RESEARCH ON THE CONTROL OF DISEASES AND PESTS IN COWPEA CULTURE IN THE CONDITIONS OF SANDY SOILS IN THE SOUTH OF OLTENIA

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Abstract

The study was carried out in the period 2021-2022 at the Research and Development Station for Plant Culture on Sands Dabuleni, Romania, with the aim of finding scientific solutions to reduce the incidence of attack produced by the identified harmful agents in the cowpea crop (Vigna unguiculata L. Walp) sown in the conditions of the sandy soils of southern Oltenia, Romania. Various environmentally friendly products with a fungicidal and insecticidal role were tested, in order to promote sustainable agriculture, by applying two phytosanitary treatments in the phases of 3-4 true leaves and the appearance of flower stalks of the cowpea plant. The results obtained for cowpea highlighted the phytosanitary treatment with the Polyversum biofungicide, in a dose of 0.1 kg/ha and the Bioinsekt insecticide, in doses of 0.5-1 l/ha, which achieved the best phytosanitary control over the attack produced by plant pests (AD=0.79%), correlated with an increase in resistance to stress conditions (bound water=3.42%; vacuolar juice concentration=10.2%) and high productivity (12.6 pods/plant, leaf index=8.04, production=2725.2 kg/ha).

***Key words**: cowpea, degree of damage, phytosanitary treatments, physiological indices, productivity*

INTRODUCTION

The cowpea (*Vigna unguiculata* L. Walp) is a leguminous plant with high agronomic value, having at the same time a significant nutritional value for human consumption, especially in Africa and in some areas of America and Asia, where it can be consumed both fresh (pods, leaves, shoots) , as well as processed (boiled, fried, baked, ground grains) (Quinn, 1999; Imrie, 2000; Tarawali et al., 2002; Singh et al., 2003). With a deep root system, a waxy layer on the leaves and a good strategy to avoid dehydration of the leaf apparatus by closing the stomata, the cowpea can capitalize on drought conditions with good results (Draghici, 2018; Nunes et al., 2022).

Failure to observe the technological links, especially the number of plants per unit area, can favor the growth of pathogen infection of the cowpea plant (Allen and Lenne 1998; Ajibade and Amusa, 2001; Adejumo and Ikotun, 2003; Duangsong et al., 2016; Draghici și colab., 2022). Pathogens and pests, which attack this plant, become very dangerous in certain climatic conditions, even leading to the compromise of the crop. Manjesh et al., (2018) stated that in India the higher incidence of rust (*Uromyces vignae*) of

