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RESEARCH ON THE INFLUENCE OF CLIMATIC PARAMETERS ON THE GEOGRAPHICAL DISTRIBUTION OF THE PEST *Tanymecus dilaticollis* Gyll. IN THE ROMANIAN PLAIN

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Abstract

The aim of the work was to determine the influence of recent climate changes on geographical distribution of the pest Tanymecus dilaticollis Gyll. in the main maize and sunflower growing areas from south and southeastern Romania. In the period 2021-2022, monitoring of the adults activity in laboratory and field conditions, adults abundance and climatic parameters were carried out in 60 farms. The results showed that the increase in temperature favour the activity of Tanymecus dilaticollis, the adult active period longevity was found to expanded by approximately 20%. The pest adult's abundance during the maize and sunflower early vegetation period varied from 3.67 to 27.24 adults per square meters in 2021 and from 7.21 to 16.27 adults per square meters in 2022.

Key words*: pest, maize, climatic parameters, Tanymecus dilaticollis.*

INTRODUCTION

Maize (*Zea mays*) is one of the world's three most important cereals along with wheat and rice. It is currently produced on nearly 100 million hectares in 125 developing countries and is among the three most widely grown crops in 75 of those countries (https://www.genebanks.org/resources/crops/maize/).With a total maize grains production of 22 million tonnes between 2021-2022 Romania occupy 2nd place in European Union, after France and 3rd place if we include Ukraine, validating that is one of the most important crops from our country (FAOSTAT database, 2024). At the same time maize yield per hectare may decrease due to biotic stresses such as pathogens, weeds or pests.

Maize leaf weevil [*Tanymecus dilaticollis* (Gyllenhal, 1834)] is a polyphagous species, which is among the most important insect pests of maize and sunflowers in Romania, Bulgaria, Serbia and Hungary (Toshova et al., 2021). Damages are caused by adults through feeding on maize leaves. In some particular conditions like monocropping or the case of high weevils' densities, maize plants are destroyed, and farmers must sow again (Čamprag et al., 1969; Paulian, 1978; Bărbulescu et al., 2001). The pest attack is dangerous when maize is in early vegetation stages, from plants emergence (BBCH 10) until four leaves stage (BBCH 14) (Georgescu et al., 2021). Romania faces an increasing number of major problems each year related to the infestation of the pest Maize Leaf Weevil, which infests large areas of arable land and can cause significant production and economic losses for Romanian farmers as well as implicitly for the national budget if specific chemical control measures are not applied.

The farmers need viable alternative in Romania to prevent yield losses caused by soil pests affecting areas of more than 2 million hectares (with a tendency to expand) of maize and sunflower, with very high densities per square meter of the pest *Tanymecus dilaticollis.* Some recent studies have already demonstrated good results of the insecticide activity of entomopathogenic fungi *Beauveria* spp. on the maize weevil, *Tanymecus dilaticollis*, under laboratory and small-scale trials in field conditions in Bulgaria (Toshova et al., 2021;) and Romania (Fătu et al., 2023) but the researches should be confirmed under large scale plots. Some corrective treatments with insecticide

applied in crop early vegetation until five leaves stage are available but not always easy to apply and involves permanent surveillance, frequent applications and high costs to control pest populations. This is the reason why up to now the solution for the effective control of these pests remains the treatment of seeds with neonicotinoid insecticides (North et al., 2018). On the other hand, there is an urgent need of reducing insecticide use in Europe in general, and neonicotinoids in particular, and proper implementation of the IPM strategies as required by the European Directive 128/2009/EC on the Sustainable Use of Pesticides.

Badiu et al. (2019) demonstrated that pest population density significantly influences attack intensity and percentage of attacked plants, which means that, including when systemic treatments are applied, the extremely high insect population density in the monitored locations will induce significant attack intensities and crop losses. The bio-ecology of *T. dillaticolis* and the distribution of pests were the subject of systematic research conducted in the 1960's and 1970's by Paulian for his PhD thesis (Paulian, 1972).

Air temperature plays a major role in the regulation of insects physiological functions like respiration, metabolism, growth and reproduction (Harvey et al., 2020), and, consecutively, the climate changes and warming temperatures can influence their behavior, longevity and population dynamics (Stange & Aires, 2010). It is anticipated that climate change to have an impact on Maize Leaf weevil populations. Badiu et al. (2019) mentioned that an increase in average temperatures over the period of winter diapause results in an increase in insect populations per unit area assessed during the vegetation period.

The aim of the study was to evaluate the influence of climatic factors on the *Tanymecus dilaticollis* adult longevity and populations densities during two successive years (2021-2022) at large surfaces in the main maize growing area of the Romanian Plain.

