the data transmitted between computers A and B. Our computer is in the same local area network with com-

puter B. We have a MAC-address, we know the MAC address-B PC and MAC-address of the gateway of our local network. Computers in modern LANs connected with each other through switches. The switch "remembers" which port is connected to the host how the MAC-address. Those receiving a packet from the computer B gateway, we do not get this package, as he will not be sent to all ports on the switch, but only the one which, according to the switch is now connected to the gateway. At a time when used hubs instead of switches, we could hear the traffic without any problems. ARP-spoofing attack is often referred to as ARP-cache poisoning, and this name is quite telling. Because we are allowed to send ARP-replies to any network node when we want, we will send the ARP-response gateway such content "I host with IP-address B PC, and here is my MAC-address [MAC-address of our host]" and the computer B will send ARP-response to such content, "I lock my MAC-address [MAC-address again our host]." After receiving these packets, the gateway and the computer B will update its ARP-cache.

Now, if the computer B wants to send data over the Internet computer A, it will send its data as it considers consistent with its ARP-table on the MAC-address of the gateway, when in fact the data will be sent to our MAC-address, and we in turn, will send them on to this MAC-address of the gateway [4; 5].

Implementation ARP spoofing attack

1. Using arp spoof

For the arp-spoofing attack in Kali Linux transit packets should be allowed. Allow IPv4 forwarding can be editing the file /etc/sysctl.conf is necessary to uncomment theline

```
net.ipv4.ip_forward = 1
```

Then run the command

```
sysctl -p /etc/sysctl.conf
```

If you do not want to allow this on a regular basis, you can enable forwarding so

```
echo 1 > /proc/sys/net/ipv4/ip_forward
```

As it is necessary to ensure that transit traffic is not blocked by iptables rules.

`arp spoof -i eth0 -t ip`
 – `i` – indicates the interface connected to the local network of the victim
 – `t` – specifies the IP-address of the host, arpcache you want to “poison”. If the key is not specified, the attack will be carried out on all hosts in a

network, ie, all participants in the network, when you try to send a packet gateway will send it to us [3].

2. Using metasploit

use auxiliary/spoof/arp/arp_poisoning module
`msf5 > search arp`
 Matching Modules

Table 1.

Name	Disclosure Date	Rank	Check	Description
auxiliary/scanner/discovery/arp_sweep		normal	Yes	ARP Sweep Local Network Discovery
auxiliary/scanner/discovery/ipv6_neighbor		normal	Yes	IPv6 Local Neighbor Discovery
auxiliary/scanner/misc/raysharp_dvr_passwords		normal	Yes	Ray Sharp DVR Password Retriever
auxiliary/spoof/arp/arp_poisoning	1999-12-22	normal	No	ARP Spoof
exploit/linux/http/dlink_dcs9311_upload	2015-02-23	great	Yes	D-Link DCS-931L File Upload
post/windows/gather/arp_scanner		normal	No	Windows Gather ARP Scanner

`msf5 > use auxiliary/spoof/arp/arp_poisoning`
`msf5 auxiliary(spoof/arp/arp_poisoning) > info`
 Name: ARP Spoof
 Module: auxiliary/spoof/arp/arp_poisoning
 License: Metasploit Framework License (BSD)
 Rank: Normal

Disclosed: 1999-12-22

Provided by:

amaloteaux <alex_maloteaux@metasploit.com>

Check supported:

No

Basic options:

Table 2.

Name	Current Setting	Required	Description
AUTO_ADD	false	yes	Auto add new host when discovered by the listener
BIDIRECTIONAL	false	yes	Spoof also the source with the dest
DHOSTS		yes	Target ip addresses
INTERFACE		no	The name of the interface
LISTENER	true	yes	Use an additional thread that will listen for arp requests to reply as fast as possible
RHOSTS		yes	The target address range or CIDR identifier
SHOSTS		yes	Spoofed ip addresses
SMAC		no	The spoofed mac

Description:

Spoof ARP replies and poison remote ARP caches to conduct IP address spoofing or a denial of service.

References:

OSVDB (11169)

<https://cvedetails.com/cve/CVE-1999-0667/>

http://en.wikipedia.org/wiki/ARP_spoofing

msf5 auxiliary(**spoofer/arp/arp_poisoning**) > [2].

In fact, everything should work simply and reliably, if not for one feature-ARP does not authenticate ARP requests and ARP responses and allows

you to send ARP responses to network nodes arbitrarily, i.e. even if the node did not send any ARP requests to the network. So, using the example of the ARP Protocol, you can clearly understand how to use a MAC address to make it possible to find out the IP address of another devices on the network. In addition, an ARP attack is only one of the possible ways getting traffic, but whether it is appropriate to choose this method or another it depends only on the goals and conditions of testing. In addition, knowing how the method of traffic interception is performed, you will be able how to select protection to protect yourself and your data [1].

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Section 3. Mathematics

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THE INVESTIGATION OF ONE-DIMENSIONAL MIXED PROBLEM FOR ONE CLASS OF NONLINEAR FOURTH ORDER EQUATIONS

Abstract. The existence theorem of a generalized solution of a one-dimensional mixed problem for a class of fourth order nonlinear equations is proved.

Keywords: mixed problem, generalized solution, a priori estimate.

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ИССЛЕДОВАНИЕ ОДНОМЕРНОЙ СМЕШАННОЙ ЗАДАЧИ ДЛЯ ОДНОГО КЛАССА НЕЛИНЕЙНЫХ УРАВНЕНИЙ ЧЕТВЁРТОГО ПОРЯДКА

Аннотация. В работе доказана теорема существования обобщённого решения одномерной смешанной задачи для одного класса нелинейных уравнений четвёртого порядка.

Ключевые слова: смешанная задача, обобщённое решение, априорная оценка.

В работе доказана теорема существования обобщённого решения следующей одномерной смешанной задачи:

$$\begin{cases} u_{txx}(t, x) - \alpha u_{xxxx}(t, x) = \\ = F(t, x, u(t, x), u_x(t, x), u_{xx}(t, x), u_{xxx}(t, x)) \\ (0 \leq t \leq T, 0 \leq x \leq \pi), & (1) \\ u(0, x) = \phi(x) \quad (0 \leq x \leq \pi), & (2) \\ u(t, 0) = u(t, \pi) = u_{xx}(t, 0) = \\ = u_{xx}(t, \pi) = 0 \quad (0 \leq t \leq T), & (3) \end{cases}$$

где $\alpha > 0$ – фиксированное число; $0 < T < +\infty$; F, ϕ – заданные функции, а $u(t, x)$ – искомая функция, причём под обобщённым решением задачи (1)–(3) понимаем следующее

Определение. Под обобщённым решением задачи (1)–(3) понимаем функцию $u(t, x)$, обладающую свойствами:

- $u(t, x), u_x(t, x), u_{xx}(t, x), u_t(t, x) \in C([0, T] \times [0, \pi])$; $u_{xxx}(t, x), u_{tx}(t, x) \in C([0, T]; L_2(0, \pi))$;
- все условия (2) и (3) удовлетворяются в обычном смысле;
- выполняется интегральное тождество

$$\int_0^T \int_0^\pi \{u_{tx}(t, x) \cdot V_x(t, x) - \alpha u_{xxxx}(t, x) \cdot V_x(t, x) + K(u(t, x)) \cdot V(t, x)\} dx dt = 0$$

для любой функции $V(t, x)$, обладающей свойствами

$$\begin{aligned} V(t, x) &\in C([0, T] \times [0, \pi]), \quad V(t, 0) = V(t, \pi) = \\ &= 0 \quad (0 \leq t \leq T), \quad V_x(t, x) \in L([0, T]; L_2(0, \pi)), \end{aligned}$$

$$\text{где } K(u(t, x)) \equiv F(t, x, u(t, x), u_x(t, x), u_{xx}(t, x), u_{xxx}(t, x)). \quad (4)$$

Обозначим через $B_{\beta_0, \dots, \beta_l, T}^{\alpha_0, \dots, \alpha_l}$ совокупность всех функций вида

$$u(t, x) = \sum_{n=1}^{\infty} u_n(t) \sin nx,$$

рассматриваемых на $[0, T] \times [0, \pi]$, для которых все функции $u_n(t) \in C^{(l)}([0, T])$ и

$$J_T(u) \equiv \sum_{i=0}^l \left\{ \sum_{n=1}^{\infty} \left(n^{\alpha_i} \cdot \max_{0 \leq t \leq T} |u_n^{(i)}(t)| \right)^{\beta_i} \right\}^{\frac{1}{\beta_i}} < +\infty,$$

где $l \geq 0$ – целое число, $\alpha_i \geq 0$ ($i = \overline{0, l}$), $1 \leq \beta_i \leq 2$ ($i = \overline{0, l}$). Норму в этом множестве определим так: $\|u\|_{B_{\beta_0, \dots, \beta_l, T}^{\alpha_0, \dots, \alpha_l}} = J_T(u)$.

Известно [1], что все эти пространства банаховы.

В работе [2] второго автора получены некоторые априорные оценки решения почти всюду задачи (1)–(3), а в работе [3] исследовано классическое решение задачи (1)–(3).

С помощью усиленного принципа Шаудера о неподвижной точке доказывается следующая теорема о существовании в целом обобщённого решения задачи (1)–(3).

Теорема. Пусть

- $\phi(x) \in C^{(2)}([0, \pi])$, $\phi''(x) \in L_2(0, \pi)$ и $\phi(0) = \phi(\pi) = \phi''(0) = \phi''(\pi) = 0$.

- $F(t, x, u_1, \dots, u_4) \in C([0, T] \times [0, \pi] \times (-\infty, \infty)^4)$.

- $\forall R > 0$ в $[0, T] \times [0, \pi] \times [-R, R]^3 \times (-\infty, \infty)$

$$|F(t, x, u_1, u_2, u_3, u_4) - F(t, x, u_1, u_2, u_3, \tilde{u}_4)| \leq C_R \cdot |u_4 - \tilde{u}_4|, \quad (5)$$

где $C_R > 0$ – постоянная.

- В $[0, T] \times [0, \pi] \times (-\infty, \infty)^4$

$$|F(t, x, u_1, \dots, u_4)| \leq C \cdot (1 + |u_1| + \dots + |u_4|), \quad (6)$$

где $C > 0$ – постоянная.

Тогда существует обобщённое решение задачи (1)–(3).

Доказательство. Определим следующий оператор H , действующий в пространстве $B_{1, T}^2$: $H(u) = V = A_u(V)$, $\forall u \in B_{1, T}^2$,

где оператор A_u определён соотношениями

$$A_u(V(t, x)) = \tilde{V}(t, x) \equiv \sum_{n=1}^{\infty} \tilde{V}_n(t) \sin nx,$$

где

$$\tilde{V}_n(t) = \phi_n \cdot e^{-\alpha n^2 t} - \frac{2}{\pi n^2} \cdot$$

$$\int_0^t \int_0^\pi M_u(V(\tau, x)) \sin nx e^{-\alpha n^2 (t-\tau)} dx d\tau \quad (n = 1, 2, \dots; t \in [0, T]),$$

числа ϕ_n ($n = 1, 2, \dots$) определены соотношением

$$\phi_n \equiv \frac{2}{\pi} \int_0^\pi \phi(x) \sin nx dx \quad (n = 1, 2, \dots),$$

и $M_u(V(t, x)) \equiv F(t, x, u(t, x), u_x(t, x), u_{xx}(t, x), V_{xxx}(t, x))$.

Очевидно, что $\forall u \in B_{2,T}^3 M_u(u(t, x)) = K(u(t, x))$, где $K(u(t, x))$ определен соотношением (4).

Теперь рассмотрим в $B_{1,T}^2$ уравнения

$$u = \lambda H(u), \quad 0 \leq \lambda \leq 1, \quad (7)$$

и априори оценим всевозможные в $B_{1,T}^2$ их решения. Так как

$$u = \lambda H(u) = \lambda V = \lambda A_u(V),$$

то получаем, что $\forall t \in [0, T]$:

$$\begin{aligned} \|u\|_{B_{2,t}^3}^2 &\equiv \|\lambda H(u)\|_{B_{2,t}^3}^2 \equiv \|\lambda V\|_{B_{2,t}^3}^2 \equiv \|\lambda A_u(V)\|_{B_{2,t}^3}^2 \leq \\ &\leq \lambda^2 \cdot a_0 + \lambda^2 \cdot \frac{2}{\alpha\pi} \cdot \int_0^t \int_0^\pi \{M_u(V(\tau, x))\}^2 dx d\tau \\ &\leq a_0 + \frac{2}{\alpha\pi} \cdot \lambda^2 \cdot \int_0^t \int_0^\pi \{M_u(V(\tau, x))\}^2 dx d\tau, \end{aligned}$$

где число a_0 определено соотношением $a_0 \equiv 2 \sum_{n=1}^{\infty} (n^3 \cdot \phi_n)^2$.

