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Spatial distribution of *Geotrogus deserticola* at Tissemessilt area in North of Algeria

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ABSTRACT

This study describes the allocation and distribution of Geotrogus deserticola beetle pest of cereals at the Province of Tissemlesilt (North of Algeria). The examination of infestations revealed seven towns infested on a total of 10, the most heavily infested towns are: Laayoun, Tissemessilt, Ouled Bessam, Khemisti, Maacem, Ammari and Sidi Boutouchent. Moreover, the common Lardjem, Sidi Abed and Beni Chaib, showed no infestation by white grubs. As for the spatial distribution of this pest, the horizon H1seems to be the profile of the most sought by this insect. Strong correlations have been brought out between the biometric variables of this pest in particular its total size, its length and that of head capsules. However, no correlation could be found between this distribution and the physicochemical parameters analyzed.

Keywords: *Geotrogus deserticola*, spatial distribution, biometric parameters, soil tests, cereals, Tissemesilt.

INTRODUCTION

Almost all of the food of global populations is provided by the food grains. Whether 96% of these alimentations are produced by cereals crops (wheat, barley, rye, oats, rice, maize, sorghum, millet, and triticale) [1].

Considering the importance of cereals in agriculture and in food, an intensification program of the latter was set up by the Ministry of Agriculture and Rural Development, as part of the plan National Agriculture and Rural Development (NARP) to improve production and productivity of cereals. Like production, yields are low and irregular character, because the cultivation of cereals is subject to climatic constraints [2], technique, socioeconomic and the diseases and pests.

In Algeria, the species *G. deserticola* attack each year thousands of hectares and caused major damage on cereals [3,4]. In recent years, very serious attacks have damaged a larger area at the

national level and have spread to the province of Guelma, to Tlemcen and Ain Temouchent. Indeed the work of the White grubs grains tend to plant health, by chemical or microbiological [5] In contrast, other are much more interested in the study of bio-ecological of this pest on cereals [6,7].

The aims of our study have focused on the spatial distribution, mapping attacks infested areas and the different correlations likely to promote its proliferation at Tissemessilt cereals areas in North Algeria, to contribute at IPM control of this pest in infested cereals areas.

MATERIALS AND METHODS

This study was carried out to assess the spatial distribution of *G. deserticola* at Tissemessilt cereals areas, and study the effect of physicochemical characteristics of the soil on white grubs encountered.

2.1. Sampling technique and collection of white grubs

The experiment was conducted during the crop year 2009-2010, the samples were taken on 10 cereals towns of the province of Tissemsilt (Ammari (35°34'N 1°42'E), Laayoun (35°41'N 2°00'E), Khemisti (35°39'N 1°57'E), Maacem (35°39'N 1°34'E), Sidi Boutouchent (35°45'N 1°44'E), Ouled Bessam (35°41' 1°51'E), Tissemsilt (35°36'N 1°48'E) , Sidi Abed (35°44'N 1°42'E), Lardjem (35°45'N 1°32'E) , Bani Chaïb (35°48'N 1°47'E). The list of these towns was recommended to us by the management of agricultural services of the province of Tissemsilt.

The experimental protocol adopted for the collection of the white grubs concerns each cereals town. For each town prospected, three stations have been invested in two horizons of samples as shown in the figure below.

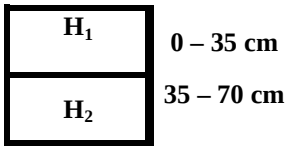


Figure 1: Sampling of *G. deserticola* according to soil horizons (H1 and H2)

Our investigations have focused on large cereals parcels with the primary aim to study the spatial distribution of *G. desrticola* at Tissemsilt cereals areas.

The sampling technique followed is to choose 3 stations within a large parcel, samples of white grubs had on the two previous cited profiles horizons along a diagonal at this large parcel [8]. Soil sampling is taken from 02 horizons; it is put into black plastic bags labeled as we mentioned all the information on stations and these characteristics (Cable GPS, terrain characteristics and type of cereals cultured). Samples of white grub recovered from the soil are taken back to the laboratory for a study of the biometric characteristics of the populations of white grubs to mapping infested parcels.

In the laboratory each soil sample is screened, the number of white grubs was estimated and the characteristics of these have been noted (weight, length and total length of the head capsule) to find the fitness of individuals within the different types of soil area prospected.

