World Journal of Environmental Biosciences

Available Online at: **www.environmentaljournals.org**

Volume7, Issue 2: 102-107

ISSN 2277- 8047

Annual and Stationary Variation of Black Rat Rattus Rattus (Linnaeus, 1758) Damage On Date Palm Inflorescences in Southeastern Algeria

Zeïd Alia[1]*, Djilani Ghemam Amara[1], Ahmed Elkhalifa Chemsa[1], Amar Eddoud[2], Karim Souttou[3], Makhlouf Sekour[2]

[1] Department of Biologic Sciences, Faculty of Natural Science and Life, University of El-Oued, 39000, Algeria,
[2]Department of Agronomic Sciences, Faculty of Natural Science and Life, University of Ouargla, 30000, Algeria,
[3]Department of Agropastoralisme Sciences, Faculty of Natural Science and Life, University of Djelfa, 17000, Algeria.

ABSTRACT

The estimated damages caused by Rattus rattus on Phoenix dactylifera (L. 1753) involved 25 sites distributed equally over 5 stations in the Souf region (south-east of Algeria). The first traces of the damages could be summed up in a deterioration of the inflorescences (spathes) before and after their openings. However, a five-year follow-up (from 2012 to 2016) revealed that 2014 (63.7±8.0 %) was the year with the highest loss rates ranging from 51.4 % to 81.2 %. On the other hand, the lowest rates were recorded in 2016 (20.5±5.4 %) with values varying between 9.5 % and 21.9 %. Depending on the stations, the highest attacks were observed in station 5 with 39.7±16.6%. On the other hand, the lowest rates were recorded in station 3 with 23.1±11.3%. Regarding the evolution of attacks, open inflorescences (29.7±19.9%) were relatively more attacked than the closed inflorescences (20.4±14.9%).

Keywords: *Rattus Rattus, Damages, Inflorescences, Date Palm, Algeria.*

Corresponding author: Zeïd Alia
e-mail✉ zad.alia @ yahoo .fr
Received: 23 December 2017
Accepted: 22 March 2018

1. INTRODUCTION

Many crops have been occasionally attacked by the rodents, especially cereals, sweet potatoes, peanuts, peas and melons (Delattre et *al.*, 1992; Bachar, 2015). The extent of the losses and the nature of the attacks differed from a plant to another (Wang et *al.*, 2017). For staple food crops such as sweet potatoes, a partially chewed tuber rarely results in a total loss, and the portion remaining intact can be consumed. On the other hand, relatively limited attacks on melons and peas cause the decay of the whole fruit (Wood and Singleton, 2014).
For trees, losses caused by rodents have been closely related to the type of biotope (Heroldová et *al.*, 2012; Wood and Singleton, 2014; Verwilghen, 2015). However, in some forests in Europe and North America, damages occurred in almost all parts of the plant, ranging from the root system to the seeds (Romankow-Zmudowska, 1980; Godfrey and Askham, 1988; Kushad, 1994; Fibien and Olivier, 2006; Miot and Delattre, 2010; Sandrine and Pierre, 2010; Wood and Singleton, 2014). In Saharan environments, dates of the palm tree have been the most sought after by rodents (Alia et *al.,* 2015). In view of their nutritional value contribution, damages have been first reported on trees in the field, and continued at the date storage sites. But, in recent years, attacks of *Rattus rattus* have been observed rather, well before fruit development, on the still closed inflorescences. It has been in this context that the present study aimed to estimate and monitor the damages caused by the Roof Rat on date palm spathes in the southeastern palm groves of Algeria.

2. STUDY AREA

The present study concerned the Souf region (33° to 34° N; 6° to 8° E) which is situated 600 km southeast of Algeria. It is located in the northern borders of the Oriental Erg (Côte, 2006; Voisin, 2004). It belongs to the Saharan bioclimatic stage with mild winter (from 1980 to 2015), characterized by a dry period which occurs in every month of the year.
Within this region, 5 stations were chosen to monitor the damages caused by the roof Rat on the Palm tree date palm for 5 years (from 2012 to 2016).
Station 1 (Debila): located 45 km (33°30'53.37'' N; 6°57'07.70'' E) northeast of El Oued city. It has a northern exposure and an altitude of 55 meters. The ground of the station is sandy in nature with some stones. The crops grown have been *P. dactylefera* (L. 1753) with a rate of 40%, followed by market garden crops (potato, tomato and pepper). Some fruit trees have been scattered randomly in this station, such as *Prunus armeniaca* (L., 1753), *Malus* sp. (M., 1754) and *Olea europaea* (L., 1753).
Station 2 (Hassi Khalifa): situated 55 km (33°34'51.15'' N; 7°3'57.05'' E) northeast of El Oued city, having an altitude of 48 meters. The soil was the same as the previous station. The