Отсюда, пользуясь неравенством (5) и (6), соотношением $\lambda V = u$ для $V = u$, получаем, что $\forall t \in [0, T]$:

$$\begin{aligned} \|u\|_{B_{2,t}^3}^2 &\leq \\ &\leq a_0 + \frac{2}{\alpha\pi} \cdot \lambda^2 5C^2 \cdot \int_0^t \left\{ \pi + \int_0^\pi u^2(\tau, x) dx + \int_0^\pi u_x^2(\tau, x) dx + \right. \\ &\left. + \int_0^\pi u_{xx}^2(\tau, x) dx + \int_0^\pi V_{xxx}^2(\tau, x) dx \right\} d\tau \leq a_0 + \frac{10}{\alpha} \cdot C^2 \cdot T + \end{aligned}$$

$$\begin{aligned} &+ \frac{10}{\alpha\pi} \cdot C^2 \cdot \int_0^t \left\{ \int_0^\pi u^2(\tau, x) dx + \int_0^\pi u_x^2(\tau, x) dx + \int_0^\pi u_{xx}^2(\tau, x) dx + \right. \\ &\left. + \int_0^\pi \lambda^2 V_{xxx}^2(\tau, x) dx \right\} d\tau = a_0 + \frac{10T}{\alpha} \cdot C^2 + \frac{10}{\alpha\pi} \cdot C^2 \cdot \\ &\quad \cdot \int_0^t \left\{ \int_0^\pi u^2(\tau, x) dx + \int_0^\pi u_x^2(\tau, x) dx + \right. \\ &\left. + \int_0^\pi u_{xx}^2(\tau, x) dx + \int_0^\pi u_{xxx}^2(\tau, x) dx \right\} d\tau \leq a_0 + \frac{10T}{\alpha} \cdot C^2 + \\ &+ \frac{10}{\alpha\pi} \cdot C^2 \cdot \int_0^t \left\{ 3\|u\|_{B_{1,\tau}^2}^2 + \frac{\pi}{2}\|u\|_{B_{2,\tau}^3}^2 \right\} d\tau \leq a_0 + \frac{10T}{\alpha} \cdot C^2 \\ &+ \frac{10}{\alpha\pi} \cdot C^2 \cdot \int_0^t \left\{ 3 \cdot \frac{\pi^2}{6}\|u\|_{B_{2,\tau}^3}^2 + \frac{\pi}{2}\|u\|_{B_{2,\tau}^3}^2 \right\} d\tau = \\ &= a_0 + \frac{10T}{\alpha} \cdot C^2 + \frac{5(\pi+1)}{\alpha} \cdot C^2 \cdot \int_0^t \|u\|_{B_{2,\tau}^3}^2 d\tau. \quad (8) \end{aligned}$$

Из (8), применив неравенство Беллмана, получаем:

$$\|u\|_{B_{2,T}^3}^2 \leq \left(a_0 + \frac{10T}{\alpha} \cdot C^2 \right) \cdot \exp \left\{ \frac{5(\pi+1)}{\alpha} \cdot C^2 \cdot T \right\} \equiv C_0^2.$$

Таким образом, всевозможные в $B_{1,T}^2$ решения u уравнений (7) априори ограничены в $B_{2,T}^3$ и, тем более, в $B_{1,T}^2$. Тогда, в силу усиленного принципа Шаудера о неподвижной точке, оператор H имеет в $B_{1,T}^2$ неподвижную точку u , которая является обобщённым решением задачи (1)–(3). Теорема доказана.

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ABOUT STRUCTURES OF INVERSE MATRICES TO BLOCK-TRIDIAGONAL WITH ZERO LEADING BLOCK ANGULAR MINORS

Abstract. The article constructed a previously unknown structure and studied direct representations of inverse matrices to block-tridiagonal with zero (or closely zero) leading block angular minors.

Keywords: matrix, minor, representations, system solutions, block-tridiagonal matrix, linear algebra, computational mathematics, ill-posed system.

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О СТРУКТУРАХ МАТРИЦ ОБРАТНЫХ К БЛОЧНО – ТРЕХДИАГОНАЛЬНЫМ С НУЛЕВЫМИ ВЕДУЩИМИ БЛОЧНО-УГЛОВЫМИ МИНОРАМИ

Аннотация. В статье построена неизвестных ранее структура и изучены свойства прямых представлений матриц обратных к блочно – трехдиагональным с нулевыми (или близко нулевыми) ведущими блочно – угловыми минорами.

Ключевые слова: матрица, минор, представления, решения системы, блочно – трехдиагональная матрица, линейная алгебра, вычислительная математика, плохо обусловленная система.

1. Введение

Данная работа посвящена построению и анализу структуры прямых представлений обратных матриц к блочно – трехдиагональным с нулевыми (или близко нулевыми) ведущими блочно – угловыми минорами. Изучение свойств явного вида обратных матриц и знание их матричной структуры необходимо при построении прямых (не итерационных) методов решения плохо обусловленных систем линейных алгебраических уравнений. Известно, что

решения плохо обусловленных систем линейных алгебраических уравнений с блочно – трехдиагональными матрицами возникают при постановке следующих задач: в процессе численного решения краевых задач математической физики; обработки и анализа экспериментальных данных в физике высоких энергий; моделирования и численного решения задач геофизики и т.д. (см., например, [1–6]).

Итак, пусть S блочно-трехдиагональная матрица общего вида

При этом для B_{ij} – элементов блоков $B(4)$ имеют место следующие прямые факторизованные представления:

Представления 1.1 (при условии I)

$$[B_{ij}(\Lambda)]_{11} = \begin{cases} \tilde{B}_{ij}(\Lambda) + \tau_i X_{kk} z_j, \\ 1 \leq i < j \leq k-1, \\ \tilde{B}_{ii}(\Lambda) + \tau_i X_{kk} z_i, \\ 1 \leq (i=j) \leq k-1, \\ \tilde{B}_{ij}(\Lambda) + \tau_i X_{kk} z_j, \\ 1 \leq j < i \leq k+1; \end{cases} \quad (5)$$

$$[B_{ij}(\Lambda)]_{22} = \begin{cases} \tilde{B}_{ij}(\Lambda) + \xi_i X_{k+1,k+1} f_j, \\ k+2 \leq i < j \leq m; \\ \tilde{B}_{ii}(\Lambda) + \xi_i X_{k+1,k+1} f_i, \\ k+2 \leq (i=j) \leq m; \\ \tilde{B}_{ij}(\Lambda) + \xi_i X_{k+1,k+1} f_j, \\ k+2 \leq j < i \leq m. \end{cases}$$

$$\begin{cases} \begin{cases} B_{kj} = X_{kk} z_j; \\ B_{k+1,j} = X_{k+1,k} z_j, \\ 1 \leq j \leq k-1. \end{cases} \\ \begin{cases} B_{i,k} = \tau_i X_{kk}; \\ B_{i,k+1} = \tau_i X_{k,k+1}, \\ 1 \leq i \leq k-1. \end{cases} \end{cases} \quad \begin{cases} \begin{cases} B_{kj} = X_{k,k+1} f_j; \\ B_{k+1,j} = X_{k+1,k} f_j, \\ k+2 \leq j \leq m. \end{cases} \\ \begin{cases} B_{i,k} = \xi_i X_{k+1,k}; \\ B_{k+1,j} = \xi_i X_{k+1,k+1}, \\ k+2 \leq i \leq m. \end{cases} \end{cases} \quad (6)$$

$$\begin{cases} [B_{ij}(\Lambda)]_{21} = \xi_i X_{k+1,k} z_j, \\ k+2 \leq i \leq m, \\ 1 \leq j \leq k-1; \end{cases} \quad \begin{cases} [B_{ij}(\Lambda)]_{12} = \tau_i X_{k+1,k} f_j, \\ 1 \leq i \leq k-1, \\ k+2 \leq j \leq m; \end{cases} \quad (7)$$

Здесь в (4) – (7) определены:

$$\begin{cases} \left\{ \tau_i = \prod_{\xi=i+1}^k c_\xi \right\}_{i=1}^{k-1}, \left\{ \xi_i = -\tilde{B}_{ii}(\Lambda) \prod_{\xi=k+3}^i \beta_\xi p_{k+2} \right\}_{i=k+2}^m, \\ \left\{ z_j = \prod_{\xi=j+1}^k \beta_\xi \right\}_{j=1}^{k-1}, \left\{ f_j = -r_{k+2} \prod_{\xi=k+3}^j c_\xi \tilde{B}_{jj}(\Lambda) \right\}_{j=k+2}^m. \end{cases} \quad (8)$$

Здесь $\tilde{B}_{ij}(\Lambda)$ – элементы – блоки усеченных обратных подматриц $\tilde{B}_1^{k-1} = [C_1^{k-1}(\Lambda)]^{-1}$ и, как функции от последовательности $\{\Lambda\}$ матриц, соответственно могут быть представлены в виде

$$\tilde{B}_{ij}(\Lambda) = \begin{cases} \tilde{B}_{ij}(\Lambda) = c_{i+1} \tilde{B}_{i+1,j}(\Lambda), \\ 1 \leq i < j \leq k-1; k+2 \leq i < j \leq m, \\ \tilde{B}_{ii}(\Lambda) = \Lambda_{i+1}^{-1} + c_{i+1} \tilde{B}_{i+1,i+1}(\Lambda) \beta_{i+1}, \\ 1 \leq (i=j) \leq k-1; k+2 \leq (i=j) \leq m, \\ \tilde{B}_{ij}(\Lambda) = \tilde{B}_{i,i+1}(\Lambda) \beta_{i+1}, \\ 1 \leq j < i \leq k-1; k+2 \leq j < i \leq m. \end{cases} \quad (9)$$

Представления 1.2 (при условии II)

$$[B_{ij}(G)]_{11} = \begin{cases} \tilde{B}_{ij}(G) + \hat{f}_i X_{kk} \hat{\xi}_j, \\ 1 \leq i < j \leq k-1, \\ \tilde{B}_{ij}(G) + \hat{f}_i X_{kk} \hat{\xi}_i, \\ 1 \leq (i=j) \leq k-1, \\ \tilde{B}_{ij}(G) + \hat{f}_i X_{kk} \hat{\xi}_j, \\ 1 \leq j < i \leq k-1; \end{cases} \quad (10)$$

$$[B_{ij}(G)]_{22} = \begin{cases} \tilde{B}_{ij}(G) + \hat{z}_i X_{k+1,k+1} \hat{\tau}_j, \\ k+2 \leq i < j \leq m; \\ \tilde{B}_{ij}(G) + \hat{z}_i X_{k+1,k+1} \hat{\tau}_i, \\ k+2 \leq (i=j) \leq m; \\ \tilde{B}_{ij}(G) + \hat{z}_i X_{k+1,k+1} \hat{\tau}_j, \\ k+2 \leq j < i \leq m. \end{cases}$$

$$\begin{cases} \begin{cases} B_{kj} = X_{kk} \hat{\xi}_j, \\ B_{k+1,j} = X_{k+1,k} \hat{\xi}_j, \\ 1 \leq j \leq k-1. \end{cases} \\ \begin{cases} B_{i,k} = \hat{f}_i X_{kk}, \\ B_{i,k+1} = \hat{f}_i X_{k,k+1}, \\ 1 \leq i \leq k-1. \end{cases} \end{cases} \quad \begin{cases} \begin{cases} B_{kj} = X_{k,k+1} \hat{\tau}_j, \\ B_{k+1,j} = X_{k+1,k+1} \hat{\tau}_j, \\ k+2 \leq j \leq m. \end{cases} \\ \begin{cases} B_{i,k} = \hat{z}_i X_{k+1,k}, \\ B_{k+1,j} = \hat{z}_i X_{k+1,k+1}, \\ k+2 \leq i \leq m. \end{cases} \end{cases} \quad (11)$$

$$\begin{cases} [B_{ij}(G)]_{12} = \hat{f}_i X_{k,k+1} \hat{\tau}_j, \\ 1 \leq i \leq k-1, \\ k+2 \leq j \leq m. \end{cases} \quad \begin{cases} [B_{ij}(G)]_{21} = \hat{z}_i X_{k+1,k} \hat{\xi}_j, \\ k+2 \leq i \leq m, \\ 1 \leq j \leq k-1. \end{cases} \quad (12)$$