2.2. Soil analyzes

Analyses of samples of soil were brought to the laboratory soil Regional El Matmar in Relizane (Algeria). The analyses focused on two categories:

- The physical analysis have focused on granulometry;
- The chemical analysis, which concerned the measurement of pH, the determination of organic material and concentration of calcium (total and active).

2.3. Data analysis

The correlations between the physical and chemical constituents of the soil and the populations of white grubs in each station are highlighted by the principal component analysis (PCA) and correspondence factor analysis (CFA) established by the logiel "Past "[9].

RESULTS

1- Distribution of *G. deserticola* at Tissemsilt areas

1.1 Global distribution of G. deserticola at Tissemsilt cereals areas

The global analysis of the spatial distribution of *G. deserticola* on cereals parcels in all 10 towns prospected revealed only seven towns were infested by the white grub of cereals. These were more or less important (Figure 2). Indeed, the stations of the town of Laayoun was most infested with a total of 12 individuals were captured in the first two stations. The towns of Tissemsilt and Ouled Bessem show size of the range of 9 and 8 individuals respectively. In contrast, the towns of Khemisti, Maacem and Ammari this number still low; it is between 4 and 2. Within the town of Sidi Boutouchent only 1 individual was inventoried. Analysis of samples per station revealed a number of white grubs fairly variable in the last stations, it is apparent that all stations were infested by *G.deserticola* except the towns of Lardjem, Sidi Abed and Beni Chaib.

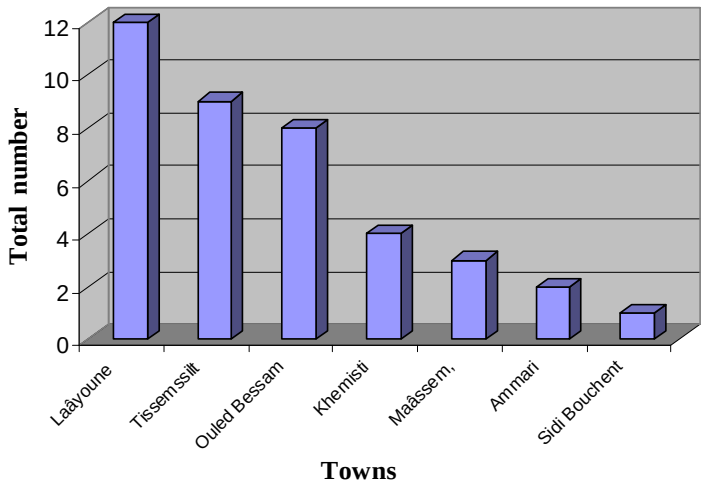


Figure 2: Total number of *G. deserticola* identified at Tissemsilt cereals areas in North of Algeria

The mapping of infestations established by the GIS method (Figure 3) at the community level explored, revealed the zones susceptible to this pest, although population numbers captured are low, this can be explained by low attacks during this season study.

The examination of the geographical distribution of the infestations by *G. deserticola* on 10 cereals towns prospected revealed 7 towns present the attacks by the white grubs, they are represented mainly by the towns of: Laayoun, Tissemsilt, Ouled Bessem, Khemisti, Maacem,

Ammari and Sidi Boutouchent. In contrast, the towns of Lardjem, Sidi Abed and Beni Chaib did not show the specimen of white grubs during our sampling.