61.64% was recorded when cowpea were sown at closer spacings (45x30 cm), while at a closer spacing large (60x75 cm) the incidence of the disease was lower (33.86%). Following extensive experiences in arid areas such as Africa, Ajibade and Amusa (2001) reported that 64% of 74 cowpea lines evaluated were identified as susceptible to attack by the pathogen *Colletotrichum capsici*, with yield losses ranging from 46-74% depending on cultivar susceptibility. Currently, in the plant breeding process, respectively the cowpea, the selection for resistance to different biotic stress factors (e.g. pathogens) is assisted by microsatellite type molecular markers (SSR) (Diouf and Hilu, 2005; Pottorff et al., 2012; Omoigui et al., 2018). Also, disease resistance of the cowpea plant has generally been increased through selection works (Ogunkanmi et al., 2008; Drăghici et al., 2018; Pandiyan et al., 2020). In Romania, the results obtained regarding the testing of 15 cowpea genotypes in sandy soil conditions revealed the identification of two types of viruses: *Cowpea mosaic virus,* transmissible through vectors and through seed, *and Cowpea aphid borne,* a virus transmissible through aphids (Cojocaru et al., 1989). Of the two types of viruses identified in beans, the most present is the *Cowpea aphid borne mosaic virus*. The vector aphid species were found at the top of plant growth: *Aphis fabae Scopoli* (black beet aphid), *Macrosiphon euphorbiae* (striped potato aphid), *Aphis gossypi* (cucumber aphid) and *Acyrthosiphon pisum* (pea green aphid). The same studies highlighted cowpea bacteriosis, a disease caused by the species of bacteria *Xanthomonas campestris pv. vignicola* and *Pseudomonas syringae pv. Vignae*. Among the cryptogamic diseases, the most damaging under the conditions of sandy soils is the rust produced by *Uromyces appendiculatus*, the cowpea being attacked by the subspecies *Uromyces phaseolis-vignae*, in which, due to the biological peculiarities, infections occur permanently. Research shows that worldwide production losses caused by the pathogen *Uromyces phaseolis-vignae* can vary between 20-40% (Pamela et al., 2014). The research carried out by Zăvoi, (1967), on the sandy soils of Tâmbureşti, pointed out that the attack of rust manifests itself on all plant organs (leaves, stems, petioles, inflorescence, pods) and in all the phenophases of cowpea plant development. The growing leaves attacked by rust suffer deformations and after a while fall, and the plant remains defoliated. The pods are attacked only in the first stages, when they are in the erect position. Strong rust infections occur after periods of high atmospheric humidity and high temperatures. Among the pests, the common red spider *Tetranychus urticae*, reported by Zăvoi (1967) and Cojocaru et al. (1989), causes damage to cowpea during the flowering period, at the beginning of July, in conditions of severe drought. The attack of the mite is manifested by the appearance of white dots, visible on the upper side of the leaves, which, as the intensity of the attack increases, form red-brown spots. At maturity, the heavily attacked cowpea genotypes showed the entire surface of the leaf browned, and its backside was covered with cloth secreted by the mite. The average density of mites per leaf varied between 0.5–88.6 individuals. The degree of damage of the red spider can reach 70-77% in the specific conditions of sandy soils (Zăvoi, 1967; Cojocaru et al., 1989). Some of the pests that can cause significant production losses in cowpea are nematodes (*Meloidogyne species*, especially *Meloidogyne incognita*, *Meloidogyne javanica* and *Meloidogyne areneria*) (Adegbite et al., 2005; Huynh et al., 2016), the level of these losses reaching to vary between 20 and 69%. Taking into account what has cowpea presented, strategies to prevent and combat harmful agents (diseases, pests) in beans grown on sandy soils involve measures to reduce the impact on the environment, through the use of pesticides.

MATERIALS AND METHODS

The study was carried out in the period 2021-2022 from Research and Development Station for Plant Culture on Sands Dăbuleni (RDSPCS Dăbuleni), located in Southern Oltenia, Romania (43°48′04″N 24°05′31″E), with the aim of finding solutions to reduce the incidence of attack produced by the harmful agents identified in the culture of cowpea placed in a 3-year rotation: cowpea-rye-sorghum. The experiment was organized within a bifactorial experience, according to the method of subdivided plots, on a sandy soil with low natural fertility, poorly supplied in total nitrogen (0.051-0.078%), medium to normal supplied in extractable phosphorus (48-89.5 ppm), reduced to medium supplied in exchangeable potassium (62.5-99.5 ppm) and with a slightly acidic soil reaction (pH_{H2O}=6.05-6.70), under irrigation conditions (water consumption of the cowpea plant, during the vegetation period, was ensured from rainfall and irrigation by applying 3 waterings with norms of 250 m^3 water/ha). Various environmentally friendly products were tested on the cowpea crop, with a fungal role (*Polyversum* at a dose of 0.1 kg/ha; *Mimox* at a dose of 3 l/ha) and an insecticidal role (*Decis Expert 100EC* at a dose of 0.075 l/ha; *Bioinsekt* in a dose of 0.5-1 l/ha and *Neemex* in a dose of 1-1.25 l/ha), compared to untreated variants, in order to promote sustainable agriculture in the area of sandy soils. The products were applied in two vegetation stages of the cowpea plant (the phases of 3-4 true leaves and the appearance of flower stalks), by foliar spraying, using about 270-300 liters of water/ha. The dose of *Bioinsekt* and *Neemex* products was increased in the second treatment, when the plant registered a more developed leaf system.

