Scientific Papers. Series A. Agronomy, Vol. LVII, 2014
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

# VULNERABILITY TO CONTAMINATION WITH PLANT PATHOGENS AND PESTS IN SPECIFIC CROP ROTATIONS OF AGROFORESTRY HOLDINGS ON SANDY SOILS

**Reta DRAGHICI, Iulian DRAGHICI, Milica DIMA**

Research - Development Center for Field Crops on Sandy Soils
207220, Dabuleni, Dolj County, Romania

Corresponding author email: retadraghici@yahoo.com

***Abstract***

*Researches regarding contamination with plant pathogens and pests, in specific rotation of agroforestry holdings on sandy soils, revealed the biological material and the climatic conditions as vulnerable points to infection. Determinations on Cowpea aphid borne virus infection in 144 cowpea genotypes, showsed a negative correlation between production and plant resistance to this pathogen, at 3-4 true leaves and flowering stages (r = - 0.792 **, r = - 0.744 **). In peanut the presence of f fusarium wilt, produced by Fusarium oxysporum f.sp. vasinfectum, that caused sporadic drying plant, was signaled with a frequency of 2.25 to 22%, depending on the genotype. In maize symptoms of infection caused by Fusarium moniliforme, Ustilago maydis and attack produced by Rhopalosiphum maidis and Ostrinia nubilalis were signaled, the degree and frequency of attack being in relation to genotype. The climatic conditions of the years 2012 and 2013 have influenced in different ways the cowpea plants infection with Pseudomonas syringae pv. vignae (Da = 18.85 to 20.64%) and Uromyces appendiculatus (Da = 12.6 to 34.7%).*

**Key words:** *diseases, genotype, pests, plants, sandy soils.*

## INTRODUCTION

Crop rotation as an agricultural practice is the cultivation of certain species into a well-determined succession, so that the resources of the soil may be depleted as little as possible, and risk of developing pests and diseases to be minimized.
The cultivation of leguminous plants (cowpea, peanuts) in crop rotation on sandy soils together with sorghum, maize, wheat and rye results in reductions the pathogens reserve and favors the development of subsequent crops of some vigorous plants with a well developed system of its own defense against pests and diseases. Agricultural ecosystems of sandy soils is an unfavorable environment for natural enemies like pathogens because of the high degree of disequilibrium as a result of anthropogenic perturbations and interventions (Cojocaru et al., 1996).
Studies show that the appearance and the development of pathogens can be determined by the coexistence of three factors: host, pathogen and external environment (Subrahmanyam et al., 2008, Newton et al., 2010).
The results obtained on sandy soils show that frequently climatic conditions at plant level can be changed compared to the data recorded by weather stations, significantly influencing infection and degree of plant pathogens attack (Oprea and Cojocaru, 1998; Draghici et al., 2013).
Thus, due to plant transpiration and large capacity of leaves to absorb direct sunlight in the leaves, humidity and temperature are higher than values in the rest of the atmosphere or soil, significantly influence the pathogen development and plant receptivity to infection produced by them.
The aim of our research was to establish the vulnerability points to contamination with plant pathogens in sandy soils

## MATERIALS AND METHODS

In order to determine the points of vulnerability to contamination with pathogens from specific crop rotations of agroforestry holdings on sandy soils, observations and determinations were performed regarding the influence of biological material on the behavior of plants to the pathogen attack and the influence of climatic conditions on the behavior of plants to the pathogens attack. In this context, in 2012-2013, at the Research - Development Center for Field Crops on Sandy Soils, Dabuleni reserch was focused on:

a- the behavior of 144 genotypes of cowpea germplasm collection to *Cowpea aphid - borne* virus using the FAO scoring scale (1-9), in different stages of plants vegetation;
b- the behavior of five maize hybrids to *Fusarium moniliforme* and *Ustilago maydis* and to *Rhopalosiphum maidis* and *Ostrinia nubilalis*;
c- the behavior of 10 genotypes of peanuts studied in germplasm collection to *Fusarium oxysporum* f.sp. *vasinfectum*;
d- the implications of climatic conditions of the years 2012 and 2013 on the attack of *Pseudomonas syringae pv. vignae* and *Uromyces appendiculatus* (Pers.), on the cowpea. Sixteen observations were made in different plant treatment variants (Table 1).