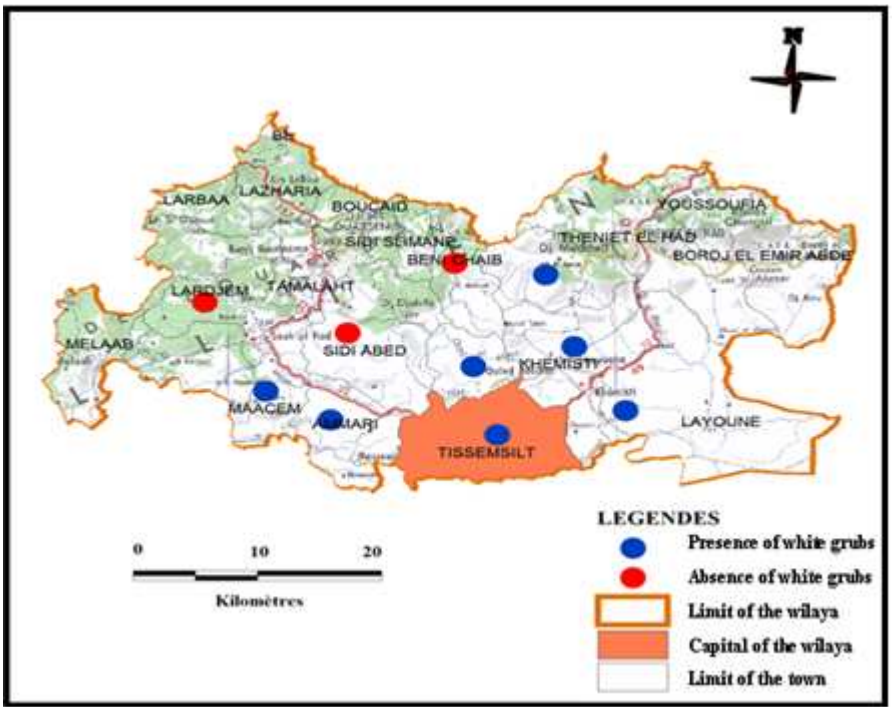


Figure 3: Geographical distribution of *G. deserticola* at Tissemsilt cereals areas in North of Algeria.

1.2 Spatial distribution of G. deserticola at Tissemsilt cereals areas in North of Algeria

The spatial distribution of *G. deserticola* was studied in two soil horizons H1 and H2. Indeed, the examination of the distribution of this insect is very pronounced at the horizon 1 (H1=0-35cm). We observed that white grubs prefer the superficial layers, probably movable and airy. Also without individual was found in the horizon 2 (H2 = 35-70 cm), outside in the town of Khemisti where only two individuals were collected at this horizon. This may be explained by the recurrence antecedent of the previous season. The following table shows the number of individuals of white grubs captured according to the both horizons.

Table 1: Spatial distribution of *G. deserticola* at Tissemsilt cereals areas in North of Algeria

Locations	Station I		Station II		Station III	
	Horizon 1	Horizon 2	Horizon 1	Horizon 2	Horizon 1	Horizon 2
Ammari	0	0	2	0	0	0
Laâyoune	8	0	4	0	0	0
Khemisti	1	2	0	0	1	0
Maâcem,	1	0	0	0	2	0
Sidi Boutouchent	0	0	1	0	0	0
Ouled Bessem	2	0	6	0	0	0
Tissemsilt	3	0	3	0	3	0
Sidi Abed	0	0	0	0	0	0
Lardjem	0	0	0	0	0	0
Beni Chaîb	0	0	0	0	0	0

1.3 Global Analysis of the repartition and the distribution of G. desrticola at Tissemsilt cereals areas in North of Algeria

We applied the general linear model (GLM) for study the distribution of *G. desrticola* at the province of Tissemsilt in order to study this distribution based on the horizons, of the stations and the towns. (Figures 4, 5 and 6). The ANOVA were applied in this study. The application of the GLM model, we can observe that this distribution varies very significantly depending on the horizons (P=0.017). Examination of these figure shows that the factor horizon appears to play an important role in the dynamics of this pest. However, the town factor and stations does not seem to be implicated as a criteria to be considered in this study (P = 0.402) and (P = 0.380) respectively.

Figure 4: Distribution of the effective inventoried of *G. deserticola at Tissemsilt cereals areas in North of Algeria*