где

$$\begin{cases} \left\{ \hat{\xi}_j = -p_k \prod_{\xi=j+1}^{k-2} c_\xi \tilde{B}_{jj}(G) \right\}_{j=1}^{k-1}, \left\{ \hat{\tau}_j = \prod_{\xi=k+2}^j \hat{\beta}_\xi \right\}_{j=k+2}^m, \\ \left\{ \hat{f}_i = -\tilde{B}_{jj}(G) \prod_{\xi=i+1}^{k-1} \beta_\xi r_k \right\}_{i=1}^{k-1}, \left\{ \hat{z}_i = \prod_{\xi=k+2}^i \hat{c}_\xi \right\}_{i=k+1}^m. \end{cases} \quad (13)$$

Здесь $\tilde{B}_{ij}(G)$ – элементы – блоки усеченных подматриц $\tilde{B}_1^{k-1} = [C_1^{k-1}(G)]^{-1}$ и $\tilde{B}_{k+2}^m = [C_{k+2}^m(G)]^{-1}$, как функции от последовательности $\{G\}$ матриц, соответственно могут быть представлены в виде

$$\tilde{B}_{ij}(G) = \begin{cases} \tilde{B}_{ij}(G) = \tilde{B}_{i-1,j}(G) \hat{b}_j, \\ \text{если } 1 \nmid j < j \nmid k-1; k+2 \nmid j < j \nmid m, \\ \tilde{B}_{ii}(G) = G_{i-1}^{-1} + \hat{c}_i \tilde{B}_{i-1,i-1}(G) \hat{b}_i, \\ \text{если } 1 \nmid (i=j) \nmid k-1; k+2 \nmid (i=j) \nmid m, \\ \tilde{B}_{ij}(G) = \hat{c}_i \tilde{B}_{i-1,j}(G), \\ \text{если } 1 \nmid j < i \nmid k-1; k+2 \nmid j < i \nmid m. \end{cases} \quad (14)$$

Представления 1.3 (при условии III)

$$[B_{ij}(\Lambda, G)]_{11} = \begin{cases} \tilde{B}_{ij}(\Lambda, G) + \hat{f}_i X_{kk} z_j, \\ 1 \leq i < j \leq k-1, \\ \tilde{B}_{ii}(\Lambda, G) + \hat{f}_i X_{kk} z_i, \\ 1 \leq (i=j) \leq k-1, \\ \tilde{B}_{ij}(\Lambda, G) + \hat{f}_i X_{kk} z_j, \\ 1 \leq j < i \leq k-1. \end{cases} \quad (15)$$

$$[B_{ij}(\Lambda, G)]_{22} = \begin{cases} \tilde{B}_{ij}(\Lambda, G) + \hat{z}_i X_{k+1k+1} f_j, \\ k+2 \leq i < j \leq m, \\ \tilde{B}_{ii}(\Lambda, G) + \hat{z}_i X_{k+1k+1} f_i, \\ k+2 \leq (i=j) \leq m, \\ \tilde{B}_{ij}(\Lambda, G) + \hat{z}_i X_{k+1k+1} f_j, \\ k+2 \leq j < i \leq m. \end{cases}$$

$$\begin{cases} B_{kj} = X_{kk} z_j, \\ B_{k+1j} = X_{k+1k} z_j, \\ \text{если } 1 \leq j \leq k-1. \end{cases} \quad \begin{cases} B_{kj} = X_{kk+1} f_j, \\ B_{k+1j} = X_{k+1k+1} f_j, \\ \text{если } k+2 \leq j \leq m. \end{cases} \quad (16)$$

$$\begin{cases} B_{ik} = \hat{f}_i X_{kk}, \\ B_{ik+1} = \hat{f}_i X_{k+1k+1}, \\ \text{если } 1 \leq i \leq k-1. \end{cases} \quad \begin{cases} B_{ik} = \hat{z}_i X_{k+1k}, \\ B_{ik+1} = \hat{z}_i X_{k+1k+1}, \\ \text{если } k+2 \leq i \leq m. \end{cases}$$

$$\begin{cases} [B_{ij}(\Lambda, G)]_{12} = \hat{f}_i X_{k+1k} f_j, \\ 1 \leq i \leq k-1, \\ k+2 \leq j \leq m. \end{cases} \quad (17)$$

$$\begin{cases} [B_{ij}(\Lambda, G)]_{21} = \hat{z}_i X_{k+1k} z_j, \\ k+2 \leq i \leq m, \\ 1 \leq j \leq k-1. \end{cases}$$

где

$$\begin{cases} \{\hat{f}_i = -\tilde{B}_{ii}(\Lambda, G) \Pi_{\xi=i+1}^{k-1} \hat{\beta}_{\xi} r_k\}_{i=1}^{k-1}, \quad \{\hat{z}_i = \Pi_{\xi=k+2}^i \hat{c}_{\xi}\}_{i=k+2}^m, \\ \{z_j = \Pi_{\xi=j+1}^k \beta_{\xi}\}_{j=1}^{k-1}, \quad \{f_j = -r_{k+2} \Pi_{\xi=k+3}^m c_{\xi} \tilde{B}_{jj}(\Lambda, G)\}_{j=k+2}^m. \end{cases} \quad (18)$$

Здесь $\tilde{B}_{ij}(\Lambda, G)$ – элементы-блоки усеченных подматриц $\tilde{B}_1^{k-1} = [C_1^{k-1}(\Lambda, G)]^{-1}$ и $\tilde{B}_{k+2}^m = [C_{k+2}^m(\Lambda, G)]^{-1}$,

При этом неизвестные $\{[X_{kk}(\Lambda), X_{kk+1}(\Lambda), X_{k+1k}(\Lambda), X_{k+1k+1}(\Lambda)], [X_{kk}(G), X_{kk+1}(G), X_{k+1k}(G), X_{k+1k+1}(G)]\}$,

как функции от последовательности $\{\Lambda\}$ и $\{G\}$ матриц, соответственно могут быть представлены в виде

$$\tilde{B}_{ij}(\Lambda, G) = \begin{cases} \Pi_{\xi=i+1}^j c_{\xi} \tilde{B}_{ij}(\Lambda, G), \\ 1 \leq i < j \leq k-1, \\ k+2 \leq i < j \leq m. \\ \tilde{B}_{ii}(\Lambda, G) \Pi_{\xi=j+1}^i \beta_{\xi}, \\ 1 \leq j < i \leq k-1, \\ k+2 \leq j < i \leq m. \end{cases} \quad (19)$$

$$\tilde{B}_{ij}(\Lambda, G) = \begin{cases} \tilde{B}_{ii}(\Lambda, G) \Pi_{\xi=i+1}^j \hat{\beta}_{\xi}, \\ 1 \leq i < j \leq k-1, \\ k+2 \leq i < j \leq m. \\ \Pi_{\xi=j+1}^i \hat{c}_{\xi} \tilde{B}_{ij}(\Lambda, G), \\ 1 \leq j < i \leq k-1, \\ k+2 \leq j < i \leq m. \end{cases} \quad (20)$$

Здесь, в (8) – (20)

$$\begin{cases} \beta_{\xi+1} = -(p_{\xi+1} \Lambda_{\xi+1}^{-1}), c_{\xi+1} = -(\Lambda_{\xi+1}^{-1} r_{\xi+1}), \\ 1 \leq \xi \leq k-1; k+2 \leq \xi \leq m-1; \\ \hat{\beta}_{\xi+1} = -(p_{\xi+1} G_{\xi+1}^{-1}), \hat{c}_{\xi+1} = -(G_{\xi+1}^{-1} r_{\xi+1}), \\ 1 \leq \xi \leq k-2; k+1 \leq \xi \leq m-1; \\ \tilde{B}_{\xi\xi} = (\Lambda_{\xi+1} + G_{\xi-1} - q_{\xi})^{-1}, 1 \leq \xi \leq k-1; k+2 \leq \xi \leq m, \end{cases} \quad (21)$$

последовательности матриц $\{\Lambda\}$ и $\{G\}$ определены в соответствии с (2) ÷ (3).

$\{[X_{kk}(\Lambda, G), X_{kk+1}(\Lambda, G), X_{k+1k}(\Lambda, G), X_{k+1k+1}(\Lambda, G)]\}$ – элементы – блоки в B(8), как функции от

последовательности $\{\Lambda\}$ либо $\{G\}$ или одновременно как функции от последовательностей $\{\Lambda\}$ и $\{G\}$ при соответствующих условиях, могут быть найдены из следующих матричных уравнений:

При условии I

$$\begin{bmatrix} \Lambda_{k+1} & r_{k+1} \\ p_{k+1} & (q_{k+1} - Q_{k+1}) \end{bmatrix} \begin{bmatrix} X_{kk}(\Lambda) & X_{kk+1}(\Lambda) \\ X_{k+1k}(\Lambda) & X_{k+1k+1}(\Lambda) \end{bmatrix} = \begin{bmatrix} E_{kk} \\ E_{k+1k+1} \end{bmatrix},$$

где $Q_{k+1}(\Lambda) = r_{k+2} \tilde{B}_{k+2k+2}(G) p_{k+2}$.

При этом $(q_{k+1} - Q_{k+1}) = G_k$, если $\{\det(G_\xi) \neq 0\}_{\xi=k+1}^{m-1}$.

При условии II

$$\begin{bmatrix} (q_k - Q_k) & r_{k+1} \\ p_{k+1} & G_k \end{bmatrix} \begin{bmatrix} X_{kk}(G) & X_{kk+1}(G) \\ X_{k+1k}(G) & X_{k+1k+1}(G) \end{bmatrix} = \begin{bmatrix} E_{kk} \\ E_{k+1k+1} \end{bmatrix},$$

где $Q_k(G) = p_k \tilde{B}_{k+1k+1}(\Lambda) r_k$. При этом $(q_k - Q_k) = \Lambda_{k+1}$, если $\{\det(\Lambda_\xi) \neq 0\}_{\xi=2}^k$.

При условии III

$$\begin{bmatrix} \Lambda_{k+1} & r_{k+1} \\ p_{k+1} & G_k \end{bmatrix} \begin{bmatrix} X_{kk}(G, \Lambda) & X_{kk+1}(G, \Lambda) \\ X_{k+1k}(G, \Lambda) & X_{k+1k+1}(G, \Lambda) \end{bmatrix} = \begin{bmatrix} E_{kk} \\ E_{k+1k+1} \end{bmatrix}.$$

Замечание. Справедливости выше приведенных представлений для \tilde{B}_{ij} элементов – блоков обратной матрицы $B = C^{-1}$ установлены [9] на основе проверки основных равенств $B C = E = C B$. При этом следует воспользоваться следующими матричными равенствами [9]:

$$\begin{cases} \hat{c}_{\xi+1} \tilde{B}_{\xi \xi} = \tilde{B}_{\xi+1 \xi+1} \beta_{\xi+1}, \\ \tilde{B}_{\xi \xi} \hat{\beta}_{\xi+1} = c_{\xi+1} \tilde{B}_{\xi+1 \xi+1}, \\ \text{для всех } 1 \leq \xi \leq k-2; k+1 \leq \xi \leq m-1, \end{cases}$$

где матрицы $\{\hat{c}_{\xi+1}, \beta_{\xi+1}, c_{\xi+1}, \hat{\beta}_{\xi+1}, \tilde{B}_{\xi \xi}\}$ – определены в (21).