MATERIALS AND METHODS

Field Survey area

The study was carried out in the south, south-eastern region of Romania, more precisely in the South-East, South-Muntenia and Bucharest-Ilfov Development Regions (Figure 1).

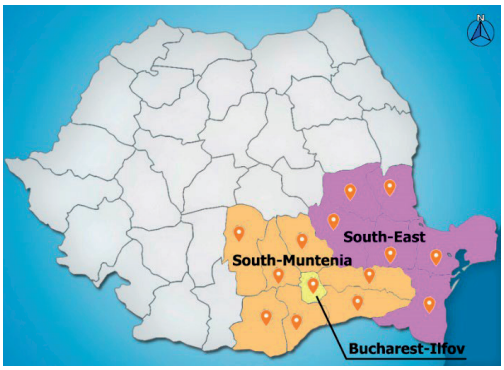

Figure 1. Area of study on Romania map

The choice of the locations was justified by the importance of this region for agricultural production, together with the favourable climatic and soil conditions for maize cultivation, as well as for the target pest *Tanymecus dilaticollis*.

Data collection

Between 2021 and 2022, a team from the Research - Development Institute for Plant Protection (R.D.I.P.P.) Bucharest and a group of farmers, associations and agricultural entities were involved in a comprehensive study dedicated to soil pest monitoring. The choice of this group was determined by their high level of expertise and involvement in the agricultural field, as well as the access they had to the agricultural land relevant to our research objectives. An original worksheet was designed by R.D.I.P.P. team of researchers to record relevant observations regarding the presence and intensity of soil pest attack and served as a data collection tool.

At the beginning of the survey, the participants were trained for conducting soil pest monitoring according to standardized protocols and were guided through the process of completing the worksheets. For each plot/parcel involved in survey, the following aspects were taken into account: locality, latitude, longitude, previous crop, current crop variety, crop vegetation stage and date of observation. The parcel identification process was carried out using current technologies, including mobile phones with GPS

applications, to precisely determine the coordinates of each parcel.
At least two main series of observations were performed in the field, focused on the assessment of soil pests present and all individuals that have been observed on 10-time standardised area of 1 square meter were counted, with attention paid to the identification and recording of the pest *Tanymecus dillaticolis*. Also, the number of plants per linear meter have been established, by accounting the number of plants on 10 linear meters in four different places of the parcel.

Data processing and analysis on the pest densities

The geographical distribution of pests density was achieved by vectorizing collection points and analyzing biological samples, namely the number of insects per square meter. Vectorization was performed by importing biological data along with geographic coordinates into the QGIS program. By interpolating the points using the IDW (Inverse Distance Weighted) function and assigning a color palette for five intervals of values, a raster GIS layer descrybing population density was generated. This type of raster was overlaid on the map of Romania, thus obtaining an overview image of the degree of *Tanymecus* infestation distribution.

Climatic influence factors on the populations of Tanymecus dillaticolis

Meteorological data were obtained from weather stations in the farm or from the local meteorological services in the area. These include: air temperature, soil temperature, and precipitation.
Adult active period longevity was determined under controlled temperature conditions. A series of 10 isolators were used at I.C.D.P.P. Bucharest with 10 insects each. The method involves as a first step obtaining an initial population of *T. dilaticollis* collected from the same field (a wheat crop in Belciugatele, Calarasi County) in early spring (29 March 2021) and rearing the adults under laboratory conditions at a temperature of 23 ± 2 degree Celsius (^{o}C) two weeks before using them in experiment. Each isolator consisted of a container with 5 maize plants covered with a transparent PVC cylindrical structure with an access area at the top that was covered with fine muslin cloth fitted by an elastic band, according to the method developed by Iamandei et al. (2024). The containers were first filled with sterilized soil and seeded with maize seed of P9537 Pioneer hybrid. Maize seeds were coated with fungicide Metalaxyl + Protioconazol + Lumidapt Kelta.
When maize plants were at BBCH 14, 10 *T. dilaticollis* adults (5 couple) were introduced into every isolator. Observation about adult activity have been performed daily, dead individuals were accounted and removed from isolators as soon as observed.
In field conditions, the influence of temperature on the *T. dilaticollis* was determined by analysing all captures at different atmospheric and soil temperatures. Further, the occurrence favorability of *T. dilaticollis* was estimated by relating the sum of the country-wide heat degrees to the Total thermal constant requirement to complete a generation, estimated to 2190-degree days (DD). WorldClim version 2.1 climate data for meteorological database covering the period 1950-2000 and the QGIS program were used to determine the sum of the degrees days.

