Global Veterinaria 21 (5): 268-277, 2019
ISSN 1992-6197

DOI: 10.5829/idosi.gv.2019.268.277

Seasonal Distribution of *Argas persicus* in Local Poultry Farms (Baladi Chicken) in Jeddah Governorate, Saudi Arabia

[1]*Amal M. Alzahrani and* [2]*Nada O. Edrees*

[1]Department of Biology, Faculty of Arts and Science in Almandaq, Al-Baha University, Saudi Arabia
[2]Department of Biology, Faculty of Science, University of Jeddah, Saudi Arabia

Abstract: The fowl tick *Argas* (*Persicargas*) *persicus* (Oken, 1818) (Acari: Argasidae) is an obligate poultry ectoparasite. It has negative effects on chicken productivity and probably kills birds due to heavy infestation and transmitting diseases such as avian borreliosis. The study aimed to determine the seasonal distribution of argasid ticks in different poultry farms at Jeddah, Saudi Arabia. Five chicken farms in Jeddah Governorate, Saudi Arabia were investigated for tick infestation during the period from Jun 2017 to May 2018. The *A. persicus* ticks were collected from the cracks, crevices and on birds. The ticks in cracks and crevices were trapped by 30 traps/farm. The ticks on birds were picked by strong forceps. Furthermore, the hen number, hen age, hen weight, egg production, egg weights were recorded. Infestation rate of *A. persicus* that comes from the total number of ticks in 30 traps per farm was calculated. A total of 7290 ticks; 2890 adults, 3432 nymphs and 968 larvae were recorded in four farms, while the fifth farm was free from any infestation during all seasons. There is a positive correlation between the average numbers of *A. persicus* ticks and the average number of the hen during the study period (r= 0.589 - 0.953). Moreover, there is a negative correlation between the average numbers of *A. persicus* ticks and the following parameters independently; the average of hen weight (r= -0.551 - -0.981), daily egg production (-0.101 - -0.606) and egg weight (-0.143 - -0.977). The fowl tick *A. persicus* causes a huge problem in Baladi chicken farms in Jeddah governorate. Therefore, it is recommended to implement a control program to improve their productivity.

Key words: Argas persicus · Argasidae · Chicken · Soft Ticks · Fowl Tick · Seasonal Distribution · Saudi Arabia

INTRODUCTION

The fowl tick *Argas* (*Persicargas*) *persicus* (Oken, 1818) (Acari: Argasidae) is a soft tick that has spread throughout the continents including Africa (e.g. Egypt; Senegal, Zimbabwe, Ethiopia, Kenya, Algeria,), Asia (e.g. Turkey, Iran,), Europ (e.g. Italy), Australia and 21 American countries [1-14]. It is an obligate poultry ectoparasite, where, it infests mainly domestic fowls, turkeys, ducks, and geese. It also attacks pigeons, wild birds and rarely human [8, 15-18].

The *A. persicus* female lays 6-7 egg batches during its lifetime, (20-100) egg per batch that is laid after a blood meal. After three weeks, eggs hatch to larvae which feed on a host for 5-10 days. The larvae detach from the host and molt to nymphs in cracks and crevices in the poultry house. The nymphs feed on a host for 5 min to few hours and molt to subsequent nymphal stage or adult stage in cracks and crevices. The nymph has four stages, each requiring a blood meal before molting to the next stage. The molting of nymphs to adult stage occurs from the second nymphal stage onwards. The adults feed and molt as the nymphal stage. The adults feed about once a month. The larvae, nymphs, and adults can survive without a blood meal for two months, one year and three years, respectively [17].

Argas persicus is the main vector of Avian spirochetosis and it transmits its causative agent *Borrelia anserina* transstadially and transovarially [19-22]. It also carries a variety of other bacterial pathogens such as *Rickettsia*, *Bartonella*, *Anaplasma* [23, 24] and viruses [25]. The *A. persicus* larvae produce

Corresponding Author: Amal M. Alzahrani, Department of Biology, Faculty of Arts and Science in Almandaq, Al-Baha University, Saudi Arabia.

a toxin that causes paralysis in chickens and ducks [17, 26]. Furthermore, a heavy infestation of *A. persicus* has negative effects on chicken productivity, e.g. lower egg productivity and kill birds [27]. Mortality due to effects of external parasites including *A. persicus* mounted to 13.9% in untreated poultry [28].