The harmful agents present in the cowpea crop were identified, observations and determinations were made regarding the degree of pest attack, plant biometrics (height, leaf index), physiological indices (dry matter, water forms, vacuolar juice concentration) and productivity (number of pods/plant, number of grains per pod and grain production).

RESULTS AND DISCUSSIONS

Climate resource assessment

The analysis of the climatic conditions recorded at the weather station of RDSPCS Dăbuleni, highlighted the increase of thermo-hydric stress in the area, by the increase of 1.16 ^{0}C in the average air temperature from May-August 2021-2022 (cowpea growing season), compared with the multiannual average (Table 1). The drought intensified in July and August, when the average air temperature recorded values of 24.45-24.85 ^{0}C, with an increase of 1.87-1.85 ^{0}C, compared to the multi-year average. Rainfall in the amount of 142.6 mm, recorded during the plant consumption period (May-August), was unevenly distributed and insufficient for the growth and development of cowpea plants, necessitating the application of 3 waterings with a rate of 250 m^3 water/ ha. Although the cowpea is a drought tolerant plant, recent evidence shows that soil water stress during the early stages of vegetative growth and flower bud formation significantly affects crop growth and development with detrimental impact on plant yield (Omolayo et al., 2021).

Table 1. Evolution of climatic conditions* during the vegetation period of the cowpea crop

Climate conditions		Calendar month				Average / Amount
		May	June	July	August	
2021-2022	Average air temperature (⁰C)	17.95	22.3	25.45	24.85	22,64
	Rainfall (mm)	46.7	50.8	15.9	29.2	142,60
	Relative air humidity (%)	58.75	65.75	52.95	53.3	57,69
1956-2020	Average air temperature (⁰C)	17.65	21.73	23.58	22.97	21,48
	Rainfall (mm)	62.62	70.02	54.6	38.14	225,38
Temperature deviation from the multi-year average (⁰C)		0,3	0.57	1.87	1.88	1.16
Rainfall deviation from the multi-year average (mm)		-15,92	-19.22	-38.7	-8.94	-82.78

