

## Original research

## Effect of *Dermanyssus gallinae* on zootechnical and productive indicators of farming chicken

V. Yevstafieva\*, \*\*, A. Petrunenko\*

\* Poltava State Agrarian University, Poltava, Ukraine

\*\* Institute of Veterinary Medicine of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine

Received: 12 January 2024  
Revised: 27 May 2024  
Accepted: 06 June 2024

Poltava State Agrarian University,  
Skovorody Str., 1/3, Poltava, 36003, Ukraine

Institute of Veterinary Medicine of the National  
Academy of Agrarian Sciences of Ukraine,  
Kyiv, Donetska Str., 30, Kyiv, 03151, Ukraine

Tel.: +38-050-183-78-78  
E-mail: [evstva@ukr.net](mailto:evstva@ukr.net)

\*Corresponding author:  
V. Yevstafieva  
[evstva@ukr.net](mailto:evstva@ukr.net)

**Abstract.** Results of the study of the impact of ticks on the productive indicators of industrial poultry farming in Ukraine are presented in the article. The spread of parasites that attack poultry leads to significant losses in the poultry industry. Modern technologies of poultry farming create favourable conditions for the rapid spread of dermanisiosis in chickens. *Dermanyssus gallinae* ticks are among the most dangerous blood-sucking ectoparasites, in addition, they are carriers of dangerous bird infections pathogens. The goal of the work was to establish the effect of *D. gallinae* parasitism on zootechnical indicators of chickens. The research was carried out on the premises of the "Poultry Farms of Poltava region" farm in the Poltava district of the Poltava region with the support of the laboratory of parasitology of the Poltava State Agrarian University (Poltava). The results of present study established detrimental impact of *D. gallinae* parasitism on zootechnical indicators of chickens (total number of birds, survival rate, live weight, livestock losses) during the poultry farming. In particular, under the conditions of contamination of the poultry house, the birds were dying before the age of 59 weeks, and the live weight of chickens with *D. gallinae* ectoparasites was 32.1% lower during this period compared to the clinically healthy birds. In clinically healthy chickens, live weight gradually increased from 1.4 to 2.2 kg from 15 weeks to 34 weeks. While in birds contaminated with ectoparasites, the weight increased from 1.3 to 1.9 kg during the same period, but gradually decreased from the 34th week to 1.4 kg at the 58th week. The survival rate of tick-contaminated chickens during the experiment decreased to 24.9% (over a period of 58 weeks) and was 73.9% lower than that of clinically healthy chickens aged 58 weeks. It was established that the death rate of chickens under the conditions of *D. gallinae* tick parasitism was 75.0%, which is 7.2 times higher than that of clinically healthy chickens. The data we obtained prove the relevance of research and development of means of solving the problem of chicken dermanisiosis in Ukraine, given the significant negative impact of ectoparasites *D. gallinae* on the live weight of chickens, the period of their breeding, and the indicators of their survival rates.

**Keywords:** dermanisiosis; gamaza ticks; bird's survival rates; live weight.

## Вплив *Dermanyssus gallinae* на зоотехнічні та продуктивні показники сільськогосподарських курей

**Анотація.** Птахівництво є важливою галуззю тваринництва та відіграє істотну роль у продовольчому балансі країни. Розведення курей дозволяє отримати цінні продовольчі товари, сировину для промисловості та органічні добрива. На сьогодні основне поголів'я курей зосереджено на птахофабриках промислового типу, в яких на обмежених площах знаходиться величезна кількість птахів. У цих умовах створюються сприятливі умови для виникнення та швидкого поширення дерманісіозу курей, що призводить до значних збитків галузі птахівництва. Кліщі *Dermanyssus gallinae* відносяться до найбільш небезпечних кровососних ектопаразитів, крім того вони є переносниками збудників небезпечних інфекцій птахів. Метою роботи було встановити вплив паразитування *Dermanyssus gallinae* на зоотехнічні показники курей. Дослідження проводили в умовах фермерського господарства «Пташині двори Полтавщини» Полтавського району Полтавської області і на базі лабораторії паразитології Полтавського державного аграрного університету (м. Полтава). Проведеними дослідженнями встановлено негативний вплив паразитування гамазових кліщів *D. gallinae* на зоотехнічні показники курей (чисельність поголів'я, збереженість, живу вагу, відхід) при їх вирощуванні. Зокрема, в умовах заклиценого пташника птиця до 59-тижневого віку гинула, а жива вага курей інвазованих дерманісусними кліщами виявилася за цей період нижчою на 0,7–32,1 % порівняно з клінічно здоровою птицею. Причому, у клінічно здорових курей жива вага поступово зростала з 1,4 до 2,2 кг, а у інвазованих – з 15-тижневого до 34-тижневого віку спочатку зростала (з 1,3 до 1,9 кг), в подальшому – поступово знижувалася (до 1,4 кг). Збереженість інвазованих кліщами курей впродовж досліду знижувалася зі 100 до 24,9 % і виявилася нижчою на 23,4–73,9 %, ніж у клінічно здорових курей. Встановлено, що відхід курей за умов паразитування дерманісусних кліщів склав 75,00 %, що у 7,2 раза вище, ніж у клінічно здорових курей. Отримані нами дані доводять актуальність проблеми дерманісіозу курей в Україні, у зв'язку із значним негативним впливом *D. gallinae* на масу тіла курей, строки їх вирощування та показники їх збереженості.