In Saudi Arabia, studies on the distribution and prevalence of *A. persicus* are lack. A study conducted by Diab *et al*. [29] revealed that *A. persicus* was recorded in Saudi Arabia. It is essential to survey argasid ticks in poultry farms in different localities to reduce the reduction in poultry industry due to tick infestation by integrated pest management. Therefore, this study aimed to determine the seasonal distribution of argasid ticks in different poultry farms at Jeddah Governorate, Saudi Arabia.

MATERIALS AND METHODS

Study Site: The study was conducted on five private chicken farms located in Abhur Alshamaliyah (A), Alhamadaniyah (B), Bryman (C), Bahrah (D) and Khumrah (E) located in Abhur Alshamaliyah, Alhamadaniyah, Bryman, Bahrah, and Khumrah respectively at Jeddah Governorate, Saudi Arabia (21°32'36"N 39°10'22"E) during the period from Jun 2017 to May 2018 (Fig. 1 and 2). Jeddah is the largest city in Makkah Province, the center of western Saudi Arabia on the coast of the Red Sea (Fig. 1). It is the second after Riyadh, the capital, with a population over 4 million people (As of 2017). Jeddah features an arid climate with a tropical temperature. Jeddah is well-known for its warm temperature during winter, which can range from 15-28°C in the afternoon. In summer, the temperature is very hot, often above 43°C in the afternoon and around 30°C in the evening. Rainfall in Jeddah is generally little and scattered. It usually rains in November and December with heavy thunderstorms in winter.

Tick Collection: The tick samples are gathered and transported directly to the laboratory, preserved in closed and sealed glass at 28±2°C and 75±5% RH for subsequent tests. Adult ticks, larvae, and nymphs were collected from selected poultry farms located at different places in Jeddah. Then, ticks were isolated and brought to the lab in double zip-locked bags. These ticks were found in the cracks, crevices, birdcages litter and on birds inside poultry houses. It is also trapped in cardboard size 10 x 7 cm and thickness of 4 mm, fixed with adhesive tape (Fig. 3, 4) inside poultry house to provide the right shelter

Fig. 1: Map of Jeddah governorate, Saudi

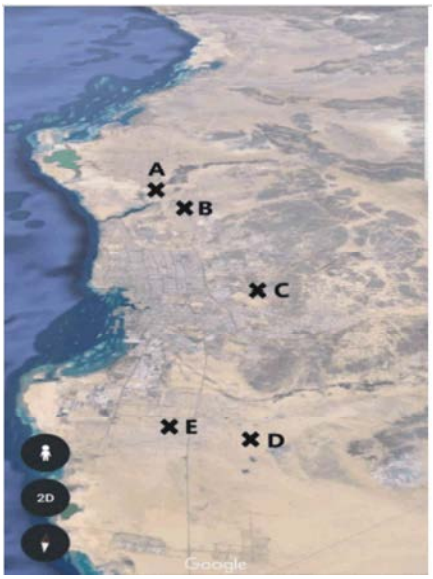

Fig. 2: Locations of the five farms: Abhur Alshamaliyah (A), Alhamadaniyah (B), Bryman (C), Bahrah (D) and Khumrah (E) where the study was conducted

Fig. 3: *A. persicus* trapped on adhesive tape fixed in the cardboard

Fig. 4: *A. persicus* trapped in a cardboard

for ticks to hide after receiving a meal of blood from chickens during the night [30]. Adult ticks were the most frequent age category found in the chicken house due to the relatively short life cycle of ticks. Moreover, larval and nymphal stages are found attached to the host for blood meal most of the time. The larvae feed for relatively long periods and increase their weight 15-20 times during engorgement [31].

Tick Identification: The collected ticks were identified at the level of species using the keys of Walker [17] and Hoogstraal [32] for adults and nymphs while the identification of larvae was confirmed by the description of Abdel-Shafy [4].

The Collected Data: The recorded data in each poultry farm in this study was the average of hen number, hen age, hen weight, egg production and egg weight. Infestation rate of *A. persicus* came from the total number of ticks in 30 traps per farm.