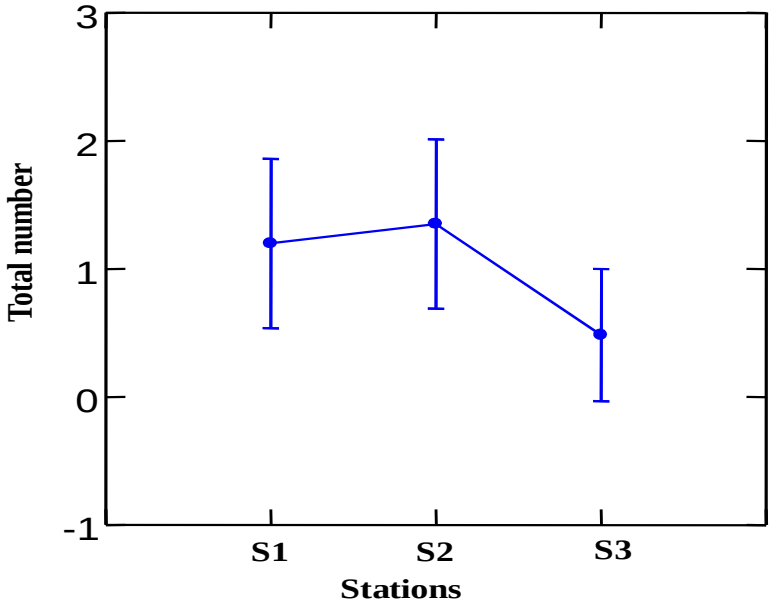
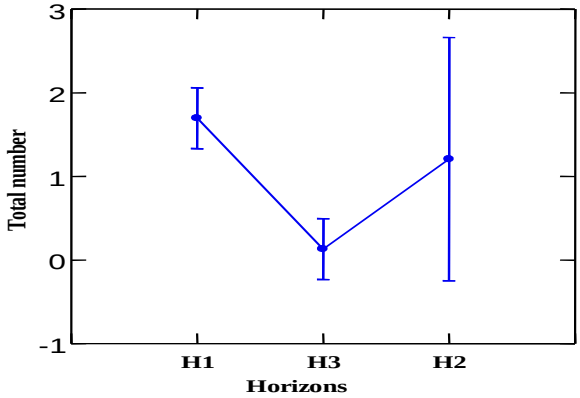


Figure 5: Distribution of staff inventoried *G. deserticola* at the stations of *Tissemsilt cereals areas in North of Algeria*



1.4 Biometric characteristics of specimens of G. deserticola collected at Tissemsilt cereals areas in North of Algeria

The examination of biometric data shows that the average weight of the most important specimen was registered at the town of Tissemesilt (0.8766 g), followed by Ouled Bessem, Sidi Boutouchent, Laayoun and Maacem respectively (0.7, 0.5333, 0.2733 and 0.1066 g). In contrast, the lowest weights are reported in the towns of Ammari and Khemisti: 0.0066 g and 0.06 g respectively. The most important total length of the observations was noted at the town of Tissemesilt with 2.7733 g, while the lowest is the order of 0.3333 g reported at the town of Ammari, this can be explained by the fact that the individuals captured are all small larval instars

(L1). Also, the examination of head capsules shows a strong relationship between the total lengths of the larvae (Table 2).

Figure 6: Distribution of staff inventoried *G. deserticola* at the horizons of the cereals towns of the province of Tissemsilt (Algeria).

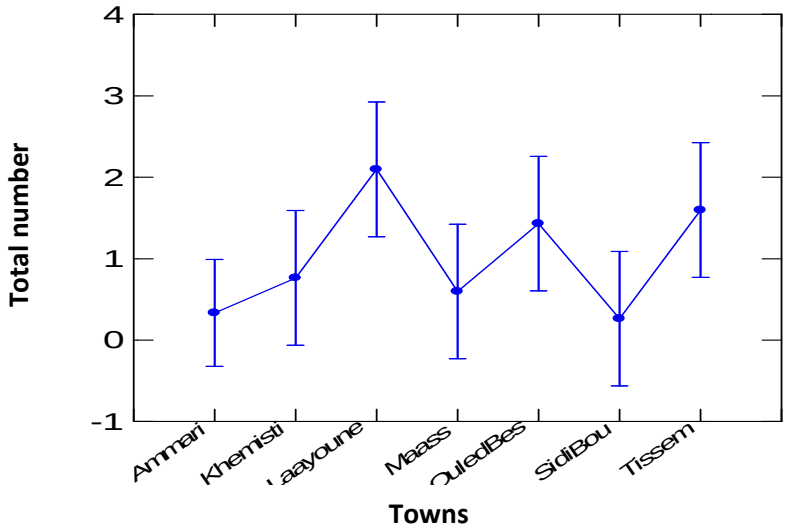


Table 2: The means and standard deviations of biometric parameters measured in specimens of *G. deserticola* collected at Tissemsilt cereals areas in North of Algeria

Towns / Biometric characters	Ammari	Maâcem	Laâyoune	Khemisti	Tissemsilt	Ouled Bessem	Sidi Boutouchent
Total weight (g)	0.0066± 0.0182	0.1066± 0.2073	0.2733± 0.5102	0.06± 0.1639	0.8766± 1.1692	0.7± 1.3244	0.5333± 1.457
Total length (cm)	0.3333± 0.9106	1.0666± 1.9958	1.3833± 2.5987	0.44± 1.2021	2.7733± 3.1176	1.86± 3.4844	1± 2.732
Length of head capsule (cm)	0.0066± 0.1821	0.1666± 0.3194	0.24± 0.4516	0.0666± 0.1821	0.4766± 0.517	0.32± 0.5978	0.1666± 0.4553

The examination of correlations of biometric samples of *G. deserticola* collected (Figure 7), shows a very high correlation between the total weight of the larvae, total length and cephalic length.