**Ключові слова:** дерманісіоз; гамазові кліщі; збереженість; відхід птиці; жива вага.

**Cite this article:** Yevstafieva, V., & Petrunenko, A. (2024). Effect of *Dermanyssus gallinae* on zootechnical and productive indicators of farming chicken. *Theoretical and Applied Veterinary Medicine*, 12(2), 17–23. doi: 10.32819/2024.12008

## Introduction

Over the last few years, one of the leading branches of livestock production in Ukraine – poultry farming – has been steadily developing. Successful and economically profitable production of poultry products requires permanent and unwavering monitoring of the epizootic status of the livestock (Flochlay et al., 2017; Avercheva, 2022; Savchenko, 2022). Among poultry diseases of infectious etiology, a significant part is related to diseases caused by ectoparasites. These pathogens belong to the list of biological agents that create significant environmental problems that negatively affect the development of poultry farming as a whole (Fujisawa et al., 2023; Ribeiro et al., 2023; Sioutas et al., 2024). Moreover, one of the most dangerous ectoparasites that is registered in poultry farming in different countries of the world is the red chicken mite *D. gallinae*, which is included in the list of the most dangerous blood-sucking parasites that are also registered in all EU countries (Calnek, 1991; Axtell, 1999; Maurer et al., 2003; Zenner et al., 2009; Sparagano et al., 2020).

*D. gallinae* (De Geer 1778) is a cosmopolitan hematophagous mite ectoparasite of wild, domestic and synanthropic birds that can also attack other mammals as well as humans (DeClercq & Nachtegaele, 1993; Haag-Wackernagel, 2005; Lucky & Sayers, 2001; Rosen et al., 2002; Mignon & Losson, 2008; Abd El-Halim et al., 2009). Dermanisiosis leads to significant economic losses, especially in terms of egg production, where the stress state of hens leads to a decrease in their laying and egg quality (Kilpinen et al., 2005; Mul & Koenraadt, 2009). In addition, *D. gallinae* is a carrier of infectious disease agents, which can lead to a sudden outbreak of infection (Valiente-Moro et al., 2005).

As a result of excessive irritation of the bird's skin and hematophagy, the parasites induce anemic syndrome, itching, emaciation, loss of feathers and weight loss in adult birds. In some cases, the death of a young bird was registered. There are also the reports that the presence of *D. gallinae* mites in the poultry house causes long-term and severe stress in chickens.

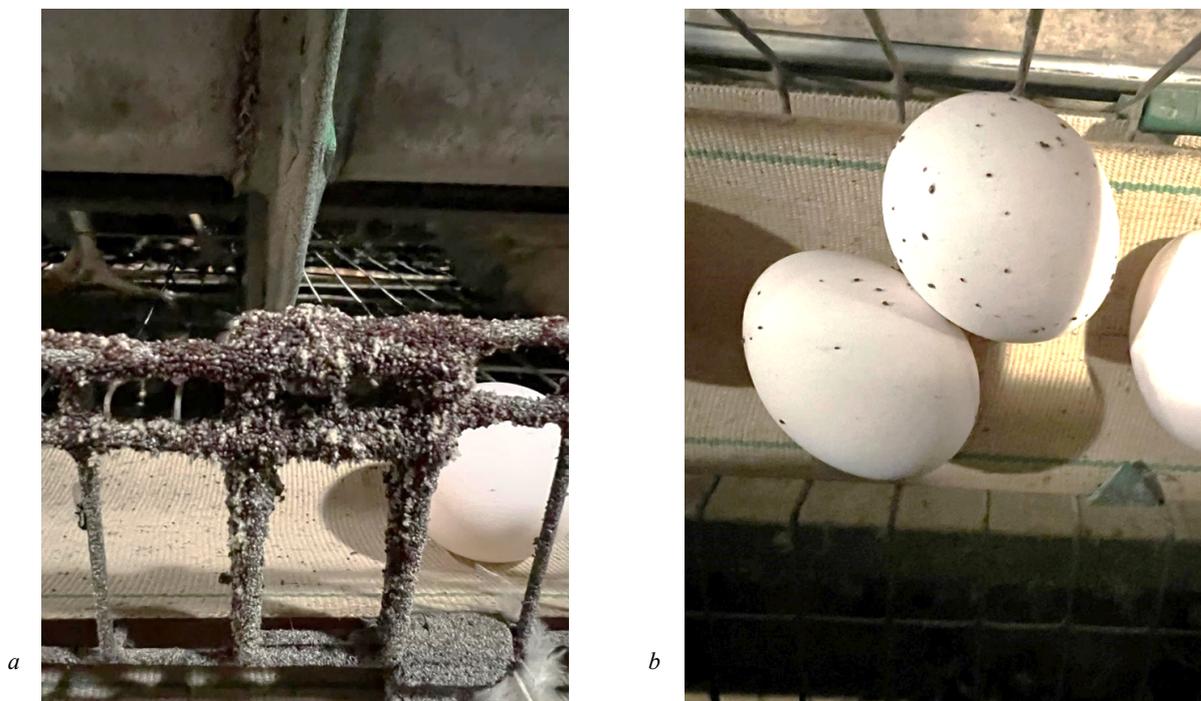
Such stress is a reaction of the bird's body to skin irritation caused by tick bites, especially at a high intensity of infestation (van Emous, 2005; Kilpinen et al., 2005). At the same time, the authors found severe pecking of parasite-infested areas, increased feed and water consumption, as well as deterioration of the general condition of the bird's organism, immunosuppression (Chauve, 1998; Kilpinen, 2005; Kowalski & Sokol, 2005; Mul, 2009).