most commonly grown crops have been *P. dactylefera* (50%) and market garden crops (40%). In addition, a few fruit trees with a random arrangement have been noted as an undergrowth crops. These included *P. armeniaca*, *Vitis vinifera* (L., 1753) and *O. europaea*. The most recorded spontaneous plants have been *Cynodon dactylon* (Pers., 1805) and *Chenopodium album* (L. 1753).

Station 3 (Miha Wensa): located 30 km (33°11' 49.68" N; 6°42' 25.78" E) southwest of El Oued city and at an altitude of 96 meters. The crops grown in this station have been *P. dactylefera* with a rate of 50 %, likewise there were some fruits trees with a random arrangement in the farms followed by market garden crops such as *Solanum tuberosum* (L., 1753).

Station 4 (Reguiba): situated 25 km (33°33' 48.72"N; 6°42' 45.14" E) northwest of El Oued city at an altitude of 53 m. The crops grown have been *P. dactylefera* with a rate of 35 %. Other crops such as fruit trees (*O. Europaea*) and market garden crops, such as potatoes with a slightly high rate (40%), and also other plant species, with a low percentage of overlap were grown.

Station 5 (Trifaoui): located 55 km (33°25' 15.27" N; 6°56' 12.65" E) northeast of El Oued city, situated at an altitude of 70 meters. The most commonly grown crops have been *P. dactylefera* (40 %) and market garden crops. There were also some fruit trees with a random arrangement, such as *O. europaea*. Other species were poorly represented.

3. METHODOLOGY

In each station, 5 sites with a minimum surface area of 1 ha (100x100m) were randomly selected. Inside, 15 palm trees were randomly selected for the damage monitoring on date palm inflorescences (spathes) (Fig. 1). Estimates of losses were made before and after the openings of the spathes, in order to detect the importance of the attacks and the food preferences of the roof Rat.

At the level of each site, the overall attack rate was calculated, which was the number of palm trees showing the damages due to roof Rat relative to the total number of feet existing in the station, expressed as a percentage. This calculated the average attack rate in each study station. Immediately afterwards, the examination of the spathes was taken into account on each tree to determine the rate of attacks by inflorescences, which was the number of spathes attacked on the total number of spathes, expressed as a percentage.

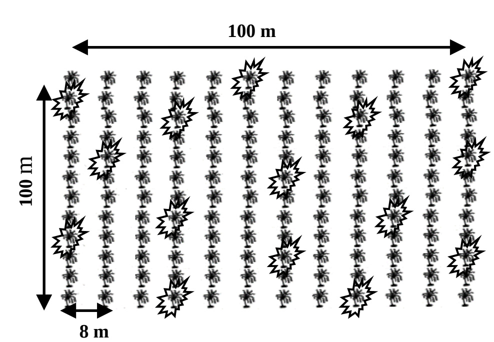

Figure 1: Schematic representation of the sampling method

The results obtained were processed by statistical analysis using data processing software such as SPSS (IBM 20), Excel-Stat (2014.5.03) and R software (R-3.4.1). The tests used included Anova (normal data), Kruskal Wallis (non-normal data) and Wilcoxon.

4. RESULTS

4.1. Kinetics of damage based on the years

The percentages of the roof Rat attack on the date palm tree for five years in the Souf region were grouped in figure 2.