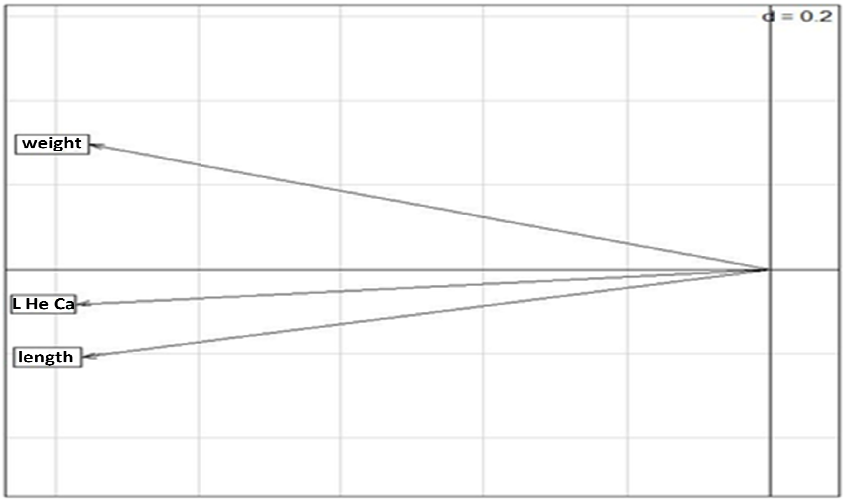


Figure 7: Correlations of biometric parameters of the collected samples of *G. deserticola*

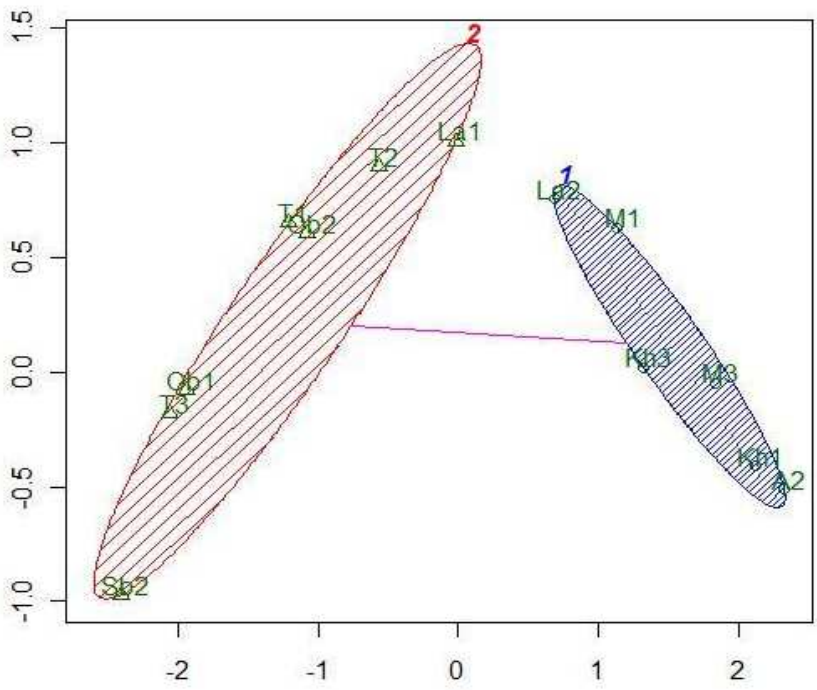


Figure 8: Map factor of two groups of collected specimens of *G. deserticola*

2 Analysis of soil infested fields and impact on the distribution of *G. deserticola*

2.1 Correlations between biometric parameters of specimens of G. deserticola collected and soil analysis of the different parcels prospected

They were a high correlation between the different variables of biometric parameters examined between them; it appears that the total weight of the specimens collected is highly correlated with the total length of these individuals and with the length of their head capsules. However, no correlation appears to exist between these parameters and characteristics of soils infested.

