RELATIONSHIP BETWEEN THE MAIZE PEST *DIABROTICA VIRGIFERA VIRGIFERA LE CONTÈ* AND THE CLIMATIC FACTORS, TROUGH MODERN STATISTICAL ANALYSIS ANOVA (BRAVAIS – PEARSON) IN THE WESTERN PART OF ROMANIA

RELAŢIA DINTRE NOUL DĂUNĂTOR AL PORUMBULUI *DIABROTICA VIRGIFERA VIRGIFERA LE CONTÈ* ŞI FACTORII CLIMATICI PRIN ANALIZA STATISTICĂ MODERNĂ (BRAVAIS – PEARSON) ÎN PARTEA DE VEST A ROMÂNIEI

GH. POPESCU*, FLOAREA ADAM*, IOANA GROZEA*, IRINA ORIOL**

**Banat's University of Agricultural Sciences and Veterinary Medicine Timişoara, Romania*

Abstract: *The aggression of the new maize pest Diabrotica virgifera virgifera Le Conté was studied during the period 2006/2007, in Sagu, at S.C. Agrogil (Arad), from rhizotrophic (larvae), phylotrophic and stigmatrophic (adults) viewpoints, under conditions of connection to a trophic base represented by 8 „Pioneer" maize hybrids and under the climatic factors' influence. The values of pest's aggression - as dependent, resulting factor or as dependent variable and of the climatic factors – as independent, influencing factors or as independent variables are presented in table 1. The data was statistically processed, with the help of the software SPSS, ANOVA variance analysis, analysis of regression and of correlation. There is a moderate relationship (correlation) between the factors of influence (independent), namely the climatic ones and the resulting factor (dependent), actually the aggression (F%) of the new maize pest (Diabrotica); data regarding „relative humidity", „wind" and „temperature" were homogeneous, and „rainfall", „dew", „nebulosity" and the dependent factor (F%) proved to be inhomogeneous. The method of exclusion, step by step, of the independent variables from the models designed proves that there is a very strong correlation between the climatic (influencing) factors and the rhizo-phylo-strigmatrophic aggression of the new pest Diabrotica, when the model includes all independent variables (temperature, RH, rainfall, wind, dew and nebulosity); this phenomenon is confirmed by the Pearson values (R=0.972), the „determination" values*

(R-Square=0.946), the values ensuring the results (Sig. F=0.052, namely over 5%) and by the concept Durbin-Watson. ANOVA variance analysis and the analyses of regression correlation lead us to the conclusion that the new maize pest (Diabrotica virgifera virgifera) is strongly influenced by humidity; rainfall and humidity have a negative influence (-0.9; -0.5), while „dew" is positive (0.9); „nebulosity", like „dew", is positive (0.90). The conclusions regarding „dew" and „nebulosity", and the conclusion that „wind" is important only when is connected to the other independent variables, are original and represent a national premiere. The testing of the influencing factors excluded from data analysis (from models) signifies (only when the factor Sig.F., the one that ensures the results, is not below 5%) that the dependent factor F% may ***increase*** *(positive influence, for example the temperature excluded would have increased F% with 0.664 units and nebulosity with 1.415 units) or* ***decrease*** *(negative influence, it would have decreased F% with 0.2-0.5 units). „Wind speed" (very important for dissemination of pathogens) did not assume the quality of accessible variable; it had reduced values, homogeneous or mild, despite the high values of maize pathogens' aggression (Helminthosporium turcicum – 84.3%, Fusarium roseum – 46.7%). In this situation, our general conclusion, of national premiere, is that the new pest, beside other independent variables (positive), assumed the role of „dissemination" and „amplification" of their pathogenesis (it has a trophic attitude against leaf blight).*

Rezumat: *Agresivitatea noului dăunător al porumbului Diabrotica virgifera virgifera Le Conté a fost urmărită perioada 2006/2007, în localitatea Şagu S.C. Agrogil (Arad) sub aspect rizotrofic (larve), filotrofic şi stigmatrofic (adulţi) în condiţii de conexare la o bază trofică reprezentată de 8 hibrizi de porumb „Pioneer" şi de influenţă a factorilor climatici. Valorile agresivităţii*