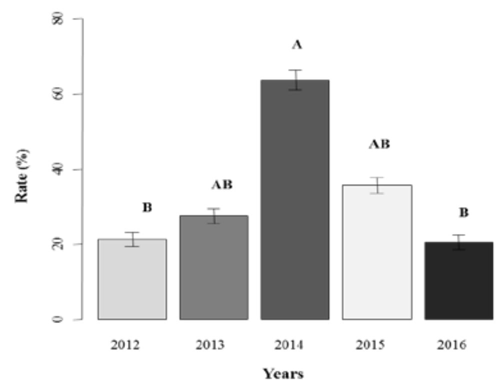

Figure 2: Rate of attack of *R. rattus* on the date palm tree in the region of Souf based on the years

According to the years, the highest rate of losses in Souf region was indicated during year 2014 with an average of 63.7 ± 8.0 % (Fig. 2). On the other hand, the lowest rate was registered during year 2016 with 20.5 ± 5.4 %. The comparison between these damages by the Kruskal-Wallis test showed the existence of a very highly significant difference (p - value = 2.288e-15) between the rates of the annual attack.

The use of Wilcoxon rank test for the damage classification showed the development of 3 groups. The first group (A) represented the year 2014 which was strictly different from the other years (Table 1). It was the year of strong attacks. The second group (B) represented the low-loss years (2012 and 2016). The year 2012 had a very significant difference with 2014 (value=1.9e-08) and 2015 (value=1.5e-04). It was the same for 2016, which had a very significant difference with 2014 (value=2.4e-08) and 2015 (value=1.4e-04) (Table 1). Finally, the third group (AB), which was the intermediate group between the other two groups (A and B), included the years in which the losses were more or less average.

Table 1: The comparisons between the averages depending on the years by the use of the Wilcoxon rank sum test

Years	2012	2013	2014	2015
2013	0.22932	-	-	-
2014	1.9e-08	5.1e-08	-	-
2015	0.00015	0.07568	1.4e-07	-
2016	1.00	0.14745	2.4e-08	0.00014

In bold face mean that there is significant difference

The average rates of attack due to *Rattus rattus* on the date palm tree in five stations of study according to the years were grouped in figure 3.

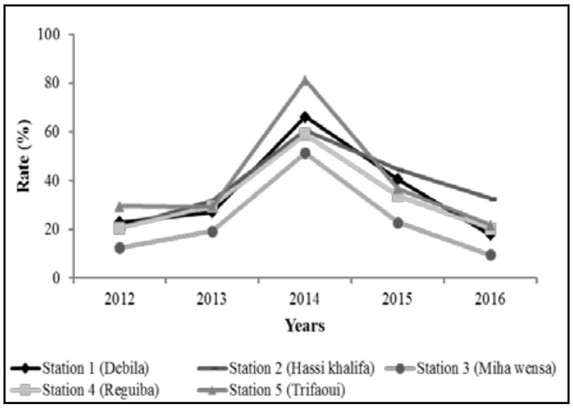

Figure 3: The rates of attack due to *R. rattus* in the region of Souf according to the years of every station

The most notable losses recorded at the various stations were recorded during 2014 (Fig. 3). In terms of stations, Station 5 had the highest losses in 2012 (29.5±6.2%) and 2014 (81.2±6.3%) compared to the other stations. Station 2 recorded the highest attack rate in 2015 (44.5±5.8%) and in 2016 (32.7±5.2%). On the other hand, station 3 was characterized by the lowest values (min = 9.35±2.3% in 2016; max = 51.4±9.1% in 2014) during all the years of the study (Fig. 3).

4.2. Kinetics of damage rate according to the stations

The figure 4 presents the rates of the *R. rattus* attack on the inflorescences of the palm tree at the five study stations in the Souf regions.

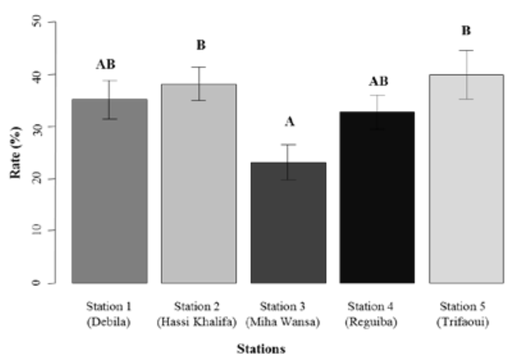

Figure 4: Rate of attack due to *R. rattus* in the Souf region according to stations

According to stations, station 5 (39.7±16.6 %) and the station 2 (38.0±11.6 %) were characterized by the highest losses, while the station 3 (23.1±11.3 %) was the least attacked by the Rats (Fig. 4).