Table 1. Experimental variants

| Number of observation | Fungicides trade name | Dose/ concentration |
|---|---|---|
| 1,2,3,4 | Untreated | |
| 5,6,7,8 | Dithane M-45 | 0.2% |
| 9,10,11,12 | Shavit F72WP | 0.2% |
| 13,14,15,16 | Topsin 500 SC | 0.07% |

The phytosanitary treatments were applied at two stages of cowpea vegetation: 3-4 true leaf stage and flowering stage. Frequency, intensity and degree attack of pathogens the pesting agents were determined. The tolerance of maize hybrids to *Ostrinia nubilalis* were appreciated by the formula: average length of cavity minus the cavities minimum length of each hybrid ≤ 50% of average length of cavity minus the cavities minimum length of all hybrids (Bărbulescu and Cosmin, 1997). Climatic factors (air temperature, relative humidity and precipitations) registered at the weather station of RDCFCSS Dăbuleni were monitored and compared to the multiannual average.

## RESULTS AND DISCUSSIONS

Evolution of the monthly temperature and precipitation registered during 2012-2013 highlights the accentuation of drought phenomenon, compared to the multiannual average (Table 2). The average monthly temperature recorded in the 2012-2013 period, from April to September was 20.61°C, with 1.75°C higher than the multiannual average, and the precipitation sum was 269.3 mm, less with 43.65 mm. Of those two years studied, the climatic conditions were deficient in 2012, when in the period of intensive growth and differentiation of plant productivity elements (June to August) were recorded 62.4 mm precipitations and a temperature average of 24.7$^{0}$C, which resulted in a very low relative air humidity with an average of 55.72%.

The microclimate created at the plant level has influenced differently the occurrence of diseases and pests on the three plant species studied. One of the vulnerable points of crops from agroforestry holdings on sandy soils to infection with the pathogens and pest is represented by biological material used for sowing. Analyzing the resistance of 144 cowpea genotypes to *Cowpea aphid - borne* virus, in the phases of 3-4 true leaves and flowering, very a good resistance of the majority of the studied cowpea genotypes was recorded (notes 1-2). In the 3-4 true leaves phase, 7% of cowpea genotypes with high sensitivity (notes 5-7) and 17.3% with an sensitivity (notes 3-4) were identified.

Disease was manifested as leaves mosaic, with deformation and reduction of the leaf lamina, plants with bush aspect and which remained small.

The observations made at flowering phase, compared to those at for 3-4 leaves stage, emphasizes a higher resistance of the plant, in the sense that the plant developed lush leaves which has not been entirely affected.

Analyzing the dependence between the cowpea production and the plant resistance to infection with virus *Cowpea aphid borne* in the 3-4 leaves and flowering stages (Figure 1) is noticed a distinct significant negative correlation (r = - 0.792 **, r = - 0.744 **). The results are confirmed by researches conducted in 1989 by Doina Cojocaru et al., which revealed the presence by cowpea mosaic produced by *Cowpea aphid borne mosaic,* which is transmitted by aphids.