*dăunătorului – ca factor dependent, rezultativ sau variabilă dependentă cât şi ale factorilor climatici – ca factori independenţi, de influenţă sau variabile independente sunt prezentate în tabelul 1. Datele au fost prelucrate statistic, folosindu-se de softul SPSS, analiza variantei ANOVA, analiza de regresie şi corelaţie. Între factorii de influenţă (independenţi), adică cei climatici şi factorul rezultativ (dependent), de fapt agresivitatea (F%) noului dăunător al porumbului (Diabrotica) există o legătură (corelaţie) moderată; omogene au fost datele privind „umiditatea relativă", „vântul " şi „temperatura", iar neomogene s-au dovedit „precipitaţiile", „roua", „nebulozitatea" şi factorul dependent (F%). Metoda exculderii pe rând a variabilelor independente, din modelele concepute, ne demonstrează că între factorii climatici (de influenţă) şi cel care se referă la agresivitatea rizo-filo-stigatrofică a noului dăunător Diabrotica, există o corelaţie foarte puternică când în model sunt incluse toate variabilele independente (temperatura,UR, precipitaţii, vântul, roua şi nebulozitatea); fenomenul este confirmat de valorile Pearson (R=0,972), a celor de „determinaţie" (R-Square=0,946), de cele de garantare a rezultatelor (Sig. F=0,052, adică peste 5%) şi de conceptul Durbin-Watson. Analiza variantei ANOVA, cea a regresiei, a corelaţiei, ne conduce la concluzia că noul dăunător al porumbului (Diabrotica virgifera virgifera) este puternic influenţat de umiditate; influenţă negativă au precipitaţiile (-0,9), umiditatea (-0,5), în timp ce roua este pozitivă (0,9); nebulozitatea, ca şi roua, este pozitivă (0,90). Concluziile referitoare la „rouă" şi „nebulozitate", cât şi cea că „vântul" este important numai atunci când este conexat la celelalte variabile independente , au caracter original şi au premieră naţională.Testarea factorilor de influenţă excluşi din analiza datelor (din modele), ne semnifică faptul (numai în condiţiile în care factorul Sig. F, cel care garantează rezultatele nu este sub 5%), că factorul dependent F% poate **creşte** (influenţă pozitivă, de exemplu temperatura exclusă ar fi crescut F% cu 0,664 unităţi; nebulozitatea cu 1,415 unităţi), sau **scade** (influenţă negativă, adică ar fi scăzut F% cu 0,2-0,5 unităţi). „Viteza vântului" (foarte importantă în diseminarea patogenilor) nu şi-a luat calitatea de variabilă influenţabilă, a avut valori reduse, omogene sau liniştite, în ciuda valorilor ridicate ale agresivităţii patogenilor porumbului (Helminthosporium turcicum – 84,3%, Fusarium roseum – 46,7%). În acest caz concluzia noastră originală şi de premieră naţională este că noul dăunător alături de alte variabile independente (pozitive) şi-a luat rolul de „diseminare" şi „amplificare" a patogeniei acestora (faţă de tăciune are o atitudine trofică).*

Key words: *Diabrotica, aggression, rhizotrophic, phylotrophic and stigmatrophic aggression, statistic SPSS, ANOVA.*
Key words*: Diabrotica, agresivitate: rizotrofică, filotrofică şi stigmatrofică, statistic SPSS, ANOVA.*

INTRODUCTION

For the new maize pest - *Diabrotica virgifera virgifera Le Conté*, the **thermal factor** as requirement for growth, development, egg deposition and etiology was researched and concluded by D.E. KUHLMAN (1970), J.J. JACKSON, J.R. FISHER (1989), S.H. OLOUMI, E. LEVINE (1989), N.C. ELLIOTT (1992), F. BAČA et al. (1995), R.C EDWARDS (2000), F. BAČA, D. LOPANDIC (2001), IOANA GROZEA (2003a, b), M.M. ELLSBURY, R.E. LEE JR. (2004), F.B. PEAIRS, S.D. PILCHER (2006), FLOAREA ADAM, IOANA GROZEA, GH. POPESCU, D. JURCA (2007), FLOAREA ADAM, IOANA GROZEA, GH. POPESCU (2007). Regarding **humidity**, mentions of the role of rainfall and relative humidity are made by R.C. EDWARDS, 2000; AL. BĂRBULESCU, 2000; F. BAČA, D. LOPANDIC, 2001; IOANA GROZEA, 2002, 2003, 2006, etc.).