Research and analysis of economic losses from dermanisiosis showed that the main components of the deterioration of production indicators of poultry farming are a decrease in the feed conversion ratio, an increase in the share of low-grade eggs and additional costs of the fighting ticks. Economic losses of the commercial poultry farming caused by the dermanisiosis in poultry are estimated at approximately 130 million euros per year (Sparagano et al., 2009). Total losses in the production of edible chicken eggs caused by ticks in Europe is estimated by individual researchers as more than 231 million euros per year (Flochlay et al., 2017). There are also reports of mortality in chickens, especially young ones, due to parasitism of a significant number of *D. gallinae*, which leads first to anemia, and then to the death of the bird due to exsanguination (Wójcik et al., 2000; Fossum et al., 2009).

Therefore, the aim of this research was to establish the detrimental effect of *D. gallinae* parasitism on zootechnical and productive indicators of chickens.

## Materials and methods

The research was carried out during 2022–2023 using animals from "Poultry Farms of Poltava region" of the Poltava district of the Poltava region. Mini-traps devices measuring 10×10 cm made of corrugated cardboard were used to estimate the number of ticks in the poultry houses. The traps were fixed in the poultry houses on various structures. They were removed 24 hours after installation. After collecting ticks from mini-traps, they were placed in Petri dishes, fixed with 70% ethyl alcohol, and their number was calculated per 100 cm<sup>2</sup>.



**Fig. 1.** Density of *D. gallinae* mites collected from farm devices and eggs.  
Part *a* – iron constructions of the poultry house; part *b* – eggs and the egg collection channel.

After a complex parasitological examination, two poultry houses with young Hy-Line cross hens of the age of 15 weeks were included into the experiment and divided for 4 groups (with 12 chickens in each group). The first flock contained chickens with a *D. gallinae* contamination level of 108 mites /100 cm<sup>2</sup> (48 individuals). The second chicken flock was a control one, containing chickens free of *D. gallinae* ticks (48 individuals). Chickens were kept under the same growing conditions. Observations were conducted for a period of 78 weeks. We were registering the live weight of chickens during the experiment (kg), the number of stock (n), survival rate (%), death volume (n), death rate (%).

Mathematical analysis of the obtained data was carried out using the Microsoft "EXCEL" application program package by determining the arithmetic mean (M) and standard deviation (SD). The significantly of differences in mean values was determined using the method of variance univariate analysis, using Fisher's test. Value of  $p < 0.05$  were considered statistically significant.

### Results

The results of the study have shown that the experimental poultry house was significantly contaminated with colonies of *D. gallinae* mites. The largest clusters of parasites were found on the iron constructions (Fig. 1 a) as well as on the eggs and the surface of the egg collection channel (Fig. 1 b).

There was established that the live weight of tick-free chickens was gradually increasing from  $1.37 \pm 0.01$  kg (at 15 weeks of age) to  $2.23 \pm 0.02$  kg (at 78 weeks of age). At the same time, the live weight of chickens infested with *D. gallinae* ticks, although it was gradually increasing from  $1.27 \pm 0.01$  to  $1.76 \pm 0.01$  kg during the 15-25 weeks of age span, turned out to be lower in 24-week-old chickens by 6.4% ( $P < 0.001$ ) compared to similar indicators in clinically healthy birds. Later, in the experimental poultry house, the live weight of chickens slightly increased from 25 to 35 weeks of age from  $1.79 \pm 0.01$  to  $1.86 \pm 0.01$  kg.

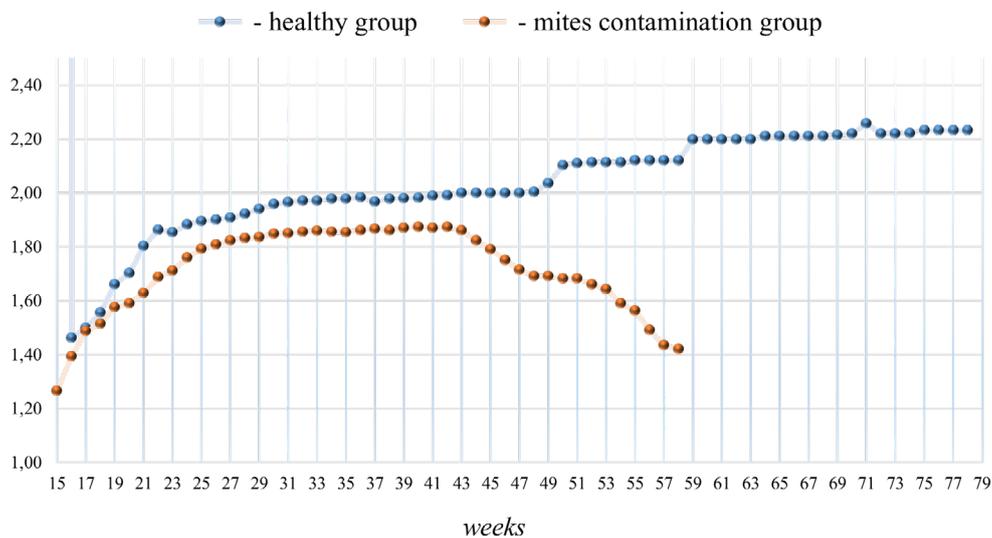


Fig. 2. Live weight data of control chickens and affected with dermanisiosis (kg) during the growing period.