RESULTS

Chicken Farms and Traps: Five Baladi chicken farms in Jeddah governorate were investigated for tick infestation by using 30 sticky traps for each during the period from July 2017 to Jun 2018. The structure of such farms allows presenting many cracks and crevices as shelters for ticks (Fig. 5a & b). The traps were fixed in the tested farms and caught either fed or unfed ticks (Fig. 5c & d). However, the fed larvae were found on the body of chickens (Fig. 5e) beside the presence some of them those completed their feeding in the cracks and crevices.

Tick Identification: The collected ticks were soft ticks belong to the family Argasidae. Figure 6 a&b show the dorsal and ventral views of the adult stage. The lateral suture line and the two pair of setae on the ventral surface of capitulum confirm that the tick is *A. persicus* (Fig. 6 c & d). The lateral suture line shows rectangular plates and the two pair of setae, whereas the ventral surface of capitulum shows posthypostomal setae and postpalpal setae. The unfed and fed larvae also resemble the structure of *A. persicus* larvae (Fig. 6e-g).

Tick Infestation: (Table 1) shows the number of the life stages of *A. persicus* in five Baladi chicken farms (A-E) as well as the temperatures and relative humidity (%) in Jeddah governorate during the period from July 2017 to Jun 2018. A total of 7290 ticks were recorded during the four seasons. About 2890, 3432 and 968 adults, nymphs and larvae were found, respectively, in four farms (A, B, D) and (E), while the (C) farm was found free from any infestation during all seasons. The total number of ticks was higher in (A), (B) and (D) farms during summer, autumn and spring seasons, it ranged between 400-1200 ticks, while the range of tick number in these farms in the winter season was 50-200 ticks. The farm (E) recorded low tick number 30, 200, 40, 300 ticks in summer, autumn, winter, and spring, respectively. The high-temperature range was recorded in summer season (30-42°C) while the other seasons had a moderate temperature range (20-35). Furthermore, the range of relative humidity was 30-70%, 60-80%, 40-60%, 40-70% in summer, autumn, winter, and spring, respectively.

Hen Traits and Their Correlation to Tick Infestation: (Table 2) shows three hen traits in the five Baladi chicken farms in Jeddah Governorate, during the period from Jun 2017 to May 2018. The first trait was the average number of hen that was the highest in the farm (D) during the four seasons recording the maximum in summer (4000 hens). Furthermore, the highest tick number was recorded in the farm (D) during all season (Fig. 7). In general, there is a positive correlation between the average number of the hen and the average number of tick during summer, Jun - Aug 2017 (r= 0.808), autumn, Sept - Nov 2017 (r=0.704), winter, Dec 2017- Feb 2018 (r=0.953) and spring, Mar - May 2018 (r=0.589). The second hen trait was the average of hen age that was in a range between (9-42) weeks in the five farms. The average of hen weight increased gradually in farms (A, B, C) and (E) reaching the range (34 - 67) weeks, while the age in farm D was 8, 18, 13 and 20 weeks in summer, autumn, winter, and spring, respectively.