RESULTS AND DISCUSSIONS

The study area coincide with the areas of greatest susceptibility to *T. dilaticollis* attack: the south and south-east of the country where the attack of the pest can compromise a crop in 2-3 days (Lup et al., 2017). Analysis of data comming from participating farmers showes that in these region there is a very high proportion of agricultural land occupied by maize, that creates big problems for them to achieve a proper crop rotation. Farmers therefore make short rotations, whereby maize returns to the same area after only 3 years, in some cases even after two years, which is not recommended by the multiannual surveys carried out in our country (Badiu et al., 2019; Iamandei & Rujescu, 2023).
According to our observations, the end of adults diapause was noted in Belciugatele (Calarasi County) during the last decade of February (25th of February) in 2021 and in mid-February (19th February) in 2022, when they started to feed on winter cereals, during

the sunny and warm period of the days. In April, when the sunflower and corn crops started to emerged at soil surfaces, the adults migrated to the respectivelly plots sometimes together with the populations of adults that have come out of diapause from the soil during a staggered process untill the beginning of May.

In 2021, the mean number of adults per square metre was between 3,6723 and 27,299 (Figure 2) while in 2022 ranged from 7.21 to 16.262 (Figure 3) in all cases, it exceeds the economic damage threshold of 3 adults/square meters, being up to 907 % higher (in 2021), respectively 542 % higher in 2022) than the limit from which crop protection treatments are recommended.

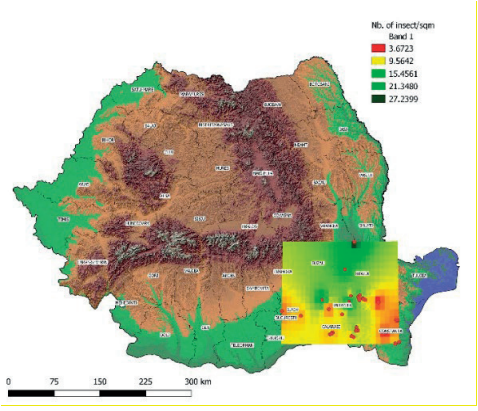

Figure 2. Number of insects/ sqm 2021

Our data confirmed the most recent data presented by Badiu et al. (2019) in their long-term study, stating that, including if systemic treatments are carried out, the extremely high population density of pest from the monitored region will induce higher attack intensities and significant harvest losses if contact insecticide are not applied in vegetation. The pest densities and variation from a year to another are influenced by weather conditions and previous crops, knowing that maize and/or sunflower, cultivated after a non-host plant species (annual leguminous, grassy cereals, rapeseed, flax etc.), leaves a reserve of up to 3 adults/sq.m in the soil while maize after maize provides a mean reserve of 10-15 adults/sq.m and up to 160 adults/sq.m. can be recorded, as reported in Braila County (Rosca & Istrate, 2009).

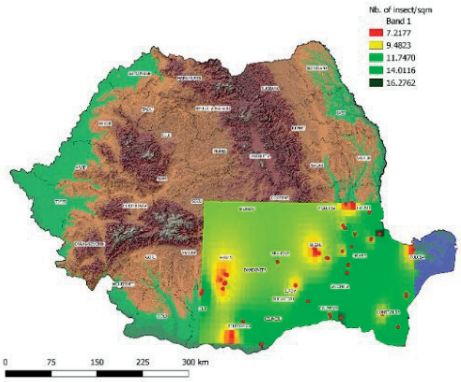

Figure 3. Number of insects/ sqm 2022

The corn leaf weevil is a thermophilic insect, in field the adults are very active, consuming intensively the seedlings both to ensure food and to cover water losses, when the average temperature during the day exceeds 20°C.

The analysis of laboratory data revealed that the adult active period mean longevity at an average temperature of 23 degrees Celsius, under controlled conditions, was of 95 days, with some individuals living up to 138 days (Figure 4). The active period it was found around two weeks longer than that observed by Paulian (1978, PhD thesis).

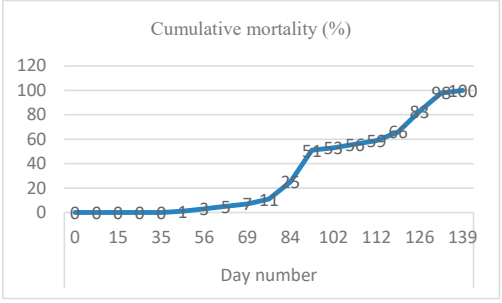

Figure 4. *Tanymecus dilaticollis* adults cumulative longevity under laboratory conditions, at 23 ± 2ºC

In field conditions, the temperature value of 23°C was also significantly correlated with the moment of maximum activity of insects, confirmed by the highest number of captured insects, with a correlation coefficient R^2 of 0.73, demonstrating that temperature is the primary factor related to the distribution and biological activity of the adult (Figure 5).