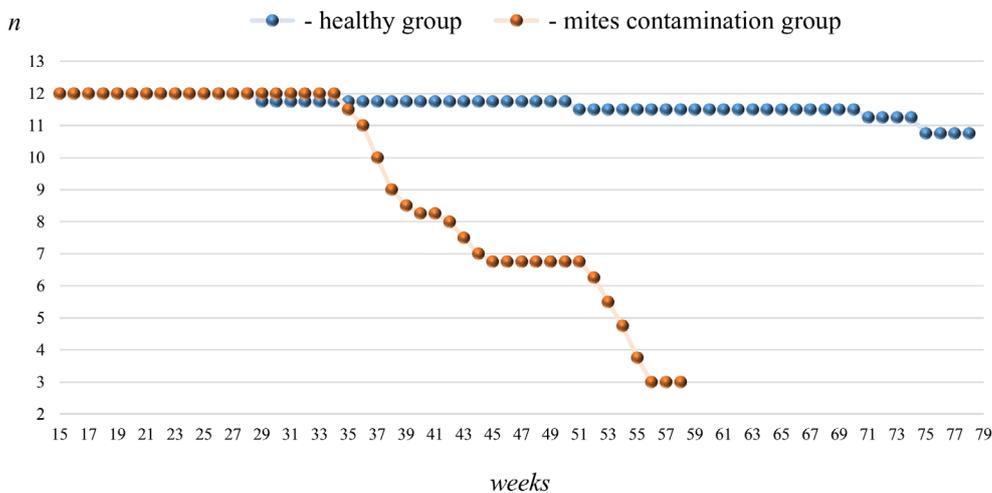


Fig. 3. Chicken number in the control group and group affected with dermanisiosis stock during the growing period (n).

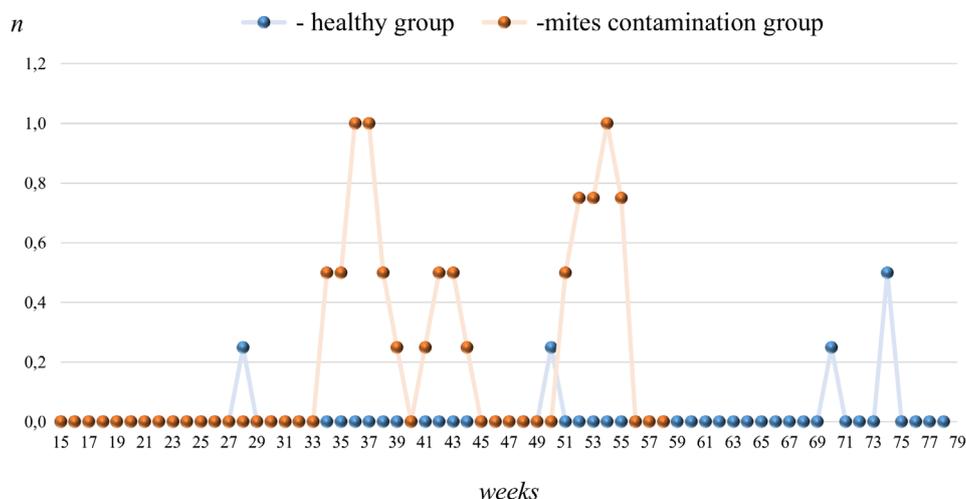


Fig. 4. Rate of chicken death in control and group affected with dermanisiosis during the growing period (n).

However, these indicators were lower in 34-week-old chickens by 6.1% ( $P < 0.001$ ) compared to clinically healthy birds. During the next 10 weeks (from 35 to 45 weeks), the live weight of experimental chickens started to decrease from  $1.85 \pm 0.01$  to  $1.82 \pm 0.02$  kg, which turned out to be 9.0% ( $P < 0.001$ ) lower in chickens 44 weeks of age than in clinically healthy birds. Subsequently, from 45 weeks to 59 weeks of age, the live weight of chickens suffering of tick parasitism decreased from  $1.79 \pm 0.02$  to  $1.42 \pm 0.15$  kg, which was 33.0% ( $P < 0.001$ ) lower in 58-week-old chickens than in clinically healthy birds (Fig. 2).

The population of poultry was changing during the growing period the following way: clinically healthy chickens have lost  $10.75 \pm 0.96$  birds by the 78th day. At the same time in the experimental flock live span was registered as 58 weeks, while the number of birds was slowly decreasing from 12 to  $3.00 \pm 1.41$  n. and by the 59th week 100% of birds have died (Fig. 3).

It was also determined that in the control poultry house, during the period of growing (from 15 to 78 weeks of age), chicken death rate was at  $1.25 \pm 0.96$  level. At the same time, in conditions of contamination of the poultry house with ticks, the death rate was significantly higher (by 7.2 times,  $P < 0.001$ ) and amounted to  $9.0 \pm 1.41$  n. (from 15th to 58th week) (Fig. 4).