*AgroExpert weather station from RDSPCS Dăbuleni

Cowpea plant behavior to pest attack. Results obtained by Schwartz et al. (2005) specify that among the pathogens that can attack cowpea, the most important to be considered are those of a bacterial nature (*Xanthomonas campestris pv. vignicola*, *Pseudomonas syringae pv. vignae*) and those of a fungal nature (*Colletotrichum spp*., *Asochyta phaseoli*, *Uromyces spp*., *Pseudocercospora cruenta*, *Cercospora canescen*s, *Macrophomina phaseolina*, *Fusarium oxysporum*, *Erisyphe polygani*, *Rhizoctonia solani*, *Sclerotium rolfsii*, etc.). In arid areas of Africa, the pathogen *Colletotrichum capsici* has been identified as responsible for the production of anthracnose in cowpea (Allen and Lenne, 1998; Thio et al., 2016, 2017). Observations made on cowpea grown on the sandy soils of southern Oltenia, regarding the identification of pathogens, revealed sporadic infection with *Colletotrichum lindemuthianum*, which causes cowpea anthracnose, and the *Cowpea Mosaic Virus*, which causes Cowpea Common Mosaic, and Cowpea Yellow Mosaic Virus, which causes Cowpea Yellow Virus. Among the pests, a strong infestation of the plant with aphid species (*Aphis gossypii, Aphis fabae and Aphis craccivora*) was reported, also responsible for the transmission of viruses in the plant. At the same time, the presence of useful entomofauna was highlighted, namely the species *Coccinella septempunctata* in various stages of development (larva and adult), which was reported in all the observations made in the culture, including after the insecticide treatments included in the experiment. Aphids, and especially *Aphis gossypi*, are cosmopolitan species that attack cowpea in all cultivation areas, causing considerable production losses and due to the viruses they transmit (Ouédraogo et al., 2002; Huynh et al., 2015; Kusi et al., 2018). Since the attack of the pathogens was isolated and insignificant, the observations from the phytosanitary point of view regarding the behavior of the cowpea variety *Aura 26*, under conditions of treatments with different formulations of fungicides and insecticides, were depending on the degree of attack produced by aphids from the species *Aphis gossypii, Aphis fabae, Aphis craccivora*. The determinations regarding the degree of attack produced by aphids on the cowpea crop were made 7 days after the application of the treatments, respectively at the development of the ramifications of the stem and before flowering (Table 2). The pest attack degree (AD) varied throughout the experience between the limits of 0.53-3.11% (in the case of the first treatment) and 1.2-4.36% (in the case of the second treatment). Both fungicides used, respectively *Polyversum* and *Mimox*, also showed a slight insecticidal effect, the degree of pest attack recorded in both moments of determination was lower than in the case of the control variant. The best insecticidal effect applied to cowpea, with or without the combination with fungicides, was recorded with the application of the *Bioinsekt* product, in the case of both treatments. Thus, the best treatment variant that determined the registration of the lowest degree of aphid attack (AD=0.79%) was the application of two treatments with *Polyversum*, in a dose of 0.1 kg/ha + *Bioinsekt*, in dose of 0.5-1 l/ha, (Determination 1, AD=0.41%; Determination 2, AD=1.42%). It was also found that the *Polyversum* product, in combination with any of the insecticides tested, had the best effect, recording the lowest values of the degree of attack, calculated for both determination moments, underlining once again the effect its insecticide.

Table 2. The influence of phytosanitary treatments on the attack degree (AD) produced by harmful organisms in the cowpea crop grown under sandy soil conditions

The experimental variant		The development phase of the stem branches.			The phase of the formation of floral stems-flowering			Average AD (%)
Fungal products (dose/ha)	Insecticidal products (dose/ha)	AD (%)	Difference	Significance	AD (%)	Difference	Significance	
Untreated	Untreated	3.11	Control.	-	4.36	Control	-	3.74
	Decis Expert 100 EC (0,075 l)	0.75	-2.37	ooo	1.55	-2.81	ooo	1.15
	Bioinsekt (0,5-1 l)	0.69	-2.43	ooo	1.45	-2.92	ooo	1.07
	Neemex (1-1,25 l)	1.23	-1.89	oo	2.52	-1.84	oo	1.87
Polyversum (0,1 kg)	Untreated	2.89	Control	-	3.72	Control	-	3.30
	Decis Expert 100 EC (0,075 l)	0.44	-2.46	ooo	1.35	-2.37	oo	0.89
	Bioinsekt (0,5-1 l)	0.39	-2.50	ooo	1.20	-2.53	ooo	0.79
	Neemex (1-1,25 l)	1.06	-1.84	oo	2.33	-1.40	o	1.69
Mimox (3 l)	Untreated	2.92	Control	-	3.91	Control.	-	3.41
	Decis Expert 100 EC (0,075 l)	0.66	-2.26	ooo	1.53	-0.81	o	1.09
	Bioinsekt (0,5-1 l)	0.53	-2.39	ooo	1.20	-1.14	o	0.86
	Neemex (1-1,25 l)	1.71	-1.22	oo	2.63	0.30	-	2.17
	LSD 5%		*0.31*			*0.62*		
	LSD 1%		*1.05*			*1.43*		
	LSD 0,1%		*1.94*			*2.48*		

Physiological behavior of the cowpea plant under stress conditions

Originally from Central Africa, the cowpea is a leguminous plant, which, thanks to its special biological and morphological characteristics (very strong root system, with a great absorption power, waxy layer on the leaves), can very well capitalize on poorly productive lands in the category of sandy soils, having a high tolerance to thermo-hydric stress conditions, (Sinclair et al., 2015; Abe et al., 2015; Egashira et al., 2016; Sánchez-Navarro et al., 2021; Drăghici et al., 2022). Research results have proven that the plant's metabolism proceeds normally under the conditions of a healthy cultural state, correlated with the direct influence of environmental factors (Hamidou et al., 2007).