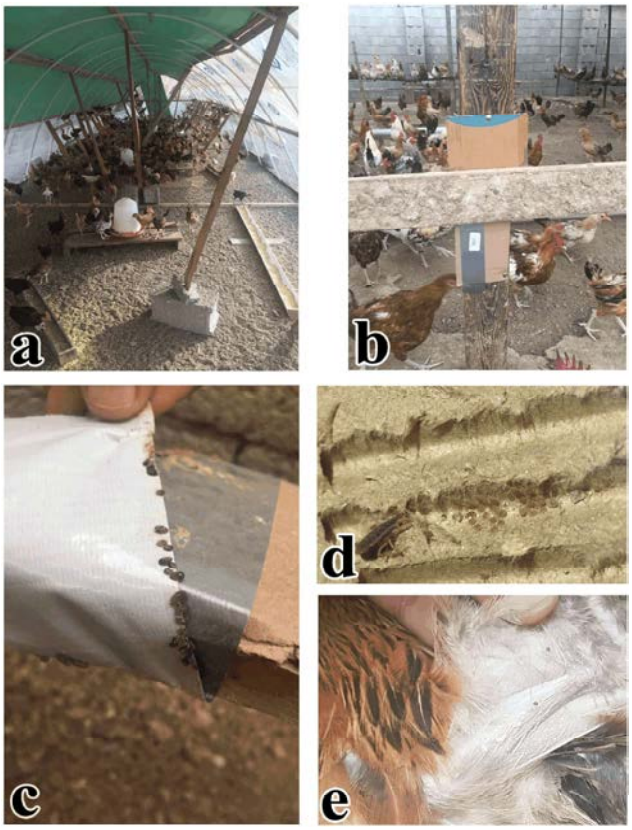

Fig. 5: *A. persicus* infestation in chicken farm: (a) View of a Baladi chicken farm, (b) tick trap fixed in a Baladi chicken farm, (c) A trap with different fed stages of *A. persicus*. (d) New hatched *A. persicus* larvae found in a tick trap, (e) A hen infested by *A. persicus* larvae

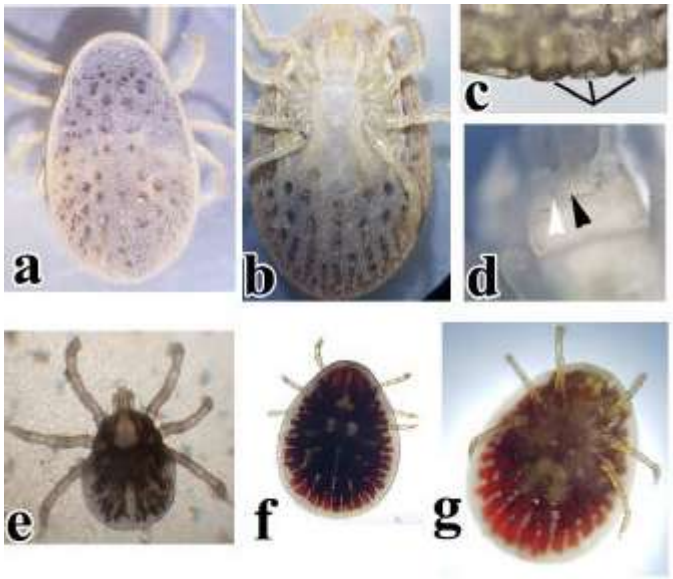

Fig. 6: Different life stages of *A. persicus*: (a) Dorsal view of the adult, (b) Ventral view of the adult female, (c) lateral suture line with rectangular plates of the adult female, (d) two pair of setae of the adult female; one posthypostaml setae (Black head arrow) and another postpalpal setae (White head arrow), (e) unfed larva, (f) dorsal view of fed larva, (g) ventral view of fed larva

Table 1: Seasonal distribution of the fowl tick *Argas persicus*, temperatures (°C) and relative humidity (%) in five Baladi chicken farms, Jeddah, Saudi Arabia during the period from July 2017 to Jun 2018

Season	Jul. (summer) 2017					Oct. (Autumn) 2017					Jan. (winter) 2018					Apr. (spring) 2018					
Farm	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	Total
Adult tick number	270	84	-	340	8	230	210	-	260	98	65	50	-	175	40	270	360	-	290	140	2890
Nymph number	350	210	-	670	22	325	320	-	480	90	5		-	25	-	240	210	-	335	150	3432
Larva number	180	106	-	190	-	45	70	-	60	12	-	-	-	-	-	90	30	-	175	10	968
Total number	800 ± 20	400	-	1200 ± 50	30	600 ± 20	600 ± 20	-	800 ± 20	200	70	50	-	200	40	600 ± 20	600 ± 20	-	800 ± 20	300	7290
T°C	30 - 42					25 - 35					20 - 30					25 - 35					
RH %	30 - 70					60 - 80					40 - 60					40 - 70					

Abhur Alshamaliyah (A), Alhamadaniyah (B), Bryman (C), Bahrah (D) and Khumrah (E)

Table 2: Field study to evaluate Baladi chicken farms infested by *Argas persicus* in Jeddah governorate, Kingdom of Saudi Arabia during the period from Jun 2017 to May 2018