The survival of clinically healthy chickens during the experiment decreased from 100 to  $95.80 \pm 4.85\%$ . At the same time, in chickens infested with *D. gallinae* ticks, survival is on a 100% level up to the 33rd week of age. Later, the indicators of bird survival gradually decrease as the following: at the age of 34 weeks  $95.83 \pm 8.35\%$ , 40 weeks –  $68.70 \pm 4.20\%$ , 45 weeks –  $56.20 \pm 12.49\%$ , 50 weeks –  $56.20 \pm 12.49\%$ , 55 weeks –  $24.98 \pm 11.79\%$ , 58 weeks –  $24.98 \pm 11.79\%$ , which is 23.4–73.9% ( $P < 0.001$ ) lower, than in clinically healthy chickens (Fig. 5).

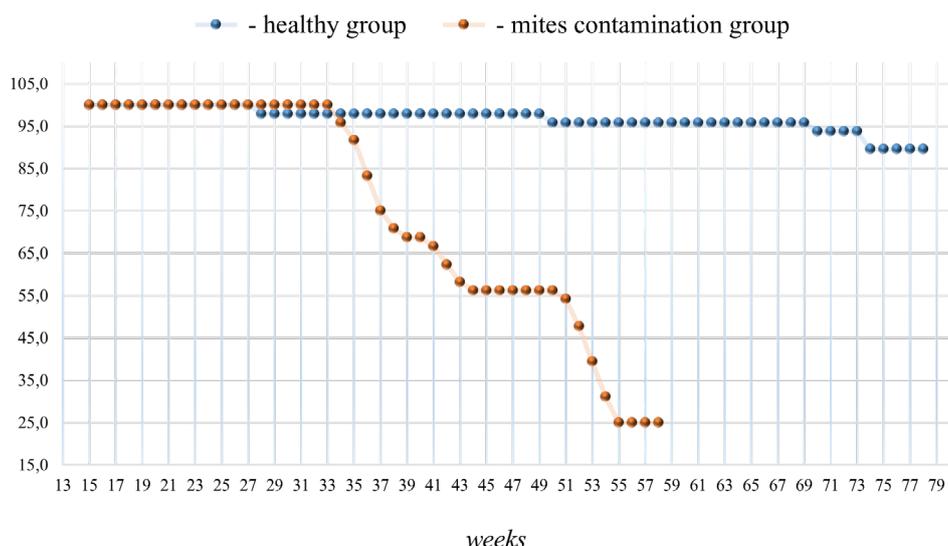


Fig. 5. Survival level of chicken stock affected with dermanisiosis during the growing period (%)

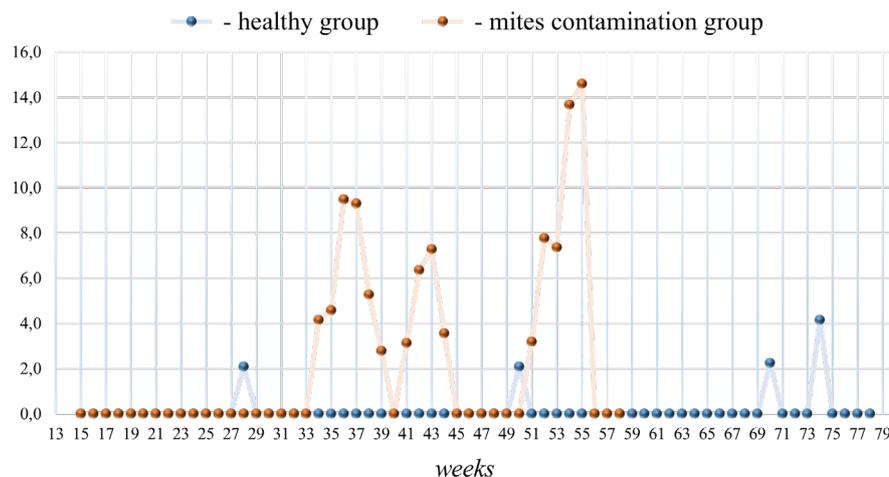


Fig. 6. Death rate of chickens due to dermanisiosis during the growing period (%)

The death rate of tick-free birds during the growing period at the age of 28 weeks was  $2.08 \pm 4.17\%$ , at the age of 50 weeks –  $2.08 \pm 4.17\%$ , at the age of 70 weeks –  $2.25 \pm 4.50\%$ , at 74 weeks of age –  $4.15 \pm 8.30\%$ . In total, during the period of the experiment, the death rate of chickens in the control poultry house was  $10.42 \pm 7.98\%$ . At the same time, in the experimental poultry house, affected by dermanisiosis, birds death rate was significantly higher and in the period from 34 weeks to 55 weeks of chicken age ranged from  $2.78 \pm 5.55\%$  to  $14.58 \pm 17.17\%$  (Fig. 6).

In total, during the period of experiment, mortality in tick infected chickens was  $75.00 \pm 11.79\%$ , which is 7.2 times ( $P < 0.001$ ) higher than that of clinically healthy chickens.

So, the results of the study showed that the invasion of *D. gallinae* in chickens during the period of their growing leads to a reduction of their term of use in the flock, low survival rate, a decrease in live body weight and an increase in the number of birds lost.