Table 3 shows the results obtained regarding the content of cowpea leaves in dry matter, forms of water (total, free and bound) and the vacuolar juice concentration

(VJC). The dry matter recorded the lowest value of 16.85% in the untreated version and a maximum of 20.23%, when treated with the *Polyversum* product (0.1 kg/ha), in combination with the *Bioinsekt* product (0.5-1 l /ha), which is an ecological insecticide with systemic action. Ensuring a healthy cultural condition in the cowpea can regulate the plant's defense mechanisms to stress factors on sandy soils. Thus, it was noted the increase in the percentage of bound water from 2.04%, a value recorded in the untreated phytosanitary version, to 2.8-3.42%, by applying treatments with products with fungicidal and insecticidal effects. The cowpea plants, which were applied two treatments with the *Polyversum* product (0.1 kg/ha) in combination with the *Bioinsekt* product (0.5-1 l/ha), behaved best under stress conditions, through binding a significant percentage of water at the cellular level (3.42%) and increasing the vacuolar juice concentration to the value of 10.2%.

Table 3. The influence of phytosanitary treatments on some physiological indices recorded in cowpea during the flowering phase

The experimental variant		Dry substance (%)	Total water (%)	Free water (%)	Bound water (%)	VJC (%)
A.Fungal products (dose/ha)	B.Insecticidal products (dose/ha)					
A1.Untreated	Untreated	16.85	83.15	81.11	2.04	8,1
	Decis Expert 100 EC (0,075 l)	18.39	81.61	79.19	2.42	8,9
	Bioinsekt (0,5-1 l)	18.48	81.52	78.56	2.96	9
	Neemex (1-1,25 l)	18.26	81.74	79.56	2.18	9,5
Average A1		18,00	82.00	79.60	2.40	8.88
A2. Polyversum (0,1 kg)	Untreated	19.76	80.24	78.07	2.17	9,3
	Decis Expert 100 EC (0,075 l)	20.18	79.82	77.12	2.70	9,35
	Bioinsekt (0,5-1 l)	20.23	79.77	76.35	3.42	10,2
	Neemex (1-1,25 l)	19.96	80.04	77.27	2.77	9,5
Average A2		20,03	79.97	77.20	2.77	9.59
A3. Mimox (3 l)	Untreated	17.35	82.65	80.02	2.63	9
	Decis Expert 100 EC (0,075 l)	19.07	80.93	78.70	2.23	9,5
	Bioinsekt (0,5-1 l)	18.60	81.40	78.60	2.80	9,8
	Neemex (1-1,25 l)	19.05	80.95	78.43	2.52	9,3
Average A3		18,52	81.48	78.94	2.54	9.53

Cowpea plant development and productivity

The development and formation of productivity elements in cowpea can be influenced both by the genetic character of the variety and by the abiotic factors that intervene during the vegetation period (Pandiyan et al., 2020; Omolayo et al., 2021). Analyzing the influence of phytosanitary treatments carried out on cowpea with non-polluting products for the environment, with fungicidal and insecticidal effect, differences were highlighted in terms of plant height, the number of pods/plant, the number of grains in the pod, the length of the pod and the leaf area index (Table 4). Thus, compared to the untreated variant, the application of phytosanitary treatments determined higher plant growth and better fruiting. The two fungicides tested, respectively *Polyversum*, in a dose of 0.1 kg/ha and *Mimox* in a dose of 3 l/ha had a similar effect regarding the vegetative aspect of the cowpea plant (plant height=95.5-96 .25 cm; 10.45-11.3 pods/plant; 11.25-11.5 grains/pod; pod length=13.7 cm; Foliar Index= 7.02-7.37), and among the insecticides, the products *Decis Expert 100 EC* (0.075 l/ha) and *Bioinsekt* (0.5-1 l/ha) had good effectiveness. The best development and fruiting results of the cowpea plant (Table 4; Photo 1) were obtained when applying the phytosanitary treatment with the biofungicide *Polyversum*, in a dose of 0.1 kg/ha and the insecticide *Bioinsekt*, in doses of 0, 5-1 l/ha (12.6 pods/plant, 12 grains/pod, pod length =14.4 cm and leaf area index =8.04). The degree of aphid attack significantly influenced the plant's resistance to stress factors (Figure 1). Thus, significantly negative correlations were established between the degree of attack with the content of bound water (r=- 0.618^0) and with the vacuolar juice concentration (r= -0.651^0).