Table 2. The climatic conditions registered at RDCFCSS Dăbuleni weather station

| Decade | Climate | Year | The months | | | | | | Average / Sum |
|---|---|---|---|---|---|---|---|---|---|
| | | | April | May | June | July | August | September | |
| I | Average temperature ($^0$C) | 2012 | 11.5 | 19.3 | 21.8 | 26.7 | 26.5 | 21.8 | 21.27 |
| | | 2013 | 10 | 21.5 | 20.2 | 21.8 | 26.9 | 19.3 | 19.95 |
| | Precipitations (mm) | 2012 | 1 | 12 | 10.8 | 0 | 0 | 0 | 23.8 |
| | | 2013 | 34.4 | 0 | 2 | 32.6 | 0.2 | 1 | 70.2 |
| | Relative air humidity (%) | 2012 | 58.4 | 64 | 71 | 54.27 | 55.76 | 47.17 | 58.43 |
| | | 2013 | 90.24 | 64 | 77.06 | 84.5 | 63.3 | 69.2 | 74.72 |
| II | Average temperature ($^0$C) | 2012 | 13.2 | 15.8 | 24.1 | 26.5 | 21.7 | 18,8 | 20.02 |
| | | 2013 | 13.4 | 20 | 23.9 | 23.3 | 25,2 | 18.1 | 20.65 |
| | Precipitations (mm) | 2012 | 65.2 | 17.6 | 16.2 | 0.6 | 21.2 | 7.8 | 123.9 |
| | | 2013 | 4.2 | 7.6 | 26.8 | 0 | 12.2 | 7.4 | 58.2 |
| | Relative air humidity (%) | 2012 | 67.7 | 80.38 | 62 | 46.92 | 58.24 | 65.62 | 63.48 |
| | | 2013 | 77.3 | 69.4 | 73.11 | 71,9 | 65,1 | 70,0 | 71.14 |
| III | Average temperature ($^0$C) | 2012 | 17 | 16.6 | 24 | 27,2 | 24,6 | 19,2 | 21.43 |
| | | 2013 | 19.5 | 18.5 | 22.2 | 25,5 | 20,6 | 15,9 | 20.37 |
| | Precipitations (mm) | 2012 | 0,4 | 64.2 | 5.4 | 7.6 | 0.6 | 0,2 | 78.4 |
| | | 2013 | 0 | 53.4 | 76.4 | 3.6 | 18.4 | 27.4 | 179.2 |
| | Relative air humidity (%) | 2012 | 60.3 | 85.96 | 61.7 | 41.7 | 49.65 | 62.76 | 60.39 |
| | | 2013 | 64.32 | 79.2 | 80.17 | 64,8 | 75 | 78.1 | 73.60 |
| Average multiannual temperature ($^o$C) /1956-2013 | | | 11.7 | 16.7 | 21.6 | 23.1 | 22.33 | 17.7 | 18.86 |
| Average multiannual precipitations (mm) / 1956-2013 | | | 45.5 | 60.6 | 67.4 | 53.3 | 38.2 | 45.5 | 310.5 |

Table 3. Frequency of attack produced by *Rhopalosiphum maidis* and *Ostrinia nubilalis* to maize hybrids studied under conditions of sandy soils

| Maize hybrid | Frequency of attack - Rhopalosiphum maidis (%) | Frequency of attack - *Ostrinia nubilalis* (%) | The length of the cavity produced by *Ostrinia nubilalis* (cm/plant) | | | Behavior to *Ostrinia nubilalis* |
|---|---|---|---|---|---|---|
| | | | minimum | maximum | average | |
| Milcov | 15.1 | 13.6 | 3.2 | 4.9 | 3.6 | Tolerant |
| Mostiştea | 15.5 | 15 | 3.6 | 5.2 | 4 | Tolerant |
| Paltin | 15.8 | 10 | 2.5 | 4 | 2.9 | Tolerant |
| Crişana | 13.05 | 21.7 | 2.6 | 6.9 | 5.2 | Sensitive |
| F 376 | 11.6 | 14.2 | 2.7 | 4.7 | 3.1 | Tolerant |
| x | x | x | 2.92 | x | 3.76 | x |

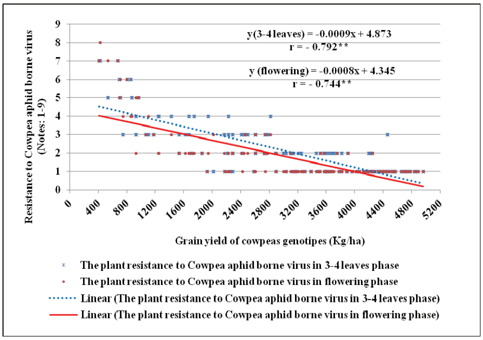


Figure 1. Correlation between *Cowpea aphid borne virus* infection and grain yield obtained from 144 cowpea genotypes

The aphids attack (*Rhopalosiphum maidis*) was recorded on leaves, stem and cob of maize plants at cob - grain formation phase, with a frequency between 11.6 to 15.8%, depending on the hybrid (Table 3).