Заключение. Таким образом, выше изучены ранее неизвестной структуры матриц обратных $B = C^{-1}$ случае по одному верхнему или нижнему или одновременно верхнему и нижнему нулевыми (или близко к нулевыми) ведущими блочно – угловыми минорами матрицы $C(1)$. При этом для элементов \tilde{B}_{ij} усеченных подматриц $\tilde{B}_1^{k-1} = [C_1^{k-1}]^{-1}$ и $\tilde{B}_{k+2}^m = [C_{k+2}^m]^{-1}$ получены различные представления. Отметим также что, эти результаты нами были использованы при конструировании решения плохо обусловленных систем линейных алгебраических уравнений общего вида [8, 9].

$$AZ = F, \tag{22}$$

где $A = (a_{ij})$ квадратная порядка n или прямоугольная размерности $m \times n$ вещественная матрица общего вида, $i = 1, \dots, m, j = 1, \dots, n, Z = (z_1, \dots, z_n)^T$ – искомый $F = (f_1, \dots, f_m)^T$ – заданный n и m -мерные векторы соответственно.

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Section 4. Agricultural sciences

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RELEVANCE OF ALTERNATE WHEAT GROWING IN THE SOUTHERN UKRAINE

Abstract. The article presents the study of the relevance of alternate wheat growing in the south of Ukraine. It is established that the introduction of mineral fertilizers contributes to the sustainable growth of grain productivity of plants in all varieties ranging from 31.4 to 107.7%. It is established that mineral fertilizers have the greatest influence on the formation of productivity of wheat plants – 61.9%, and the share of influence of sowing time and varietal composition is 12.8 and 5.9% respectively. 7.4% is for the influence of unaccounted factors.

Keywords: alternate wheat, yield, fertilizers, importance of growing, wheat varieties, alternate wheat Arabatka, alternate wheat Clarice.

The grain product is the most important among the branches of the agro-industrial complex of Ukraine. It is the basis of the agro-industrial complex of Ukraine. It is the grain economy that forms the food fund and a significant share of exports, provides the livestock industry with feed grain, and creates state reserves.

The strategic sector of the Ukrainian economy is the grain sector. It defines both the supply and value of basic food for the population of the country, including grain processing and livestock products, and forms a significant share of the income of agricultural producers.

It determines the volume of supply and the value of the main types of food for the population of the country, including grain processing and livestock production, and forms a significant share of the income of agricultural producers.

Wheat occupies the first place among the cereal crops and it is the leading food crop in Ukraine. This shows to the great economic importance of wheat. Nowadays, agricultural enterprises are interested in obtaining high and good-quality grain harvests. Therefore, there is a need to use alternative sowings areas such as alternates. By the type of development, duration of ontogeny, relation to environmental con-

ditions and, above all, temperature regime of wheat of the genus *Triticum* L., like some other annual plants, there are winter, semi-winter, spring and alternate plants. Spring crops include forms of wheat, which at spring sowing in the first year of vegetation, have the ability to earing, blooming, and forming seeds. Winter crops are varieties that are not able to form earing during spring sowing, but that bloom, mature and yield only next year. The group of semi-winter varieties includes varieties sown in areas with a long autumn period and relatively moderate and slightly frosty winter. Alternate varieties include forms that earing, both in late autumn and early spring sowings, that is, they have the ability to develop during spring and autumn sowing.

One of the limiting factors for widespread distribution and introduction of alternate varieties into production is low, in comparison with winter wheat, frost- and winter resistance. Another requirement for varieties of this type is the high yield in autumn sowings and for spring wheat – in spring sowings. Recently, disturbances of crop rotations have been increasingly observed, and unreasonable increase in sowings areas for cultivated and late industrial crops is widely practiced, which leads to the insufficient sowing and as a result to the shortage of winter and spring wheat.

For their rapid introduction into production, it is important to study their agrobiological characteristics. Therefore, a comprehensive evaluation of varieties and technologies of cultivation, the study of ecological plasticity and adaptability has scientific, economic and national value and research on this scientific subject are quite relevant [2, 50–51].

Field and laboratory tests are conducted during 2017–2020 in the Kherson region of Chaplinka district, Dolinske village.

In order to study the productivity of alternate wheat in the south of Ukraine, varieties of alternate soft wheat of Arabatka and Clarice are studied.

The experiment studied:

(A) varieties: alternate –Arabatka and Clarice;

(B) sowing dates: autumn: first decade of October; the third decade of October; the first decade of November; the third decade of November;

(C) control – without fertilizers;;;

The studies are conducted with a forecrop of weedfree fallow.

Agrotechnics is common to the Steppe zone of Ukraine, except the studied elements.

The sowing was performed with the seeder SZ-3.6 in the unit with the MTZ-80 tractor.

The land use territory of the farm is located in the second (southern) agro-climatic region of the Kherson region, which climate is very warm and arid.

Kherson region is the driest region of Ukraine. The most part of precipitation are rainfalls in summer. Snow cover is unstable and lasts for several tens of days, and in the coastal part of the region even less – about 15 days.

The Kherson region's climate is characterized by dry winds (strong winds of more than 5 m/s) at low humidity (less than 30%) and high air temperatures (above +25 °C). They adversely affect the development of crops, which leads to a significant decrease in their yield.

Other crop adverse weather conditions during the growing season include hail, heavy rain, heavy showers, strong winds and dust storms.

According to the aggregate indicators of agro-climatic resources during the active growing season of crops (sum of positive air temperatures, rainfall and hydrothermal coefficient), the territory of Kherson region is divided into two agroclimatic regions: northern – with the high level of heat supply, arid and southern – with the high level of heat supply, very dry (where the farm is located). In winter, there is usually thaw, the number of days with which in the period December-February ranges from 58 to 67, which leads to a decrease of plants frost resistance.

After prolonged thaws in the presence of snow cover, there is a significant likelihood of its destruction, which contributes to the formation of ice crust on the fields. An icy crust with a thickness of 10 mm

or more and a deposition duration of three decades or more is observed in 10% of years (once every 10 years) [1, 48].

The soil cover of the territory of the farm is represented by dark-chestnut residual saline soils of medium and heavy-loam of mechanical composition.

Soils are characterized by a clear division of the profile into two genetic horizons: humus-eluvial with a strength of 25–32 cm, dark gray with a brown tint, and humus-illuvial horizon to a depth of 52–58 cm, dark brown, compacted of nutty structure. The transition between layers is gradual.

Dark chestnut soils are characterized by a developed humus profile of up to 55 cm in strength, with boiling from HCl from a depth of 71 cm, with picking horizon of “white soft spot” from 78 to 107 cm. Arable soil is dry up to 30 cm, dense, dark gray with a slight brownish tinge, medium-loamy, has many plant roots, no boiling from HCl, the transition is gradual.

Soil-forming rock is “les” (type of parent soil) in mechanical composition, the les is heavy and medium-loamy, at a depth of 2.5–4.0 m the les contains easily soluble salts and gypsum [4, 4–7].

In the experiments, according to existing methods, phenological observations, accounting for field germination and plant densities, damage by pests and diseases, winter hardiness, analysis of photosynthetic activity and crop structure are conducted. It is planned to determine the area of the leaf surface by scanning the leaves of wheat using the AreaS computer program. Soil moisture is determined by the sensory method, total water consumption and average evaporation, water consumption coefficients and other indicators of the water regime of the soil – according to “Methodical recommendations for conducting field experiments in irrigation conditions”. Harvesting and accounting are carried out in the phase of full maturing of the grain. Cost-effectiveness is calculated according to general production standards and taking into account all costs, direct and overhead. Energy efficiency is calculated according to the method of V. O. Ushkarenko and others. The

results of the crop accounting will be processed by methods of disperse and statistical analysis using the computer program “Agrostat” developed at Kherson State Agrarian University [1, 11, 12].

The functioning of agriculture and crop yields depend on a large extent on agro-climatic conditions, especially heat and humidity. Agroclimatic conditions, in general, are satisfactory throughout Ukraine for the cultivation of field crops, but during each period of the vegetation cycle they have a different need for heat and moisture, due to the peculiarities of their growth and development [1–3].

Global climate change has been occurring on the planet in recent decades. Such changes are especially relevant for the agricultural sector of the economy, they have both negative and positive consequences, which are mainly related to warming. The threat to the grain industry is associated with the accompanying warming, which leads to prolonged droughts, as well as a tendency to increase the likelihood of extreme hydrometeorological conditions that could be detrimental to agriculture. Changes in temperature and precipitation cause significant changes in the agro-climatic conditions of the plant’s development during each interphase period of the vegetation cycle, resulting in a change in their contribution to the harvest of the field crops and, eventually, the crop itself.

The most important factor in warming is the recurrence of droughts in the autumn and spring-summer periods, as well as the extension of the autumn vegetation period of winter wheat, harsh winters, accompanied by thaws, and often rainfalls with warming and revegetation several times during the winter. The shift of sowing dates to the later ones in recent years is also associated with a large saturation of crop rotations with unconventional forecrops (stubble, corn for grain, sunflower, soybean). In addition, under the influence of natural and anthropogenic factors, the phytosanitary situation in the fields has significantly worsened [5].

Such changes require a detailed study of the effects of climate change on the productivity of field

crops and the development of measures to mitigate the adverse effects caused by changing agroclimatic conditions.

The formation of a productive stem, the number of grains in the ear, the mass of 1000 grains requires optimal amount of moisture and nutrients, which are made with the help of effective growing technologies and depends on the sowing time and seeding rate. It is possible to achieve the planned yield by combining the technology of cultivation with the specific hydrothermal conditions of the year. First of all, it is necessary to sow in optimal terms with optimal regime taking into account the biological requirements of wheat and the parameters of natural factors that change during the growing season [4, 7].

Sowing dates have a complex effect on the growth and development of wheat plants, which in turn affects the reproductive processes and, of course, the yield. In the present conditions, given the weather conditions, the forecrop and biological features of the variety, the sowing time of winter cereals is advisable to shift somewhat later than it is traditionally recommended [2, 50–51].

Phenological observations in the experiments showed that the onset and duration of individual interphase periods vary significantly depending on the sowing time and, to a lesser extent, under the influence of varietal composition. Shifting the sowing time from the first decade of October to later dates caused the extension of the interphase periods by 3–12 days. The growing season was the highest (at 161 days) in the Arabatka variety at sowing in the first term (October 10). The same term prevailed with Claris varieties (160 days).

High wheat yields are directly dependent on balanced doses of NPK and trace elements. The main factor for stable and profitable grain production is the introduction of innovative winter wheat varieties with cultivation technologies that meet the needs of the variety [6].

An important component of the development of plant nutrition systems is the use of complex physio-

logically balanced formulations. Particular attention should be paid to the creation and use of complex fertilizers for foliar fertilization, which can significantly increase the nutrient absorption rate and reduce the flow of toxic substances into the environment. Mineral nutrition should also be balanced on the elements with due regard to the soil and climatic characteristics of the particular growing region. In general, 60% of the expected maximum of the total absorption of nutrients occurs in the second half of the growing season both for winter and spring wheat [8, 86–89].

The introduction of phosphate-potassium fertilizers, which contribute to the better development of the root system and the accumulation of sugars, has a positive effect on winter wheat hibernation. These nutrients are especially valuable for winter plants in the beginning of the growing season [7, 38–40].

The introduction of mineral fertilizers provided the best results with the increase of grain yield at optimal sowing time for varieties: Arabatka – 32,8–63,7; Clarice – 36.8–96.7%. On average, factor C, the use of mineral fertilizers contributed to a significant increase in yields in the range of 35.2–69.1%.

The analysis of variance of the obtained data allowed establishing the maximum impact of fertilizers (factor B) on the productivity of wheat, the impact of which increased to 61.9%. The studied autumn and spring sowing periods (factor B) caused the formation of grain yield by 12.8%. Among the studied factors, varietal composition (factor A) had a minimal effect on plant productivity – 5.9%. According to the results of the comparison of interaction of factors that were put to study, it was proved that the largest – at 5.5%, it was for the ratio of BC factors. The impact of residual factors, which include, first of all, the difference between the weather conditions and the elements of wheat agricultural that were not studied was 7.4%.

Conclusions. Innovative developments of domestic breeding scientists who create new forms of wheat – alternate wheat, can be successfully used in

the production environment of southern Ukraine. These varieties are capable of forming high and steady yields both in autumn and in spring sowings, have a high level of adaptability and productivity.

It is determined that shifting the sowing time from the first decade of October to the later dates delayed the onset of regular interphase periods by 3–12 days. The varieties Arabatka and Clarice alternate wheat showed a decrease in the growing season during sowing in the third decade of November.