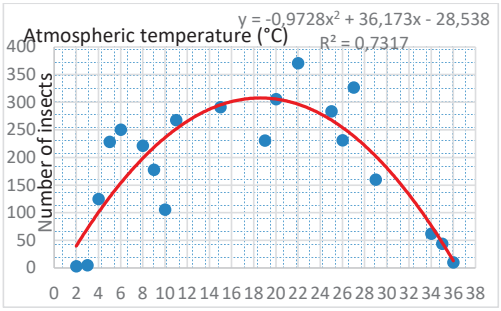

Figure 5. Correlation between the average atmospheric temperature and the number of captured insects

Given that the temperature was collected by meteorological stations at a height of 2 meters and the ground temperature is generally higher, it was necessary to make a correlation to determine the optimal temperature of biological activity of the pest. In this sense, the Khandaker equation ($T_{soil\ 10\ cm\ deep}$ = 6.224 + 0.842 * T_{air}; r = 0.93; Islam et al., 2015) was applied to the atmospheric temperature of 21.3°C representing the parameter BIO10 (Average temperature of the hottest season) specific to Călăraşi county characterized by strong attacks of the pest, obtaining the value of 24.15^{0}C (Figure 6).

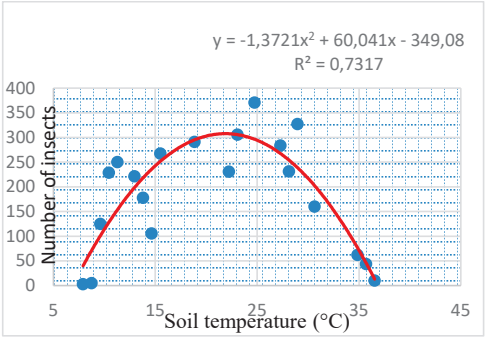

Figure 6. Correlation between the average soil temperature and the number of captured insects

Mass reproduction of the insect is favoured by higher temperatures and drought during the start of sunflower and maize vegetation period, in April and May. The area of maximum environmental suitability of the pest, estimated based on laboratory data and confirmed in the field conditions, overlaps with the area currently occupied by the two crops (Figure 7). Actually, some areas considered until recently unfavourable for Maize Leaf Weevil activity, such as Transylvania (Antonie I., 2012) register increasingly aggressive attacks in favourable years and increases of the temperatures explain the extending the pest areas to northern latitudes.

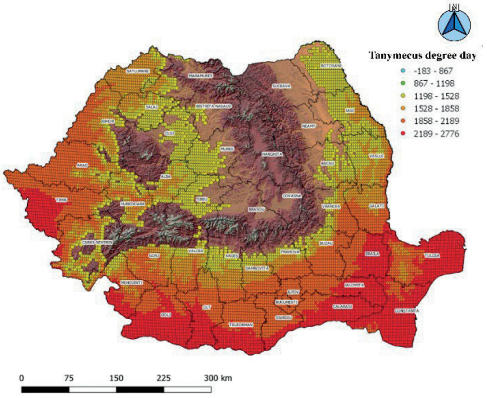

Figure 7. Thermal favourability of the pest *Tanymecus dilaticollis* in Romania

CONCLUSIONS

The recent climate changes, especially the increase in temperature in the months of April and May, with longer periods of drought, favour the activity of *Tanymecus dilaticollis* adults, the adult active period longevity was found to expanded by approximately 20%. The large-scale study of *T. dilaticollis* abundance during the maize and sunflower early vegetation period varied from 3.67 to 27.24 adults per square meters in 2021 and from 7.21 to 16.27 adults per square meters in 2022. Although the crops were established with seeds treated with systemic insecticides, the damage threshold was generally exceeded, and applications of treatments in the vegetation were mandatory. It is necessary to continue the research with a detailed analysis of the impact that other technological means might have on pest activity and the damages produced by their populations.

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REFERENCES

Antonie, I. (2012). The economic importance of the epigeal fauna in the corn agricultural ecosystem in Ocna Sibiu (Sibiu County) in 2012. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, 13(4), 25-30.

Badiu, A. F., Iamandei, M., Trotus, E., Georgescu, E. I. V. (2019). Studiu privind comportarea populațiilor de *Tanymecus* sp. în unele locații din România în perioada 2010-2018. *Acta Agricola Romanica, Seria cultura plantelor de câmp*, 1(1), 108-136.