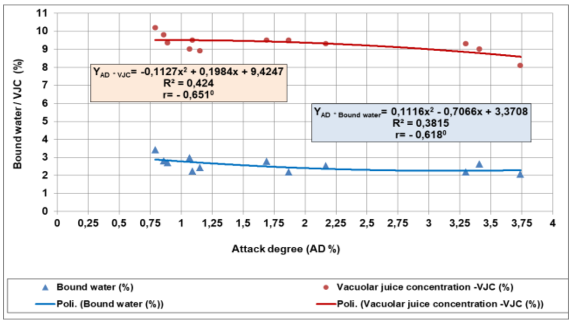

Figure 1. Correlations between the degree of pest attack with the percentage of bound water and the concentration of vacuolar juice recorded in the cowpea plant

Table 4. The influence of phytosanitary treatments on the biometric and productivity elements recorded in cowpea grown under sandy soil conditions

The experimental variant		Plant height (cm)	No. pods/plant	No. grains/pod	Pod lenght (cm)	Leaf area index (LAI)
A.Fungal products (dose/ha)	B.Insecticidal products (dose/ha)					
A1.Untreated	Untreated	86	8,8	8,2	11	5,96
	Decis Expert 100 EC (0,075 l)	83	10,2	9,4	12,4	5,89
	Bioinsekt (0,5-1 l)	75	9,2	9,2	12,8	6,21
	Neemex (1-1,25 l)	80	9,4	9,8	12,4	6,70
Average A1		**81**	**9,4**	**9,15**	**12,15**	**6,19**
A2. Polyversum (0,1 kg)	Untreated	90	10	10,4	12,2	6,74
	Decis Expert 100 EC (0,075 l)	99	11,2	12,2	14	7,18
	Bioinsekt (0,5-1 l)	101	12,6	12	14,4	8,04
	Neemex (1-1,25 l)	92	11,4	11,4	14,2	7,51
Average A2		**95,5**	**11,3**	**11,5**	**13,7**	**7,37**
A3. Mimox (3 l)	Untreated	92	9,4	10,8	13,6	6,17
	Decis Expert 100 EC (0,075 l)	95	10,2	11,6	13,4	6,98
	Bioinsekt (0,5-1 l)	104	11	11,4	14,2	7,92
	Neemex (1-1,25 l)	94	11,2	11,2	13,6	7,00
Average A3		**96,25**	**10,45**	**11,25**	**13,7**	**7,02**

Analyzing the results obtained in cowpea under the influence of the interaction of treatments with phytosanitary products with fungicide and insecticide effect, stood out with the highest production of 2725.2 kg/ha, the application of two phytosanitary treatments with the biofungicide *Polyversum,* in a dose of 0.1 kg/ha + the product *Bioinsekt*, in a dose of 0.5-1 l / /ha, which is an ecological insecticide with systemic action (Table 5). Figure 2 shows graphically the functional relationship between the degree of pest attack and the obtained grain production, with the help of a polynomial function whose correlation coefficient (r = - 0.821^{00}) indicates a distinctly significantly negative correlation.