There are not any specifications regarding the influence exerted by dew, nebulosity and wind speed; this objective, beside the climatic research in a new geographical region (Arad), with the help of the software Statistical Package for the Social Sciences (high quality software) represent a national premiere and the aim of this work.

MATERIAL AND METHOD

Within a biotrophic diversity represented by „Pioneer" maize hybrids, belonging to different maturity groups (PR 39 D81 – extra early; PR 38R92 - early; PR 38A24, PR 37D25,

PR 37M34, PR 37W05 – mid early; PR 35P12, PR 36K67 – mid late), we studied, in Arad region (2006 - 2007), the **phylotrophic** (Gr. Phyllon, Fr. phyllo-, It. fillo-, = leaf; Gr. trophikos Fr. trophique-, = nutrition), **rhizotrophic** (Gr. Rhiza, Fr. rhizo-, It. rizo-,) and **stigmatrophic** (Lat., Gr. stigma – the superior part of a flower's pestle) activity of the new pest *Diabrotica virgifera virgifera Le Conte*, in relationship with the climatic factors. Data regarding the dependent factor, namely the new pest *Diabrotica*, and also those regarding the independent variables (climatic factors) were statistically processed with the help of the software SPSS, ANOVA variance analysis, analyses of regression and correlation, the coefficients of correlation Pearson, of determination R. Square, of the concept Durbin-Watson and the results' ensuring factor (Sig. F).

RESULTS AND DISCUSSIONS

The climatic data for the period June-August 2006 and 2007, considered as independent variants or factors of influence, and also the experimental data regarding the attack of *Diabrotica virgifera virgifera* on roots (rhizotrophic activity) determined by larvae, leaves (phylotrophic activity) and stigma (stigmatrophic activity), in fact the dependent factor F% (aggression) or the resulting factor, are presented in table 1; at Observations, we may notice the average aggression in the 8 Pioneer hybrids. In 2006, regarding the three types of activity, we recorded attack percentages of 7.52% (rhizotrophy), of 41.26% (phylotrophy) and of 51.0% (stigmatrophy); in 2007, the aggression of the new maize pest had very big values, for example 40.75% (rhizotrophic), 65.5% (phylotrophic) and 92.3% (stigmatrophic). The biannual mean of the independent factor (F%) was 42.0% (table 1). Data included in table 1 was statistically processed, with the help of the software SPSS (Statistical Package for the Social Sciences), a high quality and much applied statistical software.

There is a moderate relationship between the influencing and the resulting factor, in 2006 (relative humidity, wind speed, temperature), with the specification that we recorded big variations in rainfall, nebulosity, dew, in the case of the independent variables; the biggest variation was in the dependent factor F%, and the homogeneity degree compared to the factors mentioned above is given by the homogeneity coefficients (table 2).

So, the most homogeneous data are given by RH (coefficient 9.06%), wind speed (14.24%), temperature (18.24%), and the most inhomogeneous are the data given by the other factors (22.97-87.67%). The same degree of homogeneity was maintained in 2007, too. In an accurate analysis, we may observe that we did not record any high degree homogeneity and in this situation we must study their influence exerted on the dependent variable (F%).

To establish the intensity of the correlation between the variables studied, if it is high, moderate or low, we applied the method of exclusion step by step from the model (3 models in 2006 and 4 models in 2007) – table 3. The variables' inclusion into the models may be seen in the „Predictors" below tables. The values from 2006 belonging to the correlation coefficient Pearson (R), to the determination coefficient R Square and the case of the 3 models (0.962-0.972), proves that there is a high correlation (the highest in model 1, followed by models 2 and 3) between the factor of influence (climatic) and the one related to the rhizo-phylo-stigmatrophic aggression of the new maize pest – *Diabrotica*. Moreover, the existence of such significant relationships between variables is confirmed by the concept Durbin-Watson, too (in models' order: 1.58, 1.59, 1.48) – table 3. Regarding 2007, the values confirming the existence of a strong correlation between „cause" and „effect" are slightly reduced (from „very strong" to „strong").