Bărbulescu, A., Voinescu, I., Sadagorschi, D., Penescu A., Popov, C., Vasilescu, S. (2001b). Cruieser 350 FS-A new product for maize and sunflower seed treatment against *Tanymecus dilaticollis* Gyll. *Romanian Agricultural Research*, 15: 77-87

Čamprag, D., Jasnic, S., Sekulik, R., Matic, R. (1969). Harmfulness and control of *Tanymecus dilaticollis* Gyll. in corn. *Contemporary Agriculture*, 17(5/6):261-268.

Farrar, J. J., Baur, M. E., & Elliott, S. F. (2016). Adoption of IPM practices in grape, tree fruit, and nut production in the Western United States. *Journal of Integrated Pest Management*, 7(1), 8.

Fătu, A.C., Georgescu, E., Iamandei, M., Mateescu, M., Vlad I. A. (2023). Evaluation of *Beauveria bassiana* and *Beauveria pseudobassiana* against *Tanymecus dilaticollis*. *Romanian Agricultural Research*, 40,1-8.

Furlan, L., Vasileiadis, V. P., Chiarini, F., Huiting, H., Leskovšek, R., Razinger, J., Sattin, M. (2017). Risk assessment of soil-pest damage to grain maize in Europe within the framework of Integrated Pest Management. *Crop Protection, 97*, 52-59.

Georgescu, E., Toader, M., Cană, L., Horhocea, D., Manole, T., Zaharia, R., Rîșnoveanu, L. (2021). Researches concerning the effectiveness of the maize foliar treatment compared with seeds treatment for chemical control of the maize leaf weevil (*Tanymecus dilaticollis* Gyll) in the South-East of Romania. *Annals of NARDI Fundulea*. 38, 364-375.

Harvey, J. A., Heinen, R., Gols, R., & Thakur, M. P. (2020). Climate change-mediated temperature extremes and insects: From outbreaks to breakdowns. *Global change biology*, *26*(12), 6685-6701

Iamandei, M., Rujescu, C. I. (2023). Diversity of click beetle associated with maize and sunflower crops from south and southeastern Romania. *Romanian Agricultural Research*, 40, 621-631.

Iamandei, M., Fătu, A.C., Rădulea, M., Popa, I.C., Bădulescu, A., Chiriloaie-Palade, A., Roșca I. (2024). Entomopathogenic effect of some *Beauveria* strains on the tomato leaf miner *Tuta absoluta* (*Lepidoptera*: *Gelechiidae*) larvae under semi-controlled conditions. *Acta Horticulturae*, 1391, 661-668. DOI: 10.17660/ActaHortic.2024.1391.89

Islam, K. I., Khan, A., Islam, T. (2015). Correlation between atmospheric temperature and soil temperature: a case study for Dhaka, Bangladesh. *Atmospheric and Climate Sciences*, 5(03), 200.

Lup, A., Miron, L., Alim, I.D. (2017). Studies and strategies regarding the evolution of crop yields per unit of land area in Romania, studies. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, 17(2), 227–233.

North, J. H., Gore, J., Catchot, A. L., Stewart, S. D., Lorenz, G. M., Musser, F. R., Dodds, D. M. (2018). Value of neonicotinoid insecticide seed treatments in Mid-South corn (Zea mays) production systems. *Journal of economic entomology*, *111*(1), 187-192.

Paulian, F., 1972. Contribution at knowledge of the development, ecology and control of the Tanymecus dilaticollis specie. *Doctoral thesis, IANB Bucharest, chapter IV*: 49-57; 193-200; 209-225.

Paulian, F., 1978. Maize pests and their control. *Academy of Agricultural Sciences, Agricultural Library, Bucharest*: 1-32.

Popov, C., Guran, M., Raranciuc, S., Rotarescu, M., Spiridon, C., Vasilescu, S., Gogu, F. (2005). Phytosanitary state of the cereals, leguminous for grains, forage and technical crops from Romania, year 2004. *Problems of Plant Protection*, *33*(1-2), 7-30.

Rosca, I., Istrate, R. (2009). *Tratat de Entomologie (Agricultura, Horticultura, Silvicultura)*. Ed. ALPHA MDN, 699 p.

Toshova, T., Velchev, D., Pilarska, D., Todorov, I., Draganova, S., Holuša, J., Takov, D. (2021). Effect of bioinsecticides on the grey maize weevil Tanymecus dilaticollis. *Plant Protection Science*, 57(3).

***FAO. Faostat Database, Crops and Livestock Products. Available online: https://www.fao.org/faostat/en/#data/QCL/visualize (accessed on 25 January 2024).

***https://www.genebanks.org/resources/crops/maize/