In climatic conditions of 2013 observations have highlighted the presence of *Ostrinia nubilalis* with a frequency of attack between 10 to 21.7% on stems and cob. The tolerance of maize hybrids, appreciated by the formula: average length of cavity minus the cavities minimum length ≤ 50% (3.76 - 2.92 = 0.84), emphasizes good behavior at four from the five hybrids studied in which was recorded a difference between the average and the minimum length cavities produced by *Ostrinia nubilalis* less than 0.42 cm. The maize hybrid tolerance was positively correlated with the attack frequency of this pest. The highest frequency of *Ostrinia nubilalis* was registered at Crişana hybrid (21.7%) and the lowest values were recorded at Paltin and Milcov hybrids (10 to 13.6%). In 2012 at the end of July and in August have been identified plants with *Ustilago maydis* (common corn smut) symptoms. The disease manifests as tumors on the stems and cob and had a degree of attack varying between 0-12.5%, which was negatively correlated with the grain production obtained (Figure 2).

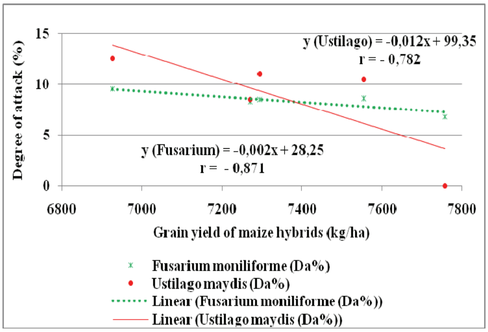


Figure 2. Correlations between the degree of attack of *Fusarium moniliforme* and *Ustilago maydis* and grain yield obtained in five maize hybrids

Although in this year (2012) were recorded average temperatures of 24.3 to 26.4°C, favorable to *Ustilago maydis* infection, lack of precipitations have limited the attack. The observations of harvested maize cob emphasises symptoms of infection caused by *Fusarium moniliforme*, the degree of attack of the five studied hybrids of maize, correlating negatively with production (Figure 2). Known as the „white flowering of grains", the disease was favored by high temperatures registered in the two years, the attack level is between 6.8 to 9.6%.

In peanut crop, the specific environmental conditions of sandy soils have favored the spread and evolution of a broad spectrum of pathogenic fungi belonging to the genus *Fusarium*, the most common being *Fusarium oxysporum f.sp. vasinfectum* (Şearpe et al., 2001). The attack was favored by high soil temperature (the optimal threshold of 27°C), possibly by alternation of soil moisture and not least by the lack of organic matter, microclimate which was present during the studied period. The observations performed from 10 peanut genotypes have shown the presence of *Fusarium oxysporum* as total or partial drying plants, with an average of 13.41% (Figure 3).

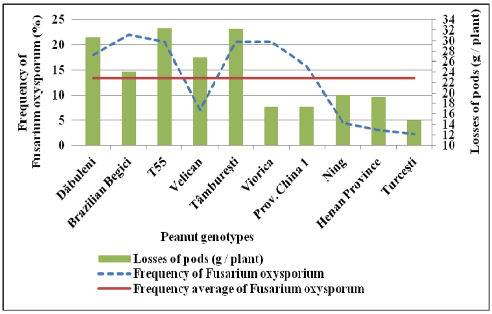


Figure 3. Frequency attack of *Fusarium oxysporum f.sp. vasinfectum* on peanut genotypes cultivated on sandy soils

The symptoms of peanuts plant infection with this fungus were present with a higher frequency during August-September (F% = 2.25 to 22). Infection of the plant with *Fusarium oxysporum* has reduced the number of pods per plant, the losses ranging from 14.7 to 32.3%, depending on the genotype.

The microclimate created at the level of leaves was a vulnerability factor to contamination with pathogens, respectively *Pseudomonas syringae pv. vignae* and *Uromyces appendiculatus (Pers.)*. Analyzing the cowpea plant resistance to *Pseudomonas syringae* and *Uromyces appendiculatus*, differences in the degree of attack, were recorded depending on climatic conditions (Figures 4 and 5).