The Kruskal-Wallis test showed a highly significant difference (p-value = 0.003218) between stationary attack rates. According to the Wilcoxon rank test, three groups were distinguished (Fig. 4). Station 3 formed group (A), which represented the least attacked station by rats. The latter had a significant difference with station 5 and 2 (p-value = 1.1e-02) (Table 2). The second group (B) was consisted of stations 2 and 5, which were characterized by the highest attacks. A third group (AB) was distinguished by the intermediate damage between the other two groups. This group was represented by stations 1 and 4 (Table 2).

Table 2: The comparisons between station averages using Wilcoxon rank sum test

Stations	Station 1	Station 2	Station 3	Station 4
Station 2	1.000	-	-	-
Station 3	0.060	**0.011**	-	-
Station 4	1.000	1.000	0.119	-
Station 5	1.000	1.000	**0.011**	1.000

In bold face mean that there is significant difference

4.3. Kinetics of rate of attack according to the inflorescence state

The rates of the roof Rat attack on the inflorescences of the palm tree before and after their openings were mentioned in figure 5.

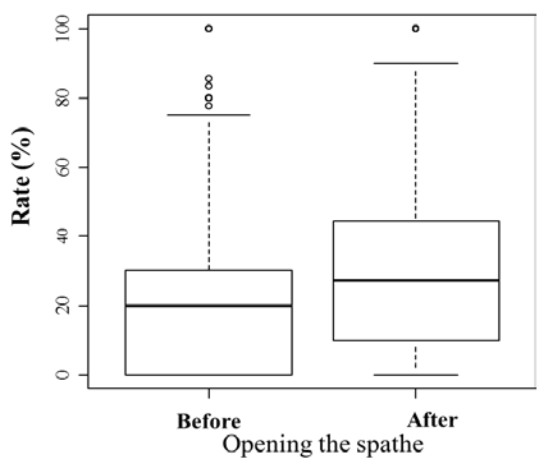

Figure 5: *R. rattus* attack rate on date palm spathes before and after their openings in the spathes in southeast Algeria

Depending on the state of the inflorescence, a comparison with the Welch test (t-test) between closed and open spathes revealed a very significant difference (value = 2.2e-16) in attack rates (Fig. 5). Open spathes (29.7±19.9%) were relatively more attacked than closed spathes (20.4±14.9%).

Depending on the stations, the attack rates of the roof Rat on date palm inflorescences have been shown in figure 6.

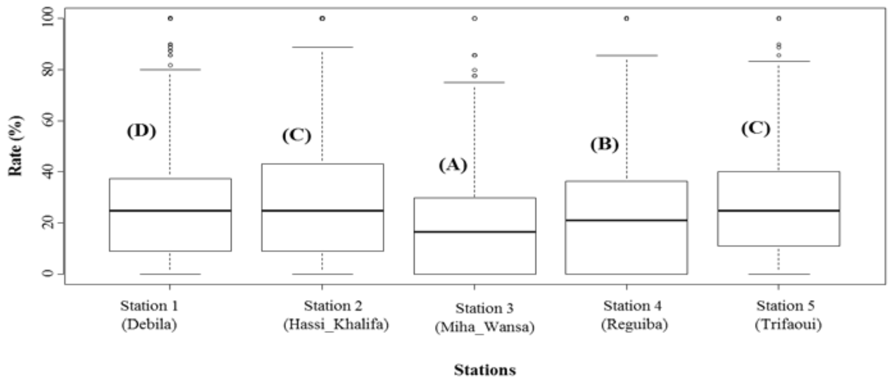

Figure 6: Stationary attack rate of *R. rattus* on date palm spathes according to their condition

The comparison (anova) between the damage recorded in the different stations showed the existence of a very significant difference (value = 2e-16) (Fig. 6). Station 2 (28.5±18.9%) and station 5 (27.1±16.7%) were characterized by the highest losses, while station 3 (19.1±16.4%) was the least attacked by the Rats.

According to the Tukey test, 4 groups were distinguished (Fig. 6). Station 3 formed group (A), which represented the least attacked station by the rats. The latter had a very significant difference with station 1 (p-value = 0.000), station 5 (p-value = 0.000) and station 4 (p-value = 0.001) (Table 3). The second group (B) represented station 4, characterized by the attacks slightly higher than those of station 3. Just after the third position, came the group (C) which stood out following relatively the important damages to those of the previous stations. It grouped stations 2 and 5 (Table 3). Finally, group (D) counted station 1, which had the highest losses compared to the other stations. The latter had a significant difference with station 4 (value = 0.023) and a very significant difference with station 3 (p-value = 0.000).