## Discussion

Parasitism is a symbiotic formed association of genetically different kinds of organisms. This relationship is based on immunobiological relationships, nutritional relationships and various interaction while the parasite uses the host as a habitat and source of nutrition and causes damage to it. Parasites of birds include a wide range of arthropods, including *D. gallinae* ticks. This ectoparasite is a temporary nest parasite and obligate hematophagous of chickens, turkeys, waterfowl and synanthropic birds. It could be found everywhere, most often in chicken houses, in the nests of synanthropic birds (Sparagano, 2020; Sparagano et al., 2020; Bartley et al., 2021). Scientists associate such a significant prevalence with several factors, such as: a short cycle of development of ticks during the year, the possibility of starvation for a long time, high resistance to acaricidal drugs. In particular, according to the development of ticks, during the day, adults hide in crevices of nests, cages, walls, ceilings, in garbage, litter, etc. At night, *D. gallinae* attack birds and suck its blood for a period of from several minutes to several hours. During this time, the mass of blood absorbed could exceed the mass of the tick by 10 times. At the same time ticks can remain viable without a host for 8–9 months, which allows the maintenance of tick populations in poultry houses during the absence of birds (Nordenfors et al., 1999; Bhowmick et al., 2020; Cocciolo et al., 2020; Wang et al., 2020).

A significant number of scientists testify to the negative impact of dermanisus mites on the general condition of chickens and their productivity (Kilpinen et al., 2005; Mul & Koenraadt, 2009; Tabari et al., 2020). Therefore, the aim of our work was to establish the influence of *D. gallinae* parasitism on zootechnical indicators of chickens.

The results of the present study indicate a significant harmful effect of tick contamination on the survival of the poultry stock, which at the age of 58 weeks was only 24.9%, which was lower than 73.9% ( $P < 0.001$ ) in clinically healthy chickens. At the same time, the death rate of chickens in the conditions of *D. gallinae* contamination of the poultry house reached 75.0%, which is 7.2 times ( $P < 0.001$ ) higher than that of clinically healthy chickens. Significant losses in production due to the stress of chickens caused by mite populations are evidenced by scientific works, where the authors note that chicken death occurs very often due to the anemia and blood loss. Also, several scientists report that even small mite populations can cause a significant negative impact on the physiological state and productivity of chickens (van Emous, 2005; Kilpinen et al., 2005). There is a report by the authors, where due to the parasitism of dermanis mites in Poland, the death rate of chickens increased by 6.2% (Cosoroaba, 2001), and in Romania, a 10-fold increase in poultry mortality was found (Wójcik et al., 2000).

The results of our research showed that *D. gallinae* mite parasitism significantly affects the live weight of chickens, which at the age of 58 weeks was  $1.42 \pm 0.15$  kg, what is by 0.7–32.1% ( $P < 0.05$  and  $P < 0.001$ ) lower compared to clinically healthy birds. The obtained data are consistent with the results of other authors, who note that dermanisiosis can lead to a decrease in the body weight of laying hens (Chauve, 1998; Kowalski & Sokół, 2009). Researchers note that dermanisiosis in chickens leads to damage to plumage and skin due to severe pecking, which is an additional cause of reduced productivity of poultry (Schreiter et al., 2022). The results of recent studies have shown that infection of chickens with *D. gallinae* negatively affects the immune responses of the host's body, reduces inflammatory reactions, which also significantly affects the indicators of the vital activity of chickens and their productivity (Fujisawa et al., 2023).

Taking into the account wide spreading of ectoparasites, the authors report significant economic losses associated with *D. gallinae*.

Production losses including the treatment and prevention costs for 600 million laying hens in the EU amount to approximately €250 million per year (Van Riel et al., 2016; Waap et al., 2019). The data we obtained prove the relevance of the study of zoonoses of chickens in Ukraine in connection with the significant negative impact of *D. gallinae* on the productivity of poultry production, terms of growing and indicators of survival.

### Conclusion

The detrimental effect of parasitism of gamy ticks *Dermanyssus gallinae* on zootechnical and productive index of chickens has been proven. The mite contamination with dermanisiosis in chickens induces the reduction of age to 59 weeks, while the survival rate at 58 weeks of age is 25% during growing period. At the same time, the live weight of the bird at the age of 58 weeks decreases by 33.0%, the survival rate – by 73.9%, and the death rate increases by 7.2 times compared to similar indicators in clinically healthy birds.

### Funding

The research was carried out within the framework of the initiative topic of scientific work: “Ecological-faunistic monitoring and development of modern methods of diagnosis, measures to combat and prevent parasitic diseases in birds” (state registration No. 0121U107882), Ukrainian Institute of Scientific and Technical Expertise and Information, Ukraine; “Monitoring and improvement of means of diagnosis, treatment and prevention of infectious diseases of animals and poultry” (state registration No. 0123U101067), Ukrainian Institute of Scientific and Technical Expertise and Information, Ukraine.

### Acknowledgement

The authors express their gratitude to director of the farm «Poultry yards of Poltava region» Viktor Gulenko for cooperation in data collection from poultry flocks and its interpretation in respect with zootechnical and productive indexes of farming birds.

### Declaration of Competing Interest

Authors declare no conflict of interests with respect to this paper.