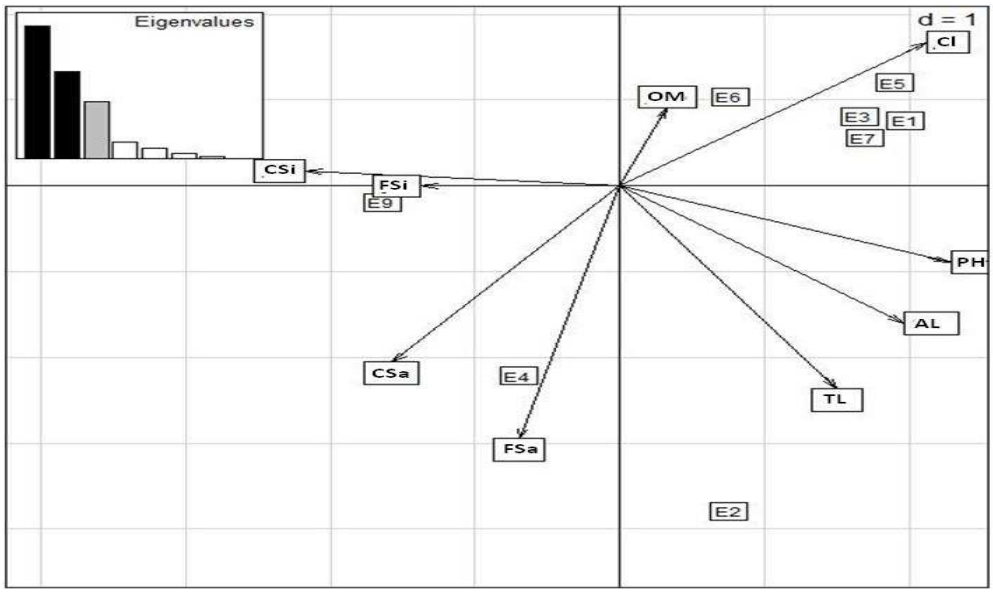


Figure 9: Canonical structure of CPA between variables and samples

2.2. The hierarchy of factors (axes)

With the first two axes, so we explain more (70.57%) of the total information, this will allow us to taken into consideration for the treatment of the data on soil parameters.

2.3. Canonical structure of statements and variables

According to Figure (9), relative to the canonical structure, we observe that the samples located on the first part of the axis (1) including E1, E3, E2, E5, E6 and E7 have behaviors (good scores) by respect to different variables including: total limestone (TL), limestone active (AL), pH, clay (C), organic matter (OM), for the rest of the samples against E4, E8, E9 and E10 located on the negative part of the same axis, offer low values compared these same variables.

2.4. Circle of correlations of soil variables

Through the reading of the circle of correlations from the CPA on soil parameters (Figure 10), we note that there are positive significant correlations between the variables located on the positive factor (1):

TL and AL (r = 75%), C and pH (r = 40%) AL and pH (r = 85%), C and OM (r = 60%).

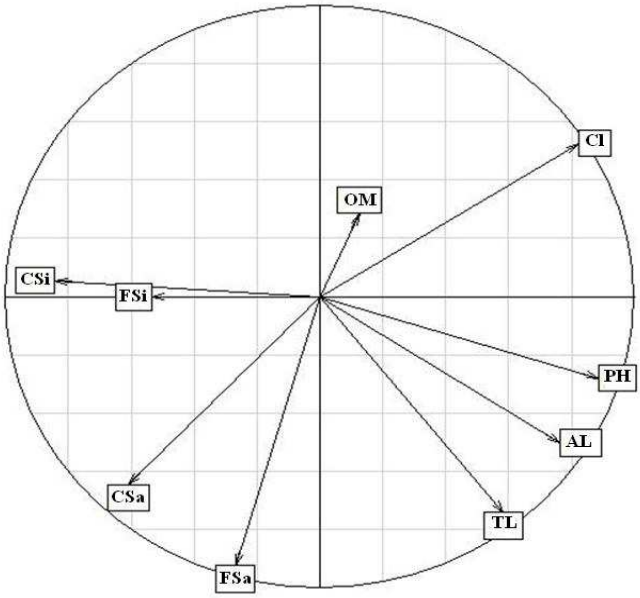


Figure 10: Circle of correlations of the variables (soil parameters)

Total limestone (TL), limestone active (AL), pH (PH), organic matter (OM), Clay (C), fine silt (FSi), coarse silt (CSi), fine sand (FSa), coarse sand (CSa).