Table 3: Matrix of comparisons of the averages (Tukey test) of attacks according to the state of the date palm inflorescences.

Stations	Station 1	Station 2	Station 3	Station 4
Station 2	0.661	-	-	-
Station 3	**0.000**	0.754	-	-
Station 4	**0.023**	**0.0001**	**0.001**	-
Station 5	0.999	**0.000**	**0.000**	**0.014**

In bold face mean that there is significant difference

For attack rates according to inflorescence states (closed and open), the results have been summarized in figure 7.

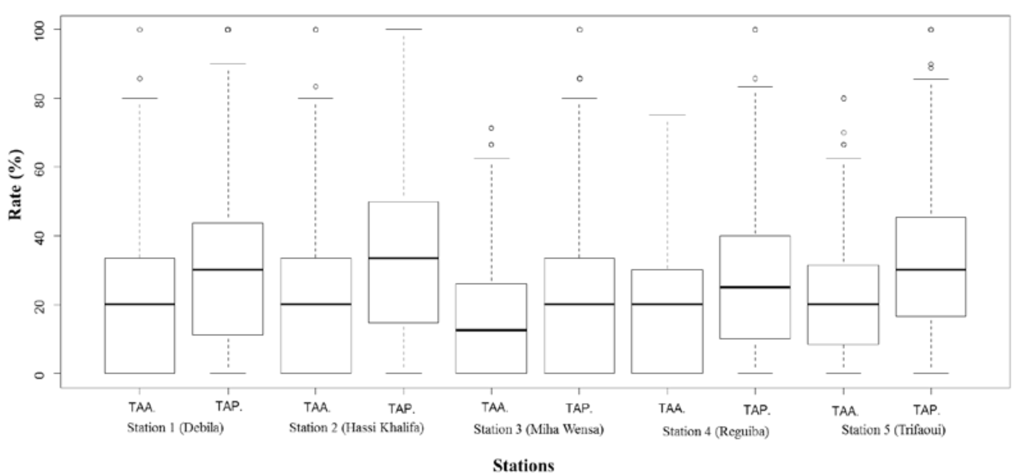

Figure 7: The rate of attack due to *R. rattus* taking into account the spathes state (closed and opened) of the palm tree in the southeast of Algeria (TAA: The rate of attack before the spathes opening; TAP: Rate of attack after the spathes opening)

Before the spathes were opened, the most notable losses were attributed to the station 2 (22.4±15.9 %), station 1 (21.9±15.4 %) and station 5 (21.9±13.9 %) (Fig. 7). On the contrary, the station 4 had the lowest rate (19.1±16.4 %). Regarding the losses after the spathes openings, station 2 (34.6±20.5%) and station 5 (32.3±18.9%) were characterized by the highest losses. Station 3, on the other hand, had the lowest attack rate during all the study years before (16.1±14.3 %) and after

(22.2±18.4 %) the openings of spathes (Fig. 7). Overall, it could be said that there was clearly a tangible increase in the rates of attack according to the time and the state of the inflorescences.

5. DISCUSSION

5.1. Kinetics attack rates attack considering the years and stations (resorts)

Throughout the world, rodents have been considered to be the major crop pests, accounting for the half of the losses (Hubert, 1984; Caroulle and Baubet, 2006). The same has been true for the study area, where roof Rats caused varying damages from one year to the next (p-value = 2.288e-15) on date palm inflorescences. The most remarkable were observed in 2014 (63.7 ± 8.0%) while the lowest ones were observed in 2016 (20.5 ± 5.4%). These results may be justified by the fact that there was a lack of an extended use of expired rodenticides (case year 2014) and the irrational hunting of predators such as owls in the study area. In addition, Verwilghen (2015) in four stations in Indonesia reported that the rate of loss on oil palms due to the rodents varied from year to year (2006 to 2012) between 2% and 7.5%. In the forests of France, these pests can attack even different types of trees, such as Oak, Beech, Poplar, Hardwood and Softwoods. The losses have mainly involved neck portion (40%), trunks (27%) and roots (25%) (Fibien and Olivier, 2006).