The ANOVA variance analysis and the analysis of correlation regression makes evident the direction and intensity of the correlation or relationship between the factors introduced into the software SPSS. So, we noticed that, in 2006, the relationship achieved

between the value „F calculated" (Fc) and „F table" (Ft) was Fc<Ft or 8.703<19.33, in model 1, with a „Sig F" of 5.2% (results' ensuring significance"; for models 2 and 3, the Sig F values are below 5% (1.4, respectively 0.5%). The conclusion is that the factors „dew", „rainfall", „wind speed", „relative humidity", „nebulosity" exert a significant influence on the factor F% (in model 1, because Sig F is 5.2%, it makes the null hypothesis to be accepted, and in models 2 and 3, it is rejected because it is below 5%). The correlation coefficients show us that rainfall, wind and relative humidity exert a negative influence on the factor F% (-0.9; -0.3; -0.5), while dew and nebulosity influences it positively (0.96; 0.90). In 2007, Sig. F values are below 5% (2.5% -model 1; 1.0% - model 2; 4.9% - model 3; 4.5% - model 4) and in this situation the null hypothesis may be accepted. In model 1, the positive influences are exerted by dew, nebulosity and wind speed, in model 2 – RH and wind, and only relative humidity in models 3 and 4. Negative action is exerted only by the factor humidity – table 4.

The statistical calculation regarding the „testing of the factors excluded from data analysis" (table 5) signifies the following: the temperature excluded from table 2 would have exerted a positive influence (correlation coefficient 0.664 and Sig. F over 5%, namely 0.69); in model 3, this factor would have influenced negatively (-0.412; Sig. F -4.5%). On the contrary, „nebulosity" (1.415), without ensuring the result (Sig. F -0.33; namely below 5%) would have increased the dependent factor F% with 1.415 units. In 2007, nebulosity exerts the same influence, and wind and dew would have had a negative influence which would have decreased the dependent factor F% with 0.2-0.5 units - table 5.

Table 1

Meteorological variables used in statistic calculus during the studied period (Jun. – Aug.) 2006-2007

Pest	Observation data	Climatic factors (averages)						F%
		Temp. (°C)	Relative humidity (%)	Rainfall (mm)	Wind speed h=2m	Total neb. (0-10)	Dew (hour)	
2006								
Diabrotica (rhizotrophy)	15 June	14.5	75	51	1.9	7.2	33^{35}	3.26
	3 July	23.4	71	54.8	1.4	4.0	76^{30}	4.23
	17 July	22.1	63	37.7	1.8	3.1	73^{20}	5.6
	1 August	24.8	64	27.6	1.3	2.2	63^{25}	7.52
Diabrotica (phylotrophy)	15 June	14.5	75	51	1.9	7.2	33^{35}	6.06
	3 July	23.4	71	54.8	1.4	4.0	76^{30}	20.55
	1 August	23.5	63	65.3	1.5	2.6	136^{45}	35.70
	14 August	19.6	78	55.7	1.5	7.1	15^{35}	41.26
Diabrotica (stigmatrophy)	1 August	24.1	63	37.6	1.4	2.7	63^{25}	46.40
	14 August	19.6		55.7	1.5	7.1	15^{35}	51.0
Aggr. att. aver. (mean) – 22,15								
2007								
Diabrotica (rhizotrophy)	15 June	21.1	68	32.6	1.5	5.1	52^{00}	5.50
	3 July	23.2	57	26.2	1.8	3.4	32^{35}	18.28
	17 July	21.6	61	34.2	1.8	4.5	26^{25}	36.98
	1 August	25.9	45	7	1.7	2.3	7^{05}	40.75
Diabrotica (phylotrophy)	15 June	21.1	68	32.6	1.5	5.1	52^{00}	19.07
	3 July	23.2	57	26.2	1.8	3.4	32^{35}	36.63
	1 August	23.8	52	41.2	1.8	3.4	33^{30}	51.75
	14 August	21.3	66	56.4	1.7	5.3	26^{50}	65.5
Diabrotica (stigmatrophy)	22 July	24.1	54	34.2	1.8	3.4	31^{00}	53.8
	5 August	22.6	51	13.8	1.8	3.5	7^{05}	92.3
Aggr. att. aver. (mean) – 42,0								