2.5. Dendrogram of soil samples

PCA combined with CAH (figure 11), reveals the existence of three groups of samples based on soil variables:

- Class 1: includes the samples E2 and E4 characterizing the common soil as follows: Laayoun and Maâcem;
- Class 2: contains the sample E8, E9 and E10 located on soils of Sidi Abed, and Lardjem Beni Chaib;
- Class 3: includes three samples: E1, E3, E5, E6 and E7 that are on the soil of Ammari, Khemisti, Sidi Boutouchent, Ouled Bessem and Tissemsilt.

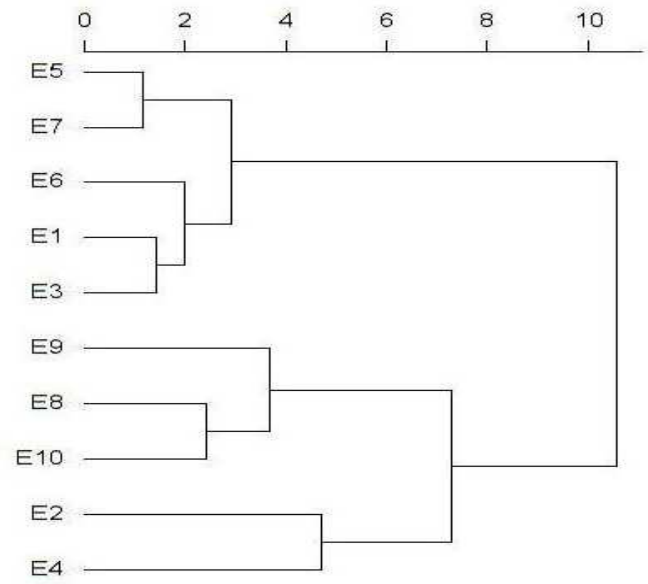


Figure 11: Dendrogram of soil samples

E1 : Ammari, E2 : Laayoun,, E3 : Khemisti, E4 : Maâcem , E5 : Sidi Boutouchent, E6: Ouled Beset, E7: Tissemsilt, E8: Sidi Abed, E9: Lardjem, E10: Beni chaib.

DISCUSSION

The spatial dynamic of *G. desrticola* has been studied at the cereals towns of the province of Tissemesilt (Algeria). The examination of this revealed 7 towns infested on a range of 10 towns examined. This pest is one of scarabeidae, considered cosmopolitan species with a wide variety of habitats from the sands of the Sahara to the oasis of the Siberian forest land.

However, their distributions are not well documented. In Reynier in 1949 in [10] noted that European cockchafer *Melolontha melolonta* closely related species of *G. desrticola* found in a large part of Europe. These Rhizotrogues are very damaging in southern Europe and northern Africa [11]. Other species such as *Phytolus snuthe* was considered one of the major enemies of sugar cane in Maurice Islands and North America. These cause the damage to cacao in India and the island of Java. In North Africa Hurpin in Balachowsky (1962) [12] reported that Melolonthinae and Rutelinae seem to adapt to different climatic conditions, most of them frequent the shores, the Mediterranean, as to Cetoniinae and Dynastinae some areas of their distribution is not well known.

The rhizotrogues are spread widely in North Africa and then we will count more than 64 different species or forms can be had near the ½ of the group worldwide. These have a very limited distribution area usually inhabits the Tell (*Pseudoapterterogyna*) and high plateau (*Geotrogus*), their southern limit stops north of the Sahara [13]. Their habitat is special: forest, full, steppe, mountain (up to 1800m). In the Djurdjura (Algeria), *Pseudoaptergyna edutarum* was noted, as well as the Aures and at an altitude meter of 1750 meters we note the presence of *Ps. grossus* and *Ps. endretorum*

According to our study, it appears that the larvae of *G. desrticola* are distributed in the superficial layers of soil, the majority of specimens collected were found at the horizon H1, It is probably as this level the larvae found these trophic resources particularly the roots of cereals from which it causes serious damage. This distribution can be explained that the orientation of

these scarabeidae would order magnetic tees variable from one tribe to another, in this aspect Schneider (1957) [14] described it was possible to disorientate with a magnet. On a three-year study (1956-1958) have noticed that the sun provides a marker to find the direction [15, 16]. However, in the pre-primary flight it would trigger the female the functioning of special institutions controlled by the reproductive cycle that provides and keeps a memory of orientation during all the life of the animal. Should be noted that when the lights are lowered and the temperature conditions favorable for all adults trying to leave the soil [17].