The varieties of alternate wheat showed a wavy tendency to decrease yields. The introduction of mineral fertilizers contributes to a steady increase in grain productivity of plants in all varieties ranging from 31.4 to 107.7%. It is set that mineral fertilizers have the greatest influence on the formation of productivity of wheat plants – 61.9%, and the share of influence of sowing terms and varietal composition is 12.8 and 5.9% respectively. 7.4% account for the influence of unaccounted factors.

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COMPARISON OF INFECTION PERCENTAGE RATE FROM COODLING MOTH WITH APPLICATION OF ACTIVE INGREDIENTS *GRANULOVIRUS*, *INDOXACARB* AND *DIFLUBENZURON* IN GOLDEN DELICIOUS AND STAR KING APPLE VARIETIES, IN KORÇA REGION FOR YEAR 2018

Abstract. The fact that in recent years the areas planted with fruits in the Korça region have been growing and mainly those cultivated with apples shows a positive side for increasing the quantity and quality of production. But on the other hand, this increase has led to a number of problems for fruit growers, mainly for apple growers in the Korca region, where one of the most prominent is the protection against diseases and pests where the most problematic is Coodling Moth (*Cydia pomonella*). The situation becomes even more problematic where growers find it difficult to find the most suitable and effective insecticide preparation for protection against this pest. Therefore, in this study, we tested three preparations with active ingredients *granulovirus*, *indoxacarb* and *diflubenzuron* and compared the infection percentage rate from coodling moth in two Golden Delicious and Star King apple varieties.

Keywords: coodling moth, infection percentage rate, F factic and teoric, boxplots diagram.

1. Introduction

In Korca district, apple is one of the main fruit tree crops. It represents 80% of the total number of fruit trees. In recent years this culture has expanded widely, with a large number of traditional and young cultivars which are well preferred by the domestic and foreign market. The new technologies that are being applied to the apple are the most modern and consequently its production has been increased year by year [1].

Fruit production is concentrated in the region of Korça with about 23% of the number of fruit trees and 30% of total fruit production, followed by the regions of Elbasan, Berat, Fier and Dibra. Production

from the Korça region accounts for more than half of Albania's total apple production the region has about 1.4 million apple trees. In the Korça area there is an early tradition of apple production more than $\frac{3}{4}$ of the fruit trees in this district are apples. Favorable soil and climatic conditions and technical knowledge have made this district an apple producing leader, which is also recognized by consumers. Within the district of Korça, the district of Korça has about 1 million apple trees, followed by Devolli, Pogradec and Kolonja regions [2].

However, it has not only positive sides because all this increase in apple cultivated area, increased

production and introduction of new varieties has led to the addition of a number of problems faced by apple farmers and growers in the Korca region on a daily basis. Where the problem of protection from pests and diseases is the main issue especially in apple culture. Affected by a variety of diseases such as scab, powdery mildew, fire blight and pests such as coodling moth, aphids, mites and San Jose Scale. But the most dangerous pest for apple growers in Korca region is definitely the Coodling moth (*Cydia pomonella*) [1].

Adult moths are 0.5 inch wide, with alternating gray and white bands on the wings and a copper band on the wing tips. Larvae are whitish with a black head when immature, and pinkish with brown heads when mature. Larvae are 0.1 inch long at hatch and 0.8 inch long at maturity. Pupae are brown and about 0.75 inch long. The eggs are very tiny and rarely seen. Larvae feed directly on the fruit, boring into it and feeding within. Larvae bore into the fruit, leaving a characteristic tunnel filled with frass that extrudes from the hole on the fruit surface. Entry holes may be anywhere on the fruit [3].

There are two types of damage: stings and deep entries. Stings are shallow entries where a larva burrows into the flesh and then dies or a larva briefly feeds at a location then abandons that site and moves to another location. Deep entries occur when a larva bores through the flesh of the fruit, eventually arriving at the center of the apple or pear where it feeds primarily on seeds. Both types of damage make fruit unmarketable, but deep entries are a problem in stored fruit because bacteria and fungi associated with the entries enhances fruit rot [4].

Referring to the above facts about pest risk, the situation becomes even more problematic where growers find it difficult to find the most suitable and effective insecticide preparation for this pest. Therefore, in this study, we tested three preparations with active ingredients *granulovirus*, *indoxacarb* and *diflubenzuron* and compared the infection percentage rate caused from coodling moth in two Golden Delicious and Star King apple varieties.

2. Materials and methods

To compare the infection percentage rate from coodling moth an experiment was conducted on a 100 m² area with 240 apple trees separated from a 5 ha plot cultivated with apple in Dvoran village of Korça region. The two main varieties of apples sampled were Golden Delicious and Star King, each representing **a1** and **a2** variants which were divided into separated rows. To facilitate the experiment and to make it more distinct from each replicate, for each variant were selected and labeled 10 apple trees such as P2 a1 b3. Based on the monitoring of pheromon traps it was possible to determine the proper time for application of chemicals (insecticides) with active ingredients: *granulosevirus*, *indoxacarb* and *diflubenzuron* which constituted in themselves the variants **b1**, **b2** and **b3**. According to each generation of pest was applied insecticide, at the end of May was realized for the first generation and at the end of the third week of July it was realized for the second generation. The block which was used as a control was located on the same parcel and it was not treated with any kind of chemical preparation (pesticide).

In terms of determining the infection percentage rate, were carried out two monitoring, the first monitoring to determine and compare pest damage for the first generation were carried out in early July, while the second monitoring to determine and compare the second generation damage was realized at the end of August. For this purpose ten labeled apple trees were analyzed per each apple tree were taken for analyse ten fruits, 100 fruit trees in total. The rate of infection and the percentage of infection indicated the number of fruits, in percentage, affected per 100 fruits analyzed. All data and results obtained were uploaded to the respective tables to conduct the data analysis as given below.

3. Results and discussion

Data on the infection percentage % rate in fruits for each variant for all three replicants in both Golden Delicious and Star King cavities for both generations studied for 2018 are presented in tables 1.1; 1.2.and

pictures 1.1; 1.2; 1.3; 1.4. From the data presented in the tables and pictures we see that:

Infection percentage % rate in fruit for each variant for all three replicates in both cultivars Golden Delicious and Star King for both generations studied for 2018 shows that in both variants where we treated with active ingredient *indoxacarb*, *diflubenzuron* dhe *granulovirus* infection percentage % rate in fruit in the cultivar Golden Delicious it was 0%, 0.3% and 2 for the first generation. Compared this with the cultivar Star King were the infection percentage % rate was 3% in treatments with *indoxacarb*, 2 % and with *diflubenzuron* and 3.3 % in the treatments with *granulovirus* for the first genera-

tion. As for the second generation in both variants where we have treated with *indoxacarb* and *diflubenzuron*, infection percentage % rate in fruits in the variety Golden Delicious was 0.3% while in the variant treated with *granulovirus* infection percentage % rate was 8.6%. While at the cultivator Star King infection percentage % rate in fruits for the second generation at the variant treated with *indoxacarb*, *diflubenzuron* and *granulovirus* infection percentage % rate has been respectively 3.3%, 1.6% and 12.6%. In comparison with the control plot where infection percentage % rate was 7–10 times higher in the first generation and more than 25–27 times in the second generation.

Table 1.1. – Data on Infection percentage (%) rate of infection in fruit for each variant for all three replicant in both Golden Delicious and Star King cultivars for both generations studied for year 2018

Year	Gener	Preparation	Golden Delicious a ₁					Star King a ₂				
			P ₁	P ₂	P ₃	Σ	Mes	P ₁	P ₂	P ₃	Σ	Mes
2018	I	<i>A.i. granulosevirus</i>	2	2	2	6	2b	4	3	3	10	3.3b
		<i>A.i. indoxacarb</i>	0	0	0	0	0b	2	2	3	7	2.3b
		<i>A.i. diflubenzuron</i>	0	1	0	1	0.3b	2	3	1	6	2b
		Control	6	10	13	29	9.6a	12	16	13	41	13.6a
		Sum	8	13	15	36	11.9	20	24	20	64	21.2
		Avarage	2	3.25	3.7	9	2.97	5	6	5	16	5.3
		LSD	Lsd = 2.87966 for p 0.05 according to the test Dunnett's									
	II	<i>A.i. granulosevirus</i>	11	6	9	26	8.6b	13	11	14	38	12.6b
		<i>A.i. indoxacarb</i>	0	0	1	1	0.3c	3	3	4	10	3.3c
		<i>A.i. diflubenzuron</i>	1	0	0	1	0.3c	2	1	2	5	1.6c
		Control	30	35	40	105	35a	40	38	37	115	38.3a
		Sum	42	41	50	133	44.2	58	53	57	168	55.8
		Avarage	10.5	10.25	12.5	33.2	11.05	14.5	13.25	14.2	42	13.95
		LSD	Lsd = 2.87966 for p 0.05 according to the test Dunnett's									

Note: a the highest level of authenticity for Lsd = 2.87966 per p 0.05 and C the lowest level of authenticity for Lsd = 2.87966 for p 0.05 according to the test Dunnett's

In (table 1.2) are presented the results of One - way ANOVA analysis of variance (Oneway Anova) on the infection percentage % rate of fruit for each variant for all three replicants in both Golden Delicious and Star King cultivars for both generations studied for 2018.

Analysis of variance indicates the presence of confirmed differences between variants over the infection percentage % rate for both generations and in both cultivars under study. This is verified by the F – factic values that are 51** in the first generation for Golden Delicious variety and 31.65** for Star King and 354.67**

in the second generation for Golden Delicious variety and 634.75** in Star King cultivar verified for levels of $P_{0.05}$ dhe $P_{0.01}$ of the probability which is bigger than the teoric F values that are 4.75 and 9.779 (Tabela 1.2)

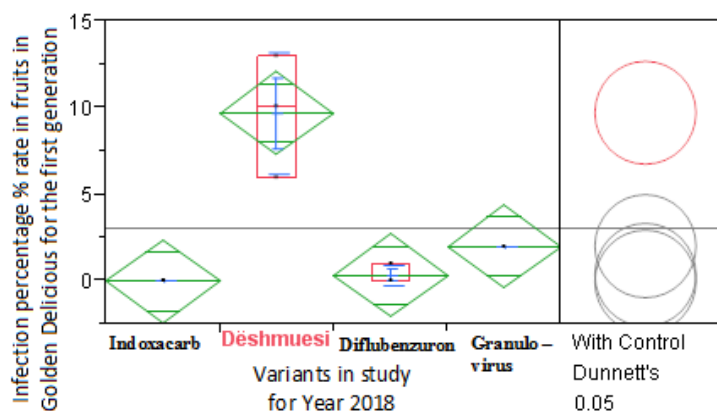
Table 1.2 – One - way ANOVA analysis of variance for the infection percentage % rate in apple fruit according replicants for all three variants in the study year 2018

Gener.	Cultivars	ANOVA						
		Sources of variation	Quadratic sum	Freedom Degrees	Quadratic mean	F factic	F teoric	
							95%	99%
1	Golden del	Variants	184.6667	3	61.5556	19.6106	4.75	9.779
		Replicant	6.5	2	3.25	1.0354	5.14	10.92
		Mistake	18.83333	6	3.13889			
		Total of error	210	11				
1	Star king	Variants	280.7	3	93.55556	60.14286	4.75	9.779
		Replicant	2.667	2	1.333333	0.857143	5.14	10.92
		Mistake	9.333	6	1.555556			
		Total of error	292.7	11				
2	Golden del	Variants	2426.917	3	808.9722	93.64309	4.75	9.779
		Replicant	12.16667	2	6.083333	0.70418	5.14	10.92
		Mistake	51.83333	6	8.638889			
		Total of error	2490.917	11				
2	Star king	Variants	2579.333	3	859.7778	719.814	4.75	9.779
		Replicant	3.5	2	1.75	1.465116	5.14	10.92
		Mistake	7.166667	6	1.194444			
		Total of error	2590	11				