### References

- Abd El-Halim, A. S., Allam, K. A., Metwally, A. M., & El Boraey, A. M. (2009). Seasonal variation of infestation rate with lice, tick and mite among rodents in certain Egyptian regions. *Journal of the Egyptian Society of Parasitology*, 39(2), 617–624.
- Avercheva, N. (2022). Zabezpechennia stiikoho rozvytku ptakhivnystv na osnovi malykh form pidpriemnystv [Sustainable development of poultry farming on the basis of small businesses]. *Taurida Scientific Herald. Series: Economics*, 14, 16–25 (in Ukrainian).
- Axtell, R. C. (1999). Poultry integrated pest management: status and future. *Integrated Pest Management Reviews*, 4, 53–73.
- Bartley, K., Chen, W., Lloyd Mills, R. I., Nunn, F., Price, D. R. G., Rombauts, S., Van de Peer, Y., Roy, L., Nisbet, A. J., & Burgess, S. T. G. (2021). Transcriptomic analysis of the poultry red mite, *Dermanyssus gallinae*, across all stages of the lifecycle. *BMC Genomics*, 22(1), 248.
- Bhowmick, B., Tang, Y., Lin, F., Øines, Ø., Zhao, J., Liao, C., Ignell, R., Hansson, B.S., & Han, Q. (2020). Comparative morphological and transcriptomic analyses reveal novel chemosensory genes in the poultry red mite, *Dermanyssus gallinae* and knockdown by RNA interference. *BioRxiv*, 10, 17923.
- Calnek, B.W. (1991). *Diseases of poultry*. Calnek, London.
- Chauve, C. (1998). The poultry red mite *Dermanyssus gallinae* (De Geer, 1778): current situation and future prospects for control. *Veterinary Parasitology*, 79(3), 239–245.
- Cocciolo, G., Circella, E., Pugliese, N., Lupini, C., Mescolini, G., Catelli, E., Borchert-Stuhlträger, M., Zoller, H., Thomas, E., & Camarda, A. (2020). Evidence of vector borne transmission of *Salmonella enterica enterica* serovar Gallinarum and fowl typhoid disease mediated by the poultry red mite, *Dermanyssus gallinae* (De Geer, 1778). *Parasites & Vectors*, 13(1), 513.
- Cosoroaba, I. (2001). Massive *Dermanyssus gallinae* invasion in battery-husbandry raised fowls. *Revue de Médecine Vétérinaire*, 152, 89–96.
- DeClercq, J., & Nachtegaele, L. (1993). *Dermanyssus gallinae* in a dog. *Canine Practice*, 18, 34–36.
- Fossum, O., Jansson, D. S., Etterlin, P. E., & Vågsholm, I. (2009). Causes of mortality in laying hens in different housing systems in 2001 to 2004. *Acta Veterinaria Scandinavica*, 51(1), 3.
- Fujisawa, S., Murata, S., Sato, T., Oishi, E., Taneno, A., Konnai, S., & Ohashi, K. (2023). Investigation of peripheral blood responses in chickens infested with *Dermanyssus gallinae*. *Parasitology International*, 95, 102754.
- George, D. R., Finn, R. D., Graham, K. M., Mul, M. F., Maurer, V., Moro, C. V., & Sparagano, O. A. (2015). Should the poultry red mite *Dermanyssus gallinae* be of wider concern for veterinary and medical science?. *Parasites & Vectors*, 8, 178.
- Haag-Wackernagel, D. (2005). Parasites from feral pigeons as a health hazard for humans. *Annals of Applied Biology*, 147, 203–210.
- Kilpinen, O. (2005). How to obtain a blood meal without being eaten by a host: the case of poultry red mite, *Dermanyssus gallinae*. *Physiological Entomology*, 30, 232–40.
- Kilpinen, O., Roepstorff, A., Permin, A., Nørgaard-Nielsen, G., Lawson, L. G., & Simonsen, H. B. (2005). Influence of *Dermanyssus gallinae* and *Ascaridia galli* infections on behaviour and health of laying hens (*Gallus gallus domesticus*). *British Poultry Science*, 46(1), 26–34.
- Kowalski, A., & Sokół, R. (2009). Influence of *Dermanyssus gallinae* (poultry red mite) invasion on the plasma levels of corticosterone, catecholamines and proteins in layer hens. *Polish Journal of Veterinary Sciences*, 12, 231–235.
- Lucky, A. W., Sayers, C., Argus, J. D., & Lucky, A. (2001). Avian mite bites acquired from a new source—pet gerbils: report of 2 cases and review of the literature. *Archives of Dermatology*, 137(2), 167–170.
- Maurer, V., Baumgärtner, J., Bieri, M., & Fölsch, D. W. (1993). The occurrence of the chicken mite *Dermanyssus gallinae* (Acari: Dermanyssidae) in Swiss poultry houses. *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*, 66, 87–97.
- Mignon, B., & Losson, B. (2008). Dermatitis in a horse associated with the poultry mite (*Dermanyssus gallinae*). *Veterinary Dermatology*, 19(1), 38–43.
- Mul, M. (2009). Control methods for *Dermanyssus gallinae* in systems for laying hens: results of an international seminar. *World's Poultry Science Journal*, 65, 589–99.
- Mul, M. F., & Koenraad, C. J. (2009). Preventing introduction and spread of *Dermanyssus gallinae* in poultry facilities using the HACCP method. *Experimental & Applied Acarology*, 48(1-2), 167–181.
- Nordenfors, H., Höglund, J., & Ugglå, A. (1999). Effects of temperature and humidity on oviposition, molting, and longevity of *Dermanyssus gallinae* (Acari: Dermanyssidae). *Journal of Medical Entomology*, 36, 68–72.
- Ribeiro, J. M., Hartmann, D., Bartošová-Sojková, P., Debat, H., Moos, M., Šimek, P., Fara, J., Palus, M., Kučera, M., Hajdušek, O., Sojka, D., Kopáček, P., & Perner, J. (2023). Blood-feeding adaptations and virome assessment of the poultry red mite *Dermanyssus gallinae* guided by RNA-seq. *Communications Biology*, 6(1), 517.