Through the smell that Scarabeidae arrive to find their food this is true for walking as for the flight it being perceived at first, for antennas and then the maxillary palps and is near the labial palps [18,13].

It appears that the larval behavior such as spatial distributions is a major criterion to study the population dynamics of white grubs and a vital topic to study population dynamics and better understand the relationships between organisms in their ecosystem (Shaung, 1983) in [13]. In this same approach, the populations of white grubs are distributed in different ways in the soil. Depending on various factors such: as searching for food, the physical favorable condition and competition reaction [19]. The dietary requirements of larvae varies according to age larval stage L3 consumes more of the nutrients, look for plants rich in sugar and poorer in nitrogen, tyrosine and Betadine [20].

Moreover, Gros *et al.,* (1980) in Debouzi *et al.* (1984) [21] proposed a model of spatial distribution of larvae in permanent pasture. The latter is divided into three levels called zones, plates and aggregates. It turns out that the movement of nesting females between forest edges and spawning (egg vol) organized on preferred directions and creates homogeneous areas (50 to 500 ha) where the expression level of implementation individuated million km².

In the plaque these authors report the plate than at the latter considered as a homogeneous area and even highly structured in a mosaic plaque (0.5 to 5 has), the density of larvae is expressed in thousands of hectare individuated by it varies with soil type, species composition, the operating mode of the plot, the presence of livestock (presence of nomads). As regards the third layer called aggregate formed by a set of plates of aggregates (0.5 to 5m²) bridges packets are registered and a high variability of the local density (number of individuals per m²). Indeed, the small number identified little cause unfavorable factors, although other years were considered as years of heavy infestations (DSA, com, people). Temperature affects a major role in the development and incubation of eggs. The optimum is located at 15°C [22]. Indeed, the optimum of development of eggs *Melolontha Melolontha* (L.) is between 15°C and 20°C for the rate of humidity between 5% and 15% [23].

This distribution of the larvae (immature stages) in the soil has a very similar general appearance. They live in the soil where they eat the roots of many plants, including some of high value an ornamental or agricultural. The first symptoms of damage that appear on the surface of the stems are wilting, while the damage progress in spots, with a mortality of plants apparently inexplicable if the conditions appear favorable soil water and that we do not suspect the presence of insects. The larvae then give adults which general morphology of is that of a cockchafer. Indeed, the available literature [12, 3, 24] described a long range of these particular beetles *G. deserticola*. The area of distribution of these species is limited to small geographical areas, *Pseudoapterogyna numidicus* (Lucas) is mainly distributed in areas of Oran, Medea, Keddara, Khemis Miliana and Theniat El Haad (Algeria). As for *G. deserticola*, it is distributed in the

regions of Medea, Berrouaghia, Theniat El Had and Tiaret (North West of Algeria) [25] this is consistent with our results.

CONCLUSION

The study of the global distribution of *G. deserticola* showed that only 7 towns were infested by this pest they were: Laayoun, Tissemessilt, Ouled Bessam, Khemisti, Maacem, and Sidi Laamari blocked, while the towns of Lardjem, Sidi Abed and Beni Chaib didn't proved any infestation.

Regarding the spatial distribution of *G. deserticola* in these municipalities and according to the profiles studied, it appears that only a horizon H1 shows more infestations compared to the horizon 2 H2 which remains most profound.

The analysis of the biometric characteristics of specimens collected showed a very high correlation between these three parameters (total weight, length and total length of head capsules). No correlation between the physico-chemical and distribution of this pest appears to exist. In practical terms we can propose to collect on higher horizons rather not exceeding the 0.50 meters for input for sampling. The soil tests indicate that throughout the majority of samples are clay with the exception of the town of Laayoun has a clay silt soil type. The overall pH is basic with a total lime content not exceeding 6%. As for the organic matter content remains very low and shall not exceed 3%.

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