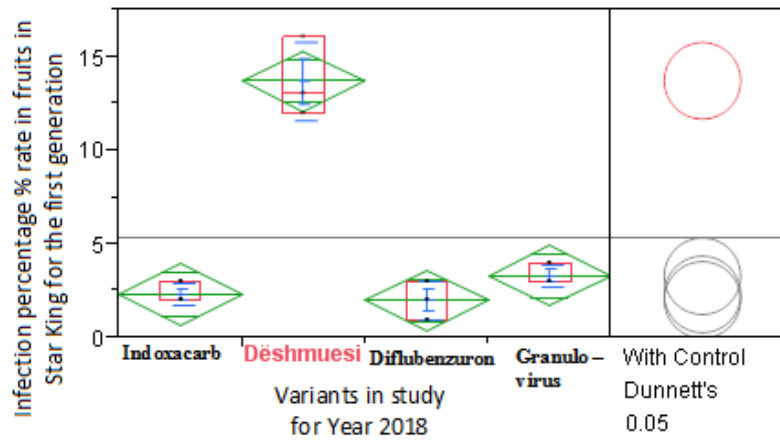
Note::** Verified for the level of probability 1% ($p < 0.01$); *****: Verified for the level of probability 5% ($0.01 = < p < 0.05$); **ns:** Without verified probability ($p > = 0.05$)

Comparison of the F – factic values of the repetitions with those of the tables shows that the repetitions do not yield statistically significant differences for both levels of veracity $P = 0.05$ and $P = 0.01$ be-

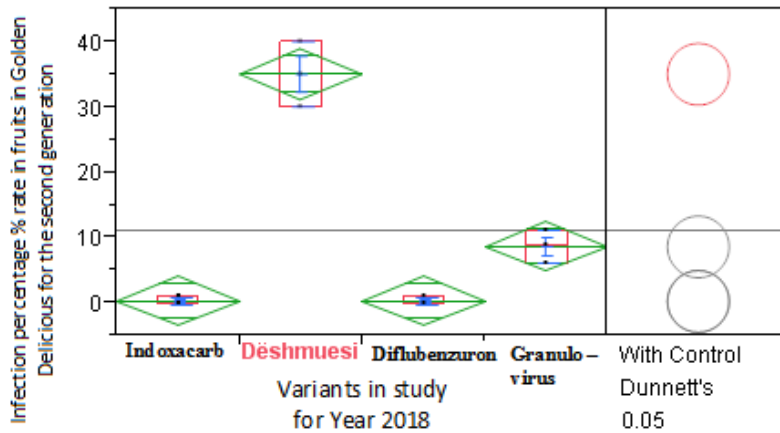
cause the actual F – factic are smaller than F – teoric which shows that our experiment is set up in the correct conditions and allows us to continue the data analysis.



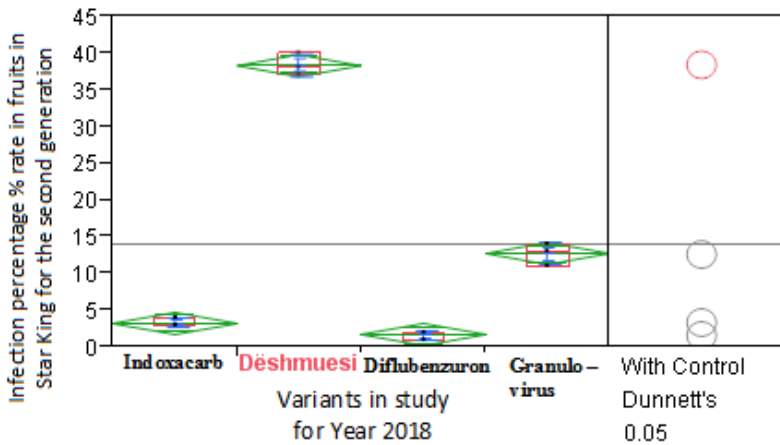
Picture 1.1. Boxplots diagram (variances, standard deviation and mean) for the infection percentage % rate of Golden Delicious apple fruit for the first generation of pests by repetition for all three variants in the study Year 2018



Picture 1.2. Boxplots diagram (variances, standard deviation and mean) for the infection percentage % rate of Star King apple fruit for the first generation of pests by repetition for all three variants in the study Year 2018



Picture 1.3. Boxplots diagram (variances, standard deviation and mean) for the infection percentage % rate of Golden Delicious apple fruit for the second generation of pests by repetition for all three variants in the study Year 2018



Picture 1.4. Boxplots diagram (variances, standard deviation and mean) for the infection percentage % rate of Star King apple fruit for the second generation of pests by repetition for all three variants in the study Year 2018

4. Conclusions

From the statistical analysis presented above at the results and discussions sector based on tables and graphs, some conclusions were presented as follows:

- Infection percentage rate in the first generation of codling moth for Golden Delicious variety when were used all three preparations *granulovirus*, *indoxacarb* and *diflubenzuron* were found to be lower up to 0% at those replicants where *indoxacarb* was applied;
- Infection percentage rate in the first generation of codling moth for Star King variety when were used all three preparations *granulovirus*, *indoxacarb* and *diflubenzuron* were found to be lower up to 2% at those replicants where *diflubenzuron* was applied;
- Infection percentage rate in the second generation of codling moth for both varieties Golden Delicious and Star King when were used all three preparations *granulovirus*, *indoxacarb* and *diflubenzuron* realized to be lower up to 0.3% at those replicants where *indoxacarb* and *diflubenzuron* was applied;
- Compared with to the other preparations *indoxacarb* and *diflubenzuron*, at the fruits where is applied the preparation *granulosevirus* the infection percentage rate turns out to be slightly higher from codling moth over both generations and in both apple varieties, 2% and 3.3% for the first generation and 8.6% and 12.6% for the second generation for both varieties;
- Better results by comparing the infection percentage % rate for the protection against codling moth was provided by *indoxacarb* and *diflubenzuron* chemical preparations over both generations;
- While the infection percentage % rate in the plot left for control results that infection and damage in the fruit caused from codling moth is many times higher 7 – 10 for the first generation and more than 25 – 27 in the second generation compared to cases where th pest is managed with the three chemical preparations;

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Section 5. Technical science

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DEVELOPMENT OF OPTIONS OF THE BROADBAND ACCESS ORGANIZATION WITH ARCHITECTURE OF FTTC

Abstract. Continuous extension of the list of network services, development of transfer technologies, and expansion of the user base leads to constant need for increase of data speed transmission at the level of access. All this promotes widespread introduction in access network of broadband fiber-optical technologies. The combination of technologies of access on fiber-optical and copper lines is applied in common when it is necessary to provide the high capacity and optimum access at cost for home or corporate users. Options of the organization of broadband access by means of the FTTC technology of ring and treelike topology are considered at connection of users' groups.

Keywords: access network, optical access, multiservice access node, the combined access “optical fiber – copper”, fiber-optical line, fiber to the curb.

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РАЗРАБОТКА ВАРИАНТОВ ОРГАНИЗАЦИИ ШИРОКОПОЛОСНОГО ДОСТУПА С АРХИТЕКТУРОЙ FTTC

Аннотация. Постоянное расширение списка сетевых услуг, развитие технологий передачи, расширение пользовательской базы приводит к постоянной потребности в повышении скорости передачи данных на уровне доступа. Все это способствует широкому внедрению в сети доступа широкополосных волоконно-оптических технологий. Комбинирование технологии доступа по оптоволоконным и медным линиям применяется совместно, когда необходимо обеспечить высокую пропускную способность и оптимальный по стоимости доступ для домашних или корпоративных пользователей. В статье рассмотрены варианты организации широкополосного доступа с помощью технологии FTTC кольцевой и древовидной топологии при подключении групп пользователей.

Ключевые слова: сеть доступа, оптический доступ, мультисервисный узел абонентского доступа, комбинированный доступ «оптоволоконно-медь», волоконно-оптическая линия, оптоволоконно до распределительного шкафа.

Введение. Семейство технологий передачи данных по волоконно-оптической линии FTTx (Fiber to the x) предоставляет оператору целый ряд возможностей повышения скорости передачи данных и увеличения числа услуг на сети доступа. Архитектура FTTC (Fiber to the Curb; оптоволоконно до распределительного шкафа) позволит в короткие сроки и с меньшими затратами реализовать услуги высокоскоростного доступа большому числу пользователей.

Варианты построения оптических структур доступа. Сценарии развертывания FTTx можно перечислить, комбинируя три параметра архитектуры FTTx: положение точки «x», технология доставки данных в оптической сети агрегации/рас-

пределения до точки «x» и технология доступа после точки «x». Соответственно до точки «x» используется активный Ethernet или какая-либо из разновидностей PON; после точки «x», как правило, xDSL, Ethernet по меди, иногда беспроводной доступ (Wi-Fi). На оптическом участке также возможно применение технологий спектрального уплотнения (в частности, CWDM – Coarse Wave length Division Multiplexing) для увеличения пропускной способности и/или уменьшения количества волокон.

Сама точка «x» расположена либо у абонента, либо между абонентом и помещением узла связи оператора (подъезд дома, уличный шкаф и др.) (рис. 1).

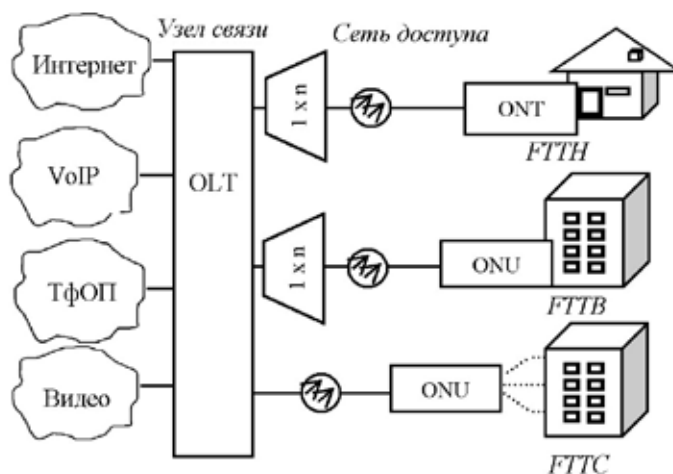


Рисунок 1. Варианты построения оптических сетей доступа

На схеме показаны варианты оптического доступа, когда оптический кабель проложен непосредственно:

- до оборудования абонента (вариант FTTH – Fiber to the Home, при котором осуществляется подключение терминала ONT в жилище у абонента),
- до здания или многоквартирного жилого дома (вариант FTTB – Fiber to the Building, при котором осуществляется подключение оптиче-

ского блока ONU, являющимся коммутатором доступа, расположенный в подъезде или на чердаке многоквартирного дома),

- до распределительного шкафа (вариант FTTC, при котором точкой доступа может являться любое оборудование мультисервисного доступа).

Схемы организации оптического доступа характеризуются также применением оптических делителей (сплиттеров) (см. рис. 1), позволяющих

разделить емкость волокна между точками доступа с определенным коэффициентом деления (1хn).

Использование оптического волокна – наиболее перспективная технология из ныне существующих, она позволяет модернизировать сеть так, чтобы можно было менять лишь оконечное передающее оборудование. Запас внутренних возможностей оптического волокна по пропускной способности еще не скоро достигнет своего предела, в отличие от передачи по медной паре и других технологий.

В течение нескольких лет услуги, в которых нуждаются пользователи, приблизили предложение операторов вплотную к границе в 100 Мбит/с. Используя до сих пор технологии DSL-доступа больше не в состоянии удовлетворить такие запросы. Если оператор стоит перед дилеммой: строить новую сеть доступа ФТТН или

модернизировать существующую инфраструктуру, то ему стоит обратить пристальное внимание на архитектуру ФТТС (табл. 1) [1].

В связи с этим, для многих действующих операторов развертывание решения ФТТС на начальном этапе строительства полномасштабной оптической сети позволит быстро и с наименьшими затратами внедрить широкополосные услуги, в частности широкополосный интернет, для достаточно большой группы пользователей. Далее развитие сети по технологиям ФТТВ, ФТТН позволят полностью модернизировать медную часть сети доступа.

Архитектура ФТТС в первую очередь предназначена для операторов, уже использующих технологии xDSL (семейство технологий высокоскоростного доступа в интернет) или PON (Passive Optical Network – пассивная оптическая сеть) [2].