The high air temperatures, with an average of 16.6 to 18.5°C and the maximum 31.8 to 32.5°C associated with a high relative air humidity (79.2 to 85.96%), in the last decade in May, have created favorable conditions in the two years of study for plant infection with *Pseudomonas syringae pv. vignae* (Figure 4).

The attack continued throughout the month of June, when bacteria has found favorable climatic conditions deployment the biological cycle (20.2 to 21.8°C air temperatures and quantity of precipitations summed from 32.4 to 105.2 mm). In these conditions, in 2013 the degree of attack on cowpeas was between 15.9 to 33.6%, with 5.65 to 19.5% higher than the attack recorded in 2012.

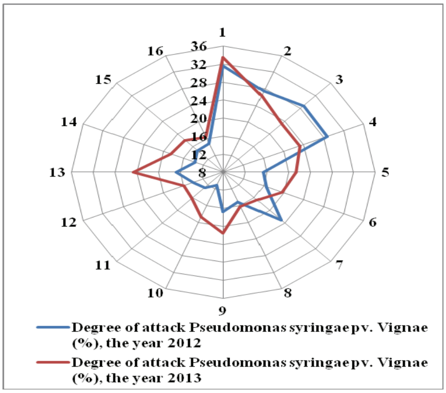


Figure 4. The influence of climatic conditions and phytosanitary treatment on the degree attack of *Pseudomonas syringae* pv. *vignae* on cowpea

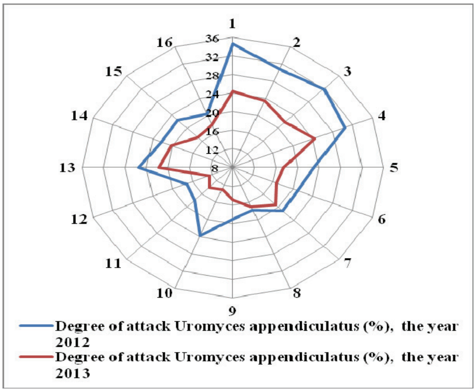


Figure 5. The influence of climatic conditions and phytosanitary treatment on the degree attack of *Uromyces appendiculatus* on cowpea

It showed an average degree of attack produced by bacteriosis 18.85% in 2012 and 20.64% in 2013, being known the fact that the bacteria grow at temperatures of 26-28°C and high relative humidity.

In the stage of differentiation the rods floral of cowpeas crop were observed rust infections, produced by *Uromyces appendiculatus* (Pers.), manifested with virulence during flowering phenophase-formed pods, a period which coincided with the end of June - first half of July. Observations made on rust attack is on cowpea crop, have shown values ranging from 12.6 to 24.5% in 2013 and 17.3 to 34.7% in 2012 (Figure 5).

The average of degree of attack of *Uromyces appendiculatus* (Pers.) was 23.75% in 2012 and 18.54% in 2013. Although the climatic conditions created in the period June-July 2013 were more favorable to infection caused by this pathogen (22.2 to 23.3°C average temperature in air with a relative humidity of 80.17 to 84.5%) compared to those recorded in 2012 (average temperatures 24-26.7°C and relative humidity of 46.9 to 61.7%), however, the degree of attack registered in 2012 it was with 28.1% higher than that recorded in 2013. The explanation lies in maintaining a higher humidity at leaves level, created through sprinkler irrigation applied more frequently in 2012, as a result of persistent drought. High temperatures of 24 to 26.7°C, associated with prolonged wetting of leaves, has created a favorable environment for the development the fungus spores and producing the successive infections in foliar apparatus.

| *Legend of Figures 4, 5:* | |
|---|---|
| 1,2,3,4……….. | Untreated |
| 5,6,7,8……….. | Dithane M-45 - 0.2% |
| 9,10,11,12……. | Shavit F72WP - 0.2% |
| 13,14,15,16…... | Topsin 500 SC - 0.07% |

The phytosanitary treatments applied in cowpea crop with Shavit F72WP, in concentration of 0.02% (average of observations 9,10,11,12) had the best efficacy in preventing and controling *Pseudomonas syringae pv. vignae*, the degree attack recording an average of 15.86%, with 43.21% less, compared to the untreated variant, where the degree of attack was 27.93% (average of observations 1, 2, 3, 4).