- Rosen, S., Yeruham, I., & Braverman, Y. (2002). Dermatitis in humans associated with the mites *Pyemotes tritici*, *Dermanyssus gallinae*, *Ornithonyssus bacoti* and *Androlaelaps casalis* in Israel. *Medical and Veterinary Entomology*, 16(4), 442–444.
- Savchenko, T. (2022). Stan i perspektyvy rozvytku rehionalnykh rynkiv produktsii ptakhivnystv v umovakh yevrointehratsii [State and prospects of the development of regional markets of poultry products in the conditions of euro interaction]. *Uzhorod National University Herald. Series: International Economic Relations and World Economy*, 44, 77–83 (in Ukrainian).
- Schreiter, R., Herzog, M., & Freick, M. (2022). Effects of the poultry red mite (*Dermanyssus gallinae*) load on the plumage condition in commercial laying hen farms. *PloS One*, 17(11), e0277513.
- Sigognault Flochlay, A., Thomas, E., & Sparagano, O. (2017). Poultry red mite (*Dermanyssus gallinae*) infestation: a broad impact parasitological disease that still remains a significant challenge for the egg-laying industry in Europe. *Parasites & Vectors*, 10(1), 357.
- Sioutas, G., Gelasakis, A. I., & Papadopoulos, E. (2024). Spatial distribution of *Dermanyssus gallinae* infestations in Greece and their association with ambient temperature, Humidity, and Altitude. *Pathogens*, 13(4), 347.
- Sparagano, O. (2020). A nonexhaustive overview on potential impacts of the poultry red mite (*Dermanyssus gallinae*) on poultry production systems. *Journal of Animal Science*, 98(1), 58–62.
- Sparagano, O. A. E., George, D. R., Finn, R. D., Giangaspero, A., Bartley, K., & Ho, J. (2020). *Dermanyssus gallinae* and chicken egg production: impact, management, and a predicted compatibility matrix for integrated approaches. *Experimental & Applied Acarology*, 82(4), 441–453.
- Sparagano, O., Pavličević, A., Murano, T., Camarda, A., Sahibi, H., Kilpinen, O., Mul, M., van Emous, R., le Bouquin, S., Hoel, K., & Cafiero, M. A. (2009). Prevalence and key figures for the poultry red mite *Dermanyssus gallinae* infections in poultry farm systems. *Experimental & Applied Acarology*, 48(1-2), 3–10.
- Tabari, M. A., Rostami, A., Khodashenas, A., Maggi, F., Petrelli, R., Giordani, C., Taponjoui, L. A., Papa, F., Zuo, Y., Cianfaglione, K., & Youssefi, M. R. (2020). Acaricidal activity, mode of action, and persistent efficacy of selected essential oils on the poultry red mite (*Dermanyssus gallinae*). *Food and Chemical Toxicology*, 138, 111207.
- Valiente-Moro, C., Chauve, C., & Zenner, L. (2005). Vectorial role of some dermanysoid mites (Acari, Mesostigmata, Dermanyssoidea). *Parasite*, 12(2), 99–109.
- Van Emous, R. (2005). Wage war against the red mite. *Poultry International*, 44, 26–33.
- Van Riel, J. W., Mul, M. F., Guy, J. H. & George, D. R. (2016). Investigations on economics of operational control of *Dermanyssus gallinae*. In Abstract book of the 2nd COST Conference and management committee meeting (p. 39). Zagreb, Croatia.
- Waap, H., Nunes, T., Mul, M. F., Gomes, J., & Bartley, K. (2019). Survey on the prevalence of *Dermanyssus gallinae* in commercial laying farms in Portugal. *Avian Pathology*, 48(1), 2–9.
- Wang, C., Xu, X., Yu, H., Huang, Y., Li, H., Wan, Q., & Pan, B. (2020). Low-temperature storage of the poultry red mite, *Dermanyssus gallinae*, facilitates laboratory colony maintenance and population growth. *Parasitology*, 147(7), 740–746.
- Wójcik, A.R., Grygon-Franckiewicz, B., Zbikowska, E. & Wasielewski, L. (2000). Invasion of *Dermanyssus gallinae* (De Geer, 1778) in poultry farms in the Toruń region. *Wiadomosci Parazytologiczne*, 46, 511–515.
- Zenner, L., Bon, G., Chauve, C., Nemoz, C., & Lubac, S. (2009). Monitoring of *Dermanyssus gallinae* in free-range poultry farms. *Experimental & Applied Acarology*, 48(1-2), 157–166.