Таблица 1. – Сравнение характеристик оптических архитектур доступа

	ФТТС/VDSL2	ФТТВ/VDSL2	ФТТВ/ЕПТН	ФТТН/P2P	ФТТН/GPON
Инвестиции	~ 200 евро	~ 300 евро	150 евро	500–2000 евро	500–2000 евро
Эксплуатационные расходы	Средние	Средние	Высокие	Низкие	Низкие
Время реализации	Быстро	Среднее	Среднее	Медленно	Медленно
Скорость передачи	↓30–60 Мбит/с ↑4–30 Мбит/с	↓50–100 Мбит/с ↑30–100 Мбит/с	↓100 Мбит/с ↑100 Мбит/с	↓↑100 Мбит/с или 1 Гбит/с	↓↑ ~ 50–150 Мбит/с
Предпочтительная зона обслуживания	город/пригород/село	город	город (многоэтажная застройка)	город/пригород	город (многоэтажная застройка)
Дистанционное питание ТА	да	нет	да/нет	нет	нет

Реализация решения ФТТС подразумевает использование мультисервисного узла абонентского доступа MSAN (Multi Service Access Node). Данное оборудование является интегрированным продуктом для обеспечения сетевого доступа и предоставления услуг. На этапе перехода к сетям NGN (Next Generation Networks)

оборудование MSAN способно взаимодействовать как с цифровыми системами коммутации, так и с оборудованием пакетной сети – медиашлюзами.

Обобщенная схема подключения MSAN по технологии ФТТС и реализация услуг представлена на (рисунке 2).

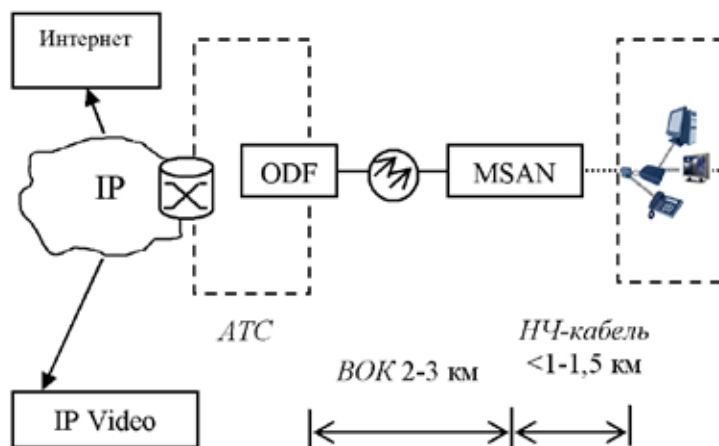


Рисунок 2. Развитие уровня доступа на базе MSAN

Из рисунка видно, что для реализации сети доступа по технологии FTTC на базе MSAN необходимо следующее: оборудование MSAN, маршрутизаторы/коммутаторы уровня агрегации, коммутаторы уровня доступа, оптический кросс ODF (Optical Distribution Frame).

Возможности MSAN: может поддерживать несколько способов построения сети – «цепь», «дерево», «звезда», «кольцо» и «кольцо с ответвлениями», «касательные» и «пересекающиеся кольца», может связываться с любой станцией по стандартному интерфейсу V5.2, либо связываться с терминалом оптической линии OLT средствами частного протокола или протокола V5.2, может подключаться к широкополосной магистральной сети IP по интерфейсам Gigabit Ethernet / Fast Ethernet.

Кроме того, в MSAN существует возможность выбора интерфейсов- волоконно-оптический интерфейс, интерфейсы VDSL2, ADSL2+, SHDSL, интерфейсы мобильной и стационарной связи WiMAX.

При реализации MSAN на уровне доступа оптическая широкополосная сеть также будет иметь типичную двухуровневую структуру (OLT+ONU). В данном случае по технологии FTTC в оборудование OLT будет подключаться MSAN. OLT – терминал (окончание) оптической линии, находится на станции и выполняет

обработку протоколов, транспортировку и распределение потоков информации. ONU (Optical Network Unit) – оптический сетевой блок находится на стороне сети доступа и служит для предоставления абонентам доступа к сети. OLT управляет ONU. OLT может иметь доступ к нескольким ONU.

Разработка схемы организации доступа FTTC. Выше было отмечено, что FTTC лучшее решение быстрого развертывания оптического доступа и расширения услуг для группы построек и жилых районов. В этом случае оптико-волоконный кабель доходит до устойчивого к изменчивым атмосферным условиям оконечного устройства, уличного шкафа при дороге, часто устанавливаемого на месте окончания бывших медных магистральных линий. Это позволяет использовать существующие медные абонентские соединения и проводные каналы для дальнейшего соединения с абонентом. Следует подчеркнуть, что предоставляемая для пользования полоса до пользователя, и тем самым диапазон предоставляемых услуг мультимедиа зависит здесь от длины и качества медных проводов и применяемой технологии передачи данных на этом отрезке (например, HDSL, SDSL, ADSL). В уличных шкафах устанавливается также аварийное питание (аккумуляторы), позволяющее продолжить работу ещё в течение нескольких часов после исчезновения питания

от электросети. Преимуществом FTTC в данном случае является то, что стоимость этого решения делится между многими абонентами.

При разработке схемы подключения оборудования доступа необходимо учитывать место размещения оборудования - среди многоквартирных домов или групп жилых построек.

В случае многоэтажных построек с достаточно большим числом пользователей интернет, выгодно подключать узлы доступа по кольцевой схеме с резервированием оптического волокна (рис. 3). Узлы доступа MSAN расположе-

ны в центре жилого массива в уличных шкафах. Между оборудованием уровня агрегации и уровня доступа используются две пары оптических волокон (прием и передача). Кабель заводится от АТС и разводится по трассам. В каждый коммутатор уровня доступа заводится одна пара оптического волокна и выводится, подключая новые точки доступа (MSAN). На одной паре волокна можно подключить до 5 элементов доступа. Для надежности работы такой схемы её замыкают, образуя «кольцо» по второй паре волокна.

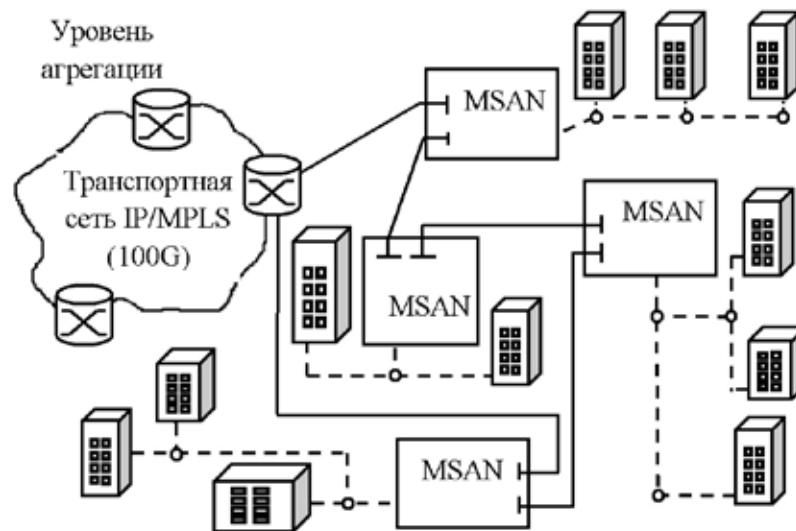


Рисунок 3. Вариант кольцевой схемы организации FTTC с MSAN

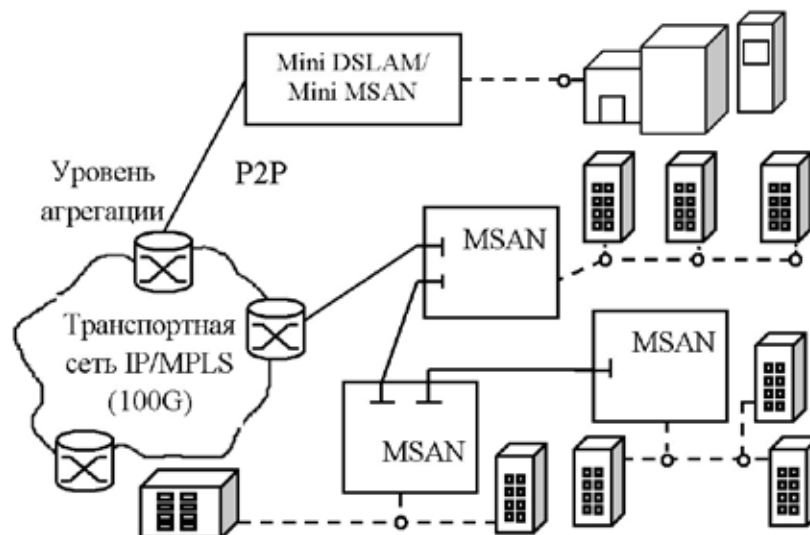


Рисунок 4. Вариант древовидной схемы организации FTTC по технологии xPON

Древовидная схема подключения MSAN по технологии FTTC образуется в случае, так называемого «незамкнутого кольца» (рис. 4). При этом используется только одна пара волокна, на которую также подключаются до 5 точек доступа. Данную схему можно применять при подключении относительно небольших групп пользователей, при этом экономится пара оптоволоконных кабелей. Надежность данной схемы ниже, чем кольцевой. Емкость MSAN выбирается равной емкости демонтируемого магистрального медного кабеля на данном участке. Узлом агрегации является сама АТС, от которой выводится волоконно-оптический кабель.

Особенностью доступа FTTC с MSAN также является возможность организации служб ШПД и речевых служб в одном стативе различными пользователями. При подключении пользователя,

являющегося как физическим, так и юридическим лицом, но требующего все услуги Triple Play организуют доступ «точка-точка» (схема подключения P2P, приведенная на рис. 4). В данном случае точкой доступа будет MiniMSAN или также MiniDSLAM.

В заключении можно сделать вывод, что комбинированный доступ «оптоволокно-медь», что представляет собой технология FTTC, позволит абонентам поддерживать как традиционные услуги телефонии, так и высокоскоростной интернет по xDSL. Скорость услуг ШПД вырастет за счет сокращения длины медного участка. Данный способ внедрения оптического уровня на сети доступа позволит оператору в короткие сроки и без больших эксплуатационных затрат предоставить большой перечень телекоммуникационных услуг различным группам пользователей.

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ENVIRONMENTAL PROBLEMS AND POSSIBLE SOLUTIONS

Abstract. The article discusses the occurrence of environmental problems, the analysis of various problems on the causes of occurrences and possible solutions to these problems.

Keywords: environmental crisis, natural resources, real and potential resources, economic depression, oxygen, carcinogenic and mutagenic effects.

Throughout the course of human history, the environment has been viewed as an endless source of natural resources. The urgent problem today is not just about the interaction of man with the natural environment, but also the threat to the existence of this environment and, consequently, the survival of the human race. This is the essence of the environmental crisis. The looting of free natural resources by using all means, especially modern techniques, has greatly reduced them. As a result, it is known that natural resources are limited, and some of them have disappeared. The unprecedented use of natural resources, the increase in industrial production, and the increased number of vehicles have caused severe environmental pollution. Currently, about 120 billion tons of earth are consumed annually for human needs. more than t. The economy uses more than 4.000 km³ of water annually, with 10 billion cubic meters of fuel burning. tons of O₂ [1].

Knowing the classification of natural resources is important for the rational use of them. All natural resources are allocated to real and potential resources during the development period.

The general question of the rational use of natural resources is to find the best or most appropriate way to use natural and artificial ecosystems. The main principles of the use of natural resources are the study, protection, development and transformation

of the natural environment. Limited resources of natural resources, imperfections for their extraction and processing technologies lead to the degradation of biogeocenoses, environmental pollution, disturbance of climate and biochemical cycles.

By the end of the 20th century, mankind was faced with an objective conflict, and the solution to this problem has become such a big and complex issue that it has become a worldwide problem. We are talking about scientific and technical progress since its inception, the latest modern scientific ideas and technologies, the strong industrialization of agriculture, the renewal and expansion of used raw materials and the industry, computerization and robotization of many technical processes will bring humanity to the heights of society. the notion that it promotes prosperity and prosperity. Indeed, after the “great economic depression” of the 1960 s and 1980 s, the economies of Western Europe, the United States and Japan jumped sharply, allowing for a dramatic rise in living standards. But it has quickly become apparent in these countries that ITT can have a number of negative consequences, not only a positive impact on the state’s economy, but also a disruptive change in the entire ecosystem and, above all, the human environment. has become [2].