Also systemic and contact action of the Shavit F72WP, applied at 0.2%, was highlighted through reducing with 40.3% the attack of *Uromyces appendiculatus* (Pers.), compared with untreated variant, where the degree attack was 27.8% (Figure 5).

## CONCLUSIONS

The biological material used in seeding is one vulnerable points to infection with plant pathogens and pests in agroforestry holdings on sandy soils.

Out of the 144 genotypes of cowpeas, 75.7% were characterized as highly resistant (notes 1-2) to infection produced by *Cowpea aphid borne virus,* 7% with high sensitivity (notes 5-8) and 17% with sensitivity (notes 3-4), with a negative correlation between production and plant resistance to this pathogen at 3-4 true leaves and flowering phases (r = - 0.792 **, r = - 0.744 **).

In peanut, the presence of fusarium wilt caused by *Fusarium oxysporum f.sp.vasinfectum*, was signaled, with dried plants symptoms and with 2.25 to 22%, frequency depending on the genotype.

In maize, symptoms of infection caused by *Ustilago maydis* (Da 0-12.5%) and by *Fusarium moniliforme* (Da 6.8 to 9.6%) were signaled, as well as *Rhopalosiphum maidis* and *Ostrinia nubilalis* attack. A good behavior to Rhopalosiphum and Ostrinia and to pathogens also showing the hybrids Milcov, Mostiştea, Paltin şi F 376.

The climatic conditions of the years 2012 and 2013 influenced differently the degree of attack of *Pseudomonas syringae pv vignae* on cowpea (Da = 18.85% in 2012; Da = 20.64% in 2013) and *Uromyces appendiculatus* (Da = 23.75% in 2012; Da = 18.53% in 2013).

The phytosanitary treatment of the cowpea crop with Shavit F72WP (0.2%) had the best efficacy in preventing and controling *Pseudomonas syringae pv. vignae* and *Uromyces appendiculatus.*

## AKNOWLEDGEMENTS

The paper is a part of the ADER Project 5.1.2, from Sectorial Programme "ADER 2020", funded by Ministry of Agriculture and Rural Development-Romania.

## REFERENCES

Bărbulescu Al., Cosmin O., 1997. Consagvinizate lines of maize from Fundulea, characterized by a certain degree of resistance against Ostrinia nubilalis Hb. The Problem of the Protection of Pants, Vol XXV, no. 1, p. 1-8.

Cojocaru D., Bleoju M., Niucolaescu M., 1989. The behavior of some lines of cowpeas to pests and diseases attack from Dăbuleni sands area. Central Research Station for Plant Culture on Sands, Dăbuleni. Volume VII, p. 187-197.

Cojocaru D., Nicolaescu M., Severin V., Stancescu C., Bleoju M., 1996. Mosaic and bacteriosis of cowpea. Testing the Means for Plant Protection, vol. XXIV, p. 65-70.

Draghici R., Draghici I., Diaconu A., Croitoru M., Andrei A.M., 2013. Study on identification and involvement pesting agents in physiology and productivity some maize hybrids grown on sandy soils. Romanian Journal for Plant Protection, Vol. VI.

Newton A.C., Gravouil C., Fountaine J.M., 2010. Managing the ecology of foliar pathogens: ecological tolerance in crops, Annals of Applied Biology ISSN 0003-4746. doi:10.1111/j.1744-7348.2010.00437.x., Scotland, UK.

Oprea M., Cojocaru D., 1998. Results on the the study and prevention of pathogens peanuts, Anal ICPP Bucharest, Vol XXV.

Subrahmanyam P., Williams J. H., McDonald D., Gibbons R.W., 1984. The influence of foliar diseases and their control by selective fungicides on a range of groundnut *(Arachis hypogaea* L.) genotypes. Annals of Applied Biology. Volume 104, Issue 3, pages 467–476, June 1984. Article first published online: 26 FEB 2008. DOI: 10.1111/j.1744-7348.1984.tb03029.x.

Şearpe D., Ciolacu F., Dima M., 2001. Behavior of wheat, maize, sunflower and peanuts cultivars to attack pathogens and pests, Scientific Papers SCCCPN Dabuleni, vol. XIII, p. 145-156.