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a) *Phase 3-4 branches of the cowpea plant*

b) *Flowering phase of the cowpea plant*

Photo 1 (a, b). Cowpea crop treated with *Polyversum* (0.1 kg/ha) + *Bioinsekt* (0.5-1 l/ha)

Table 5. The influence of phytosanitary treatments on the production of beans obtained in the cowpea culture under the conditions of sandy soils

Nr. Var.	The experimental variant		Grain Yield (kg/ha)	Difference		Significance
	Fungal products (dose/ha)	Insecticidal products (dose/ha)		%	kg/ha	
V1	Untreated	Untreated	1625.5	100.0	Control	Control
V2		Decis Expert 100 EC (0,075 l/ha)	2309.1	142.1	683.6	**
V3		Bioinsekt (0,5-1 l/ha)	2290.8	140.9	665.3	**
V4		Neemex (1-1,25 l/ha)	2202.9	135.5	577.4	*
V5	Polyversum (0,1 kg/ha)	Untreated	2238.3	100.0	Control	Control
V6		Decis Expert 100 EC (0,075 l/ha)	2690.8	120.2	452.5	*
V7		Bioinsekt (0,5-1 l/ha)	2725.2	121.8	486.9	*
V8		Neemex (1-1,25 l/ha)	2518.1	112.5	279.8	-
V9	Mimox (3 l/ha)	Untreated	2086.8	100.0	Control	Control
V10		Decis Expert 100 EC (0,075 l/ha)	2510.1	120.3	423.3	-
V11		Bioinsekt (0,5-1 l/ha)	2511.3	120.3	424.5	-
V12		Neemex (1-1,25 l/ha)	2420.6	116.0	333.8	-
				LSD 5%	*439.6*	
				LSD 1%	*602.8*	
				LSD 0.1%	*820.5*	

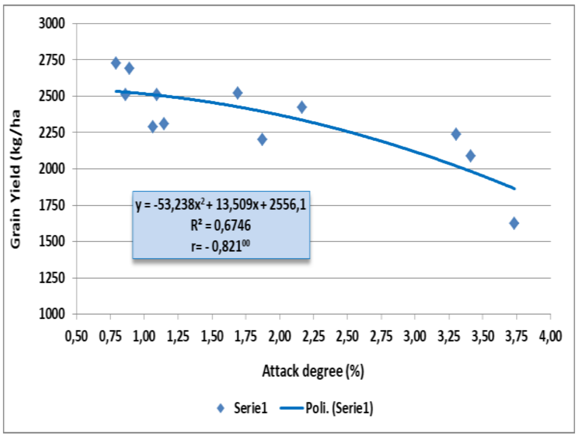

Figure 2. Correlation between the degree of pest attack and grain yield obtained in the cowpea crop under sandy soil conditions

CONCLUSIONS

The results obtained for cowpea highlighted the phytosanitary treatment with the biofungicide *Polyversum,* in a dose of 0.1 kg/ha and the insecticide *Bioinsekt,* in doses of 0.5-1 l/ha, which achieved the best phytosanitary control over the attack produced by the agents of damage to the plant (AD=0.79%), which was positively correlated with the development of the leaf apparatus and the productivity of the plant (leaf area index =8.04; number of pods/plant=12.6; number of grains/pod=12, pod length=14.4 cm).

The application of two treatments with the biofungicide *Polyversum,* in a dose of 0.1 kg/ha and the ecological insecticide *Bioinsekt,* in doses of 0.5-1 l/ha, in the phases of 3-4 true leaves and at the appearance of flower stalks, had as a result, a better behavior of cowpea plants under stress conditions, by binding a significant percentage of water at the cellular level (3.42% bound water), recording a higher content of dry matter (20.23%) and increasing vacuolar juice concentration (10.2%), with positive implications on the level of production achieved (2725.2 kg/ha).

A distinctly significant negative correlation (r=-0.821^{00}) was revealed between the degree of pest attack and cowpea production obtained.

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