In the early 1980 s, it was reported that intensive economic activity of humanity has resulted in strong

negative changes on our planet, including climate change, ozone depletion in the atmosphere, pollution of the entire biosphere, desertification in some geographical areas, and severe soil salinization. It has been shown that many species of flora and fauna are extinct. The most disproportionate consequence of this situation is that every change in the external environment has a direct or indirect effect on the human body. Mankind is at the top of the pyramid of these complex environmental problems. This led to the formation of a new field of ecology – human ecology. Human ecology is a part of the overall ecosystem, which aims to study the processes of interaction between humans and nature. Human ecology also differs in many respects, and the most important of them is medical ecology. This field examines the effects and interactions of the changing environment with the human body.

In recent years, there has been a decrease in the inflow of river water into the Aral Sea as a result of increased water consumption for agricultural irrigation and industrial development. Uzbekistan had about 400.000 irrigated lands at the beginning of the 20th century, and by 1988 it had reached 4 million 100.000. Uzbekistan has been transformed into an agricultural republic of the former Soviet Union. By 1970, cotton had grown to 4 million 43 km³ of water reached the Aral Sea with a plan of 6 million m³ water did not fill with water.

Another reason for the Aral Sea problem is the Karakum canal, which was built in 1959–67. Its length is 950 km, the ship is sailing, it receives 300 m³ of water per second from the Amu Darya, and 3 reservoirs have been built in the river.

It is important to note that environmental factors are highly effective only when they are complex to the organisms. In the absence or absence of any of these factors, normal growth and development of organisms is incomplete. Therefore, each of the environmental factors is necessary for the organism and cannot be replaced by the other. Therefore, environmental factors play an important role in the life

of the organism. For example, plant life can not be fully developed without the fertilizer of cotton cultivation and fertilization. Or the opposite would have the same consequences.

The results obtained in the experiments are important for the further development of students' knowledge, skills and skills, as well as for a deeper understanding of the importance of environmental sustainability and sustainable development. At the same time, it is worth noting the water consumption ratio (the amount of water per product unit). Water consumption is measured in m³/t units. For example, 2–4 m³ per ton of coal, 30–40 m³ per ton of oil products, 100 m³ per ton of nitric acid, 400 m³ per 1 ton of silica, 400 m³ per ton of nickel, 1 ton of copper., 500 m³ for production of cardboard, boiler (separately for each), 600 m³ for 1 ton of nitrogen fertilizers, and 1500 m³ for 1 ton of ammonia for 1000–1500 m³ 1 ton of cotton yarn 2500–5000 m³ of water depending on the production technology. Therefore, it is advisable to build factories close to the water source, depending on the product type, chemical composition and water consumption ratio. For example, the water supply at the Bukhara Oil Refinery Unitary enterprise, which was launched on August 22, 1997, is provided by Kuyi Mazar. The annual water consumption is 6280 thousand m³. Of these, 1.200.000 m³ of clean drinking water will be used for the town of Karaulbazar, and the rest will be used for plant operations and for Neftchi settlement. The plant is located in the area of domestic and technological wastewater and is designed to discharge 2900 m³/day of sewage treatment facilities at full capacity (after cleaning up to 98–99% by oil, mechanical, biological, physical and chemical methods), is thrown into the streambed [3; 4].

At a time when fresh water scarcity is common in all regions, the issue of recycling wastewater into open water reservoirs and its reuse remains a pressing issue for today. In the same way, the reservoirs needed for the population can be maintained. This can be done by using a centralized plumbing system,

such as a single-layer sand filter or a two-layer sand anthracite filter.

Then chlorinated water is returned to its original state. In this way, the oxygen in the water can be increased to 2 mg and the substances to 1.5–3 mg. In addition, nitrogen and phosphorus in the water must also be removed. Wastewater treatment is costly, so this method can only be used if necessary.

It should be noted that treated water should be used for technical purposes only. Drinking water should never be allowed. Heavy metal salts, polycyclic aromatic carbon waters, nitrose compounds are a constant component of urban wastewater. They have the ability to act as carcinogenic and mutagenic. Treatment of purified water also produces chemicals that completely alter the quality of water.

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A DEEP LEARNING APPLICATION IN INDUSTRY: WATER METER NUMBERS RECOGNITION

Abstract. I have applied CNN (Convolutional Neural Network) to recognize numbers in water meter images. To train the neural network, I collected twenty thousand of water meter pictures to build an image data set. I have built a model and trained on the data set. Additionally, I will demonstrate to fine-tune a pre-trained model to achieve better accuracy. I will present the neural network architecture, experiment details and result.

Keywords: Deep learning, number recognition, Computer vision, Image processing, transfer learning, convolutional neural network.

1. Introduction

Image number recognition is an active application field of deep learning. Popular datasets such as MNIST and SVHN have been investigated with various neural networks [1; 2; 3]. In this study, I demonstrate to identify image numbers using CNN model on water meter number data set. I collected 20000 real world water meter pictures as dataset WM1, shown in (Figure 1). The image was cropped to have only number region as dataset WM2, shown in Figure 2 and the image was further separated into single number as dataset WM3, shown in (Figure 3).



Figure 1.

Images in the dataset was first converted to black/white images using gray scale process since colored number does not provide extra information for number recognition. After pre-processing image data with various python libraries and OpenCV, I built neural network model containing several CNN layers with Tensorflow 2.0. I trained the model on dataset WM and achieve 80–90% accuracy. Further accuracy improvement has been discussed.



Figure 2.



Figure 3.

2. Neural Network Model

The model has three blocks of each which contains two layers of CNN followed by max pooling, batch normalization and dropout. Each CNN layer uses ReLU (Rectified Linear Unit) as activation function. Batch normalization and dropout with probability of 0.5 were used to avoid the appearance of over fitting. Adam Optimizer was used with

epsilon of 0.1, and the learning rate was selected using the method of Learning Rate Exponential Decay (decayed learning rate=initial learning rate*{decay rate}^{((global step)/(decay step))}). The training was running on GTX 1080 with allocated memory of 8.0Gb.

3. Experiment Details

3.1 Preprocess

Original images (Figure 1) were manually cropped as in (Figure 2). The cropped images were then processed programmatically to single digits with equal widths (Figure 3). The distribution of number counts is shown in (Figure 4).

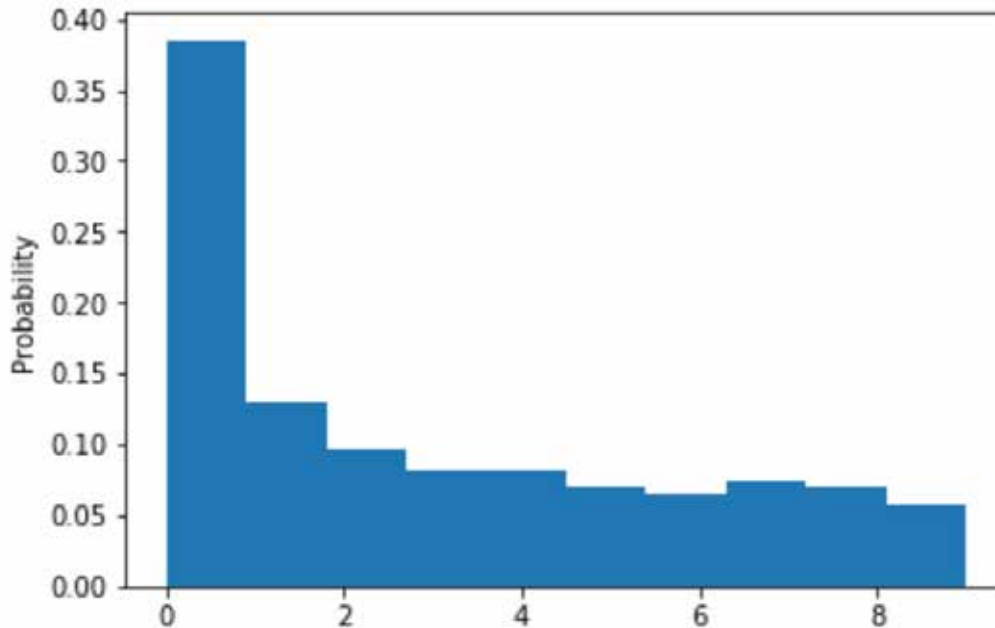


Figure 4.

3.2 Experimental procedure

Dataset was split into training and test sets with sklearn package. Images data were loaded, resized to 28×28 , augmented and the pixel values were normalized with tensorflow image package. The processed image data and labels were fitted to the model for training with 10000 epochs.

Batch size which defines the number of samples trained together through the neural network have been varied and various optimizer such as AdamOptimizer, MomentumOptimizer and Adadelta have been used to optimize accuracy and performance.

4. Results

To utilize transfer learning from SVHN training hyper parameters, I trained the model on SVHN,

then fine-tuned on dataset WM3. The accuracy is improved to ~86%

I also trained the model on dataset WM2. Since the image is a sequence of numbers, the accuracy is much lower at ~75%.

5. Discussion

Different setting of training parameters can affect the performance of the training process.

For example, by appropriately increasing the batch size, we can raise memory utilization ratio, increase execution speed and improve the accuracy of the direction of gradient descent to decrease the amplitude of vibration during training process. Smaller batch size requires less memory, but too small batch size can result in under fitting because

of not convergent for training process. Therefore choosing a proper batch size depends on finding the balance point between the capacity and utilization ratio of memory.

From experiment, we also find that select optimizer is very important to improve the performance of system. GradientDescentOptimizer is easy to implement, but the calculation of direction of updating gradient is just by Linear Weighting Model for feature vector and learning rates for all feature weight are the same. AdamOptimizer can adjust learning rate automatically when the mean gradient or variance is smaller. Therefore the performance of system with AdamOptimizer is much better than that with GradientDescentOptimizer when the model is trained.

Object detection with neural networks can be used to localize a group of numbers on the images to reduce manual work and further improve accuracy. A unique challenge to this water meter number problem is to recognize a number that is represented by two partial digits. More such image data are required in future studies.

6. Conclusion

I have demonstrated that deep learning neural network can be used to recognize each number from collected real world water meter images. Through fine-tuning on pre-trained model, the labeled data size can be reduced and the accuracy can be improved. A sequence of numbers can also be recognized simultaneously.

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Contents

Section 1. Biology	3
<i>Babayan Bella</i> ANTIBIOTIC RESISTANCE AND XENOBIOTIC BIODEGRADATION CORRELATION IN NATIVE SOIL PSEUDOMONAS CHLORORAPHIS GROUP	3
Section 2. Information Technology	12
<i>Guliyev Imdat Firdovs</i> ARP ATTACK IN KALI LINUX FOR PENTESTING SECURE TRANSMISSION OF PACKETS	12
Section 3. Mathematics	16
<i>Aliyev Samed Jahangir oqлу, Aliyeva Arzu Qambar qizi</i> THE INVESTIGATION OF ONE-DIMENSIONAL MIXED PROBLEM FOR ONE CLASS OF NONLINEAR FOURTH ORDER EQUATIONS.	16
<i>Rakhmonov Turdimukhammad Tukhtamatovich</i> ABOUT STRUCTURES OF INVERSE MATRICES TO BLOCK-TRIDIAGONAL WITH ZERO LEADING BLOCK ANGULAR MINORS.	19
Section 4. Agricultural sciences	25
<i>Averchev Alexander, Kulish Victoriia</i> RELEVANCE OF ALTERNATE WHEAT GROWING IN THE SOUTHERN UKRAINE	25
<i>Karapanzi Nikolin, Skenderasi Besnik, Shahini Shpend</i> COMPARISON OF INFECTION PERCENTAGE RATE FROM COODLING MOTH WITH APPLICATION OF ACTIVE INGREDIENTS GRANULOVIRUS, INDOXACARB AND DIFLUBENZURON IN GOLDEN DELICIOUS AND STAR KING APPLE VARIETIES, IN KORCA REGION FOR YEAR 2018.	30
Section 5. Technical science	36
<i>Abdujapparova Mubarak Baltabaevna</i> DEVELOPMENT OF OPTIONS OF THE BROADBAND ACCESS ORGANIZATION WITH ARCHITECTURE OF FTTC	36
<i>Aslonov Bakhtiyor Bobokulovich</i> ENVIRONMENTAL PROBLEMS AND POSSIBLE SOLUTIONS	42
<i>Hanson Lu</i> A DEEP LEARNING APPLICATION IN INDUSTRY: WATER METER NUMBERS RECOGNITION.	45