The attacks of the roof Rat also presented a spatiotemporal variability in the study area. Some stations, such as station 5, which recorded high losses in 2014 (81.2±6.3%) and station 2 during 2015 (44.5±5.8%), were heavily attacked. While others, such as Station 3, were slightly affected (min = 9.35±2.3% in 2016; max = 51.4±9.1% in 2014). This same observation was already reported around the world, particularly in the forests of France (Fibien and Olivier, 2006), West Java in Indonesia (Singleton et al., 2005), Beskydy National Nature Reserve in the Czech Republic (Heroldová et *al.*, 2012) and the Delta Ayeyarwady in Myanmar (Me-Htwe et *al.*, 2016). In France, the highest losses were recorded in 1994 with 110 trees per hectare compared to only 10 trees/ha in 2005. It should be mentioned that the roof Rat was introduced into the study area following the introduction of a manure poultry from the northern regions (Tébessa, Batna, khanchla, Sétif and Blida) to be used as an organic amendment for market garden crops. This animal made a good use of palm groves in the study area, where the length of the trees usually exceeded 2m for nesting. In the Ayeyarwady Delta (Myanmar), the losses on rice grains due to the rodents varied from year to year, and from station to station. The highest losses were in station 1 (14% in 2013 and 4% in 2014) and station 2 (8.2% in 2013; 1.2% in 2014). In addition, Wood and Singleton (2003) mentioned that the potential losses to palm oil forests in Malaysia were estimated at 5-10% of the country's overall production.

5.2. Kinetics of the attack rate according to the state of the inflorescences:

The damage of the roof Rats to inflorescences changed with time depending on the stage of the development of the fruits. Spathes that have been still closed were less attacked than those that were already open (p-value = 2e-16). This was clearly visible at all the stations, especially station 2 (28.5±18.9%). The latter was characterized by the losses after opening (34.6±20.5%) of the spathes higher than those recorded on the spathes that were still closed (22.4±15.9%). The same was true in Indonesia (West Java), where rice damage varied according to the growth stage of the crop, and was evaluated during the dry season at 54% in the primordial stage, 32% in the start-up stage, but only 16% in the ripening stage (Singleton et *al.*, 2005). While when it came to the different crops in Mexico, the losses varied according to the species, with percentages ranging from 32.7% (sugar cane) to 65% (rice and oats) (Sánchez-Cordero and Martínez-Meyer, 2000). Furthermore, Heroldová et *al.* (2012), in the Beskydy Mountain National Nature Reserve (Republic of Czech Republic) reported that the damage caused by rodents in winter (1999/2000) ranged from 16.4% to 23.5%. It was apparently clear that rodents attacked different crops such as rice, wheat, sugarcane, maize, pearl millet, sorghum, legumes and the others. They could cause losses ranging from 2% to 15% to as high as 100% for field crops (Buckle and Smith, 1994; Parshad, 1999). These damages have been highly variable, and have been correlated with rodent density (Jens and Emil, 2010).

6. CONCLUSION

The study of the impact of Roof Rat on date palm inflorescence showed the extent of damage caused by these pests. The latter caused very variable losses depending on the stations and time. Spathes that were opened were more attacked than those that were closed. If they were not controlled or especially when the methods used were not good enough, as in the case with 2014 (use of an expired rodenticide), the extent of the losses was clearly tangible. In addition, there was a decrease in the number of natural predators, especially raptors, who were hunted heavily in the region due to the lack of myth and macabre legends.

Disclosure of interest

The authors declared no conflict of interests.

REFERENCES

1. Alia, Z., Tannech, N., Sekour, M., Soutou, K., 2015. Study of the damage caused by rodents on some crops in the Souf region (Algeria). Organized by the Faculty of Sciences of Nature and Life, University Kasdi MERBAH Ouargla (29 to 30 November 2015).
2. Bachar, M.F., 2015. Contribution to the bioecological study of wild rodents in the Biskra region. Ph.D. thesis, Mohamed Khider University, Biskra, 239p.
3. Buckle, A.P., Smith, R.H., 1994. Rodent Pests and Their Control. University Press, Cambridge, United Kingdom, 165 p.
4. Caroulle, F., Baubet, O., 2006. Rodent damage in the forest: how to fix it? natural or human risks. Rev. For. LVIII (5), 449-462.
5. Côte, M., 2006. If the Suf was told to me, how is a landscape made and unmade? Ed. Media-Plus, Constantine, 136 p.
6. Delattre, P., Giraudoux, P., Habert, M., Quéré, J.P., 1992. The fight against rodents in hardwood plantations:

Application of integrated control techniques - Revue forestières française, XLIV (Special issue): 91-98.
7. Fibien, C., Olivier, B., 2006. Rodent damage in the forest: how to fix it? - French Forest Review, LVIII (5): 449-462.
8. Godfrey, M.E.R., Askham L.R., 1988. Non-toxic control techniques for Microtus spp. in apple orchards. Bulletin OEPP, 18 (2): 265-269.
9. Heroldová, M., Bryja, J., Janova, E., Suchomel, J., Homolka, M., 2012. Rodent damage to natural and replanted mountain forest regeneration. The Scientific World Journal, volume 2012, ID 872536, 06 pages.
10. Hubert, B., 1984. Rodents and the problems they pose to crops and stocks. Laboratory of Applied Zoology of ORSTOM in Dakar (Senegal), N: B 15841, ex 1: 85-102.
11. Jens, J., Emil T., 2010. Rodent outbreaks in Europe: dynamics and damage. In Rodent outbreaks: ecology and impacts. S. Grant, B. Steve, B. Peter and H. Bill, International Rice Research Institute (IRRI) 289.
12. Kushad, M.M., 1994. Vole control in commercial apple orchards. Transactions of the Illinois State Horticultural Society, 128, 25-28.
13. Me Htwe, N., Singletona, G.R., Mawb P.P., 2016. Post-harvest impacts of rodents in Myanmar; how much rice do they eat and damage? - Pest Management Science, eds. Wiley Online Library and Society of Chemical Industry, DOI: 10.1002/ps.4292, 7p.
14. Miot, S., Delattre, P., 2010. Rodents in orchards of organic production: methods of preventive and continuous control, Courrier of the environment of the INRA, (58): 55-68.
15. Parshad, V.R., 1999. Rodent control in India. Integrated Pest Management Reviews, eds. Kluwer Academic Publishers. Printed in the Netherlands, (4): 97–126.
16. Romankow-Zmudowska, A., 1980. Influence of snowy winter 1978-1979 on injuries caused by rodents (Common vole, Microtus arvalis) in the orchard productive farm near Poznan. Prace Naukowe Instytutu Ochrony Roslin, 22 (2), 105-116.
17. Sánchez-Cordero, V. & Martínez-Meyer, E. Museum specimen data predict crop damage by tropical rodents. Proceedings of the National Academy of Sciences Jun, 2000, 97 (13) 7074-7077; DOI:10.1073/pnas.110489897.
18. Sandrine, M., Pierre, D., 2010. Rodents in Organic Orchards: Preventive and Continuous Control Methods. the environmental letter of INRA, Paris: National Institute for Agronomic Research Permanent Delegation to the Environment, (58): 55-68. "HAL-00939703v1, 2014".
19. Singleton, G.R., Sudarmaji, J.J., Krebs C.J., 2005. Integrated management to reduce rodent damage to lowland rice crops in Indonesia- Agriculture, Ecosystems and Environment, eds. Elsevier and science direct, (107) :75-82.
20. Verwilghen, A., 2015. Rodent pest management and predator communities in oil palm plantations in Indonesia: a comparison of two contrasting systems-Doctoral thesis, University of France Comte, France, 278p.
21. Voisin, P., 2004. Le Souf. Ed. El-Walide, El-Oued, Alger, 190 p.
22. Wang, D., Li, Q., Li, K., Guo, Y., 2017. Modified trap barrier system for the management of rodents in maize fields in Jilin Province, China- Crop Protection, (98): 172-178.
23. Wood, B.J., Singleton, G.R., 2003. A critical review of the development of rat control in Malaysian- Crop Protection, (22): 445–461.
24. Wood, B.J., Singleton, G.R., 2014. Rodents in Agriculture and Forestry. Page 33-80 in A.P. Buckle, A.P., Smith, R.H., eds. Rodent Pests and their Control, 2nd Ed. CAB International, Willingford, Oxen, UK, 405p.