Table 2

Mean and standard deviation for analyzed factors

Analyzed variables	Mean		Std. Deviation		Homogeneity coefficients	
	2006	2007	2006	2007	2006	2007
Rel. humid (%)	70,10	57,90	6,34	7,78	9,06	13,44
Wind speed (m/s)	1,56	1,72	0,22	0,12	14,24	7,15
Temp. (°C)	20,95	22,79	3,82	1,56	18,24	6,88
Rainfall (mm)	49,12	30,44	11,28	13,70	22,97	45,01
Total nebul. (0-10)	4,72	3,94	2,16	0,99	45,89	25,24
Dew (hours)	58,61	29,98	36,45	15,16	62,19	50,59
F (aggress. att.)	22,158	42,05	19,42	25,37	87,67	60,33

Table 3

Multiple regression models resulted from statistic calculus

Mod.	R		R Square		Adj. R Square		Std. err. of the estimate		Change statistics						Durbin -Watson	
									R Square Change		F Change		Sig. F. Change			
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1	0,972 [a]	0,910 [a]	0,946	0,827	0,837	0,482	7,842	18,26	0,946	0,827	8,703	2,39	0,052	0,253	1,583	1,123
2	0,971 [b]	0,909 [b]	0,942	0,827	0,870	0,611	6,998	15,83	-0,003	0,000	0,185	0,006	0,696	0,942	1,598	1,125
3	0,962 [c]	0,898 [c]	0,925	0,807	0,865	0,652	7,147	14,96	-0,018	-0,020	1,215	0,46	0,332	0,533	1,488	1,218
4	-	0,845 [d]	-	0,714	-	0,571	-	16,61	-	-0,093	-	2,39	-	0,182	-	1,469

2006 a. Predictors: (Constant), Dew, Rainf., Wind Sp., Temp., Rel. humid., Neb.
b. Predictors: (Constant), Dew, Rainf., Wind Sp., Rel. humid., Neb.
c. Predictors: (Constant), Dew, Rainf., Wind Sp., Rel. humid.
d. Dependent variable: F

2007 a. Predictors: (Constant), Temp., Wind Sp., Rainf., Dew, Rel. humid., Neb.
b. Predictors: (Constant), Temp., Wind Sp., Rainf., Dew, Rel. humid.
c. Predictors: (Constant), Temp., Rainf., Dew, Rel. humid.
d. Predictors: (Constant), Temp., Rainf., Rel. humid.
e. Dependent variable: F

Table 4

ANOVA (Analysis of variance) results

Model		Sum of Squares		df		Mean Square		F. calc.		F tab. 5%		Sig. F	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1	Regression	3212,00	4792,35	6	6	535,33	798,72	8,703	2,395	19,33	19,33	0,52 [a]	0,253 [a]
	Residual	184,52	1000,53	3	3	61,50	333,51						
	Total	3396,52	5792,88	9	9	-	-						
2	Regression	3200,62	4790,30	5	5	640,124	958,06	13,070	3,822	9,01	9,01	0,14 [b]	0,109 [b]
	Residual	195,904	1002,58	4	4	48,976	250,64						
	Total	3396,52	5792,88	9	9	-	-						
3	Regression	3141,107	4673,83	4	4	785,27	1168,45	15,372	5,221	6,39	6,39	0,05 [c]	0,49 [c]
	Residual	255,418	1119,05	5	5	51,08	223,81						
	Total	3,396,52	5792,884	9	9	-	-						
4	Regression	-	4137,310	-	3	-	1379,10	-	4,998	-	5,41	-	0,45 [d]
	Residual	-	1655,57	-	6	-	275,92						
	Total	-	5972,88	-	9	-	-						

2006 a. Predictors: (Constant), Dew, Rainf., Wind Sp., Temp., Rel. humid., Neb.
b. Predictors: (Constant), Dew, Rainf., Wind Sp., Rel. humid., Neb.
c. Predictors: (Constant), Dew, Rainf., Wind Sp., Rel. humid.
d. Dependent variable: F

2007 a. Predictors: (Constant), Temp., Wind Sp., Rainf., Dew, Rel. humid., Neb.
b. Predictors: (Constant), Temp., Wind Sp., Rainf., Dew, Rel. humid.
c. Predictors: (Constant), Temp., Rainf., Dew, Rel. humid.
d. Predictors: (Constant), Temp., Rainf., Rel. humid.
e. Dependent variable: F

Table 5

Excluded factor analysis from model (tests stat. – t. Sig., Tolerance and VIF – Variance Inflation Factor)
2006/2007 Year 2006

Model	Beta In	t	Sig.	Partial Correlation	Colinearity Statistic		
					Tolerance	VIF	Minim Tolerance
2. Temperature	0,644 [a]	0,430	0,696	0,241	0,008	131,486	0,001
3. Temperature	-0,412 [b]	-0,823	0,457	-0,381	0,064	15,591	0,042
4. Total neb.	1,415 [c]	1,102	0,332	0,483	0,009	114,238	0,009

a. Predictors in the model: (Constant), Dew, Rainf., Wind Sp., Rel. humid., Neb.
b. Predictors in the model: (Constant), Dew, Rainf., Wind Sp., Rel. humid.
c. Dependent Variable: F%

Year 2007

Model	Beta In	t	Sig.	Partial Correlation	Colinearity Statistic	
					Tolerance	VIF
2. Nebulosity	0,265 [a]	0,078	0,942	0,045	0,005	197,873
3. Nebulosity	0,798 [b]	0,655	0,548	0,311	0,029	34,016
Wind speed	-0,247 [b]	-0,0682	0,533	-0,323	0,330	3,028
4. Nebulosity	1,343 [c]	1,219	0,277	0,479	0,036	27,548
Wind speed	-0,200 [c]	-0,0493	0,643	-0,215	0,333	3,005
Dew	-0,575 [c]	-1,548	0,182	-0,569	0,280	3,576

a. Predictors in the model: (Constant), Temp., Wind Sp., Rainf., Dew, Rel. humid.
b. Predictors in the model: (Constant), Temp., Rainf., Dew, Rel. humid.
c. Predictors in the model: (Constant), Temp., Rainf., Rel. humid.
d. Dependent Variable: F%

CONCLUSIONS

1. There is a moderate relationship (correlation) between the factors of influence (independent), namely the climatic ones and the resulting factor (dependent), actually the aggression (F%) of the new maize pest (*Diabrotica*); data regarding „relative humidity", „wind" and „temperature" were homogeneous, and „rainfall", „dew", „nebulosity" and the dependent factor (F%) proved to be inhomogeneous.

2. The method of exclusion, step by step, of the independent variables from the models designed proves that there is a very strong correlation between the climatic (influencing) factors and the rhizo-phylo-strigmatrophic aggression of the new pest *Diabrotica*, when the model includes all independent variables (temperature, RH, rainfall, wind, dew and nebulosity); this phenomenon is confirmed by the Pearson values (R=0.972), the „determination" values (R-Square=0.946), the values ensuring the results (Sig. F=0.052, namely over 5%) and by the concept Durbin-Watson.

3. ANOVA variance analysis and the analyses of regression correlation lead us to the conclusion that the new maize pest (*Diabrotica virgifera virgifera*) is strongly influenced by humidity; rainfall and humidity have a negative influence (-0.9; -0.5), while „dew" is positive (0.9); „nebulosity", like „dew", is positive (0.90). The conclusions regarding „dew" and „nebulosity", and the conclusion that „wind" is important only when is connected to the other independent variables, are original and represent a national premiere.

4. The testing of the factors excluded from data analysis (from models) signifies the fact that (only if the factor Sig. F, the one ensuring the results, is not below 5%) the dependent factor F% may **increase** (positive influence, for example the excluded temperature would have increased F% with 0.664 units; nebulosity with 1.415 units), or it may **decrease** (negative influence, namely it would have decreased F% with 0.2-0.5 units).

5. „Wind speed" (very important for dissemination of pathogens) did not assume the quality of accessible variable; it had reduced values, homogeneous or mild, despite the high values of maize pathogens' aggression (*Helminthosporium turcicum* – 84.3%, *Fusarium roseum* – 46.7%). In this situation, our general conclusion, of national premiere, is that the new pest, beside other independent variables (positive), assumed the role of „dissemination" and „amplification" of their pathogenesis (it has a trophic attitude against leaf blight).

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