Season	Jun - Aug (summer) 2017					Sep - Nov (Autumn) 2017					Dec - Feb (winter) 2017 / 2018					Mar - May (spring) 2018				
Farm	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Average hen number	350	280	150	4000 ± 100	120	340	300	200	1500 ± 50	100	250	320	150	2500 ± 50	90	90	300	180	500	60
Average hen age (wk)	42	12	10	9	25	50	20	18	17	34	57	28	26	13	43	67	37	34	20	51
Average hen weight (gm)	800	700	600	450	1000	800	820	850	600	1000	800	900	1100	500	1000	750	850	1150	600	900
Average egg production (daily)	80	NV	NV	NV	60	80	100	50	NV	50	70	180	90	NV	50	30	100	120	150	20
Average egg weight (gm)	38	NV	NV	NV	40	38	38	38	NV	40	37	38	43	NV	40	37	38	44	37	38

Abhur Alshamaliyah (A), Alhamadaniyah (B), Bryman (C), Bahrah (D) and Khumrah (E)

* NV = Negative

† Owner's purpose of chicken raise: Farm A (Eggs), Farm B (Eggs and meat), Farm C (Eggs and meat), Farm D (Business) and Farm E (Eggs and meat)

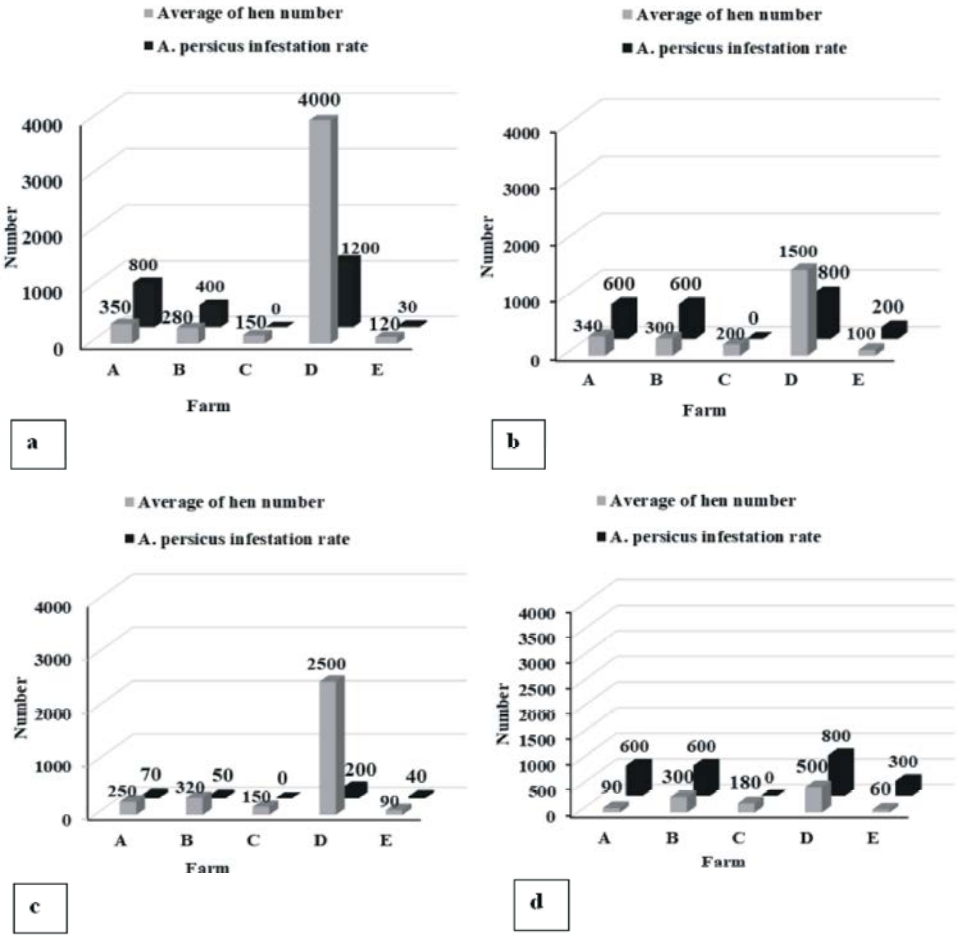

Fig. 7: The infestation rate of *A. persicus* (tick number /30 traps) and the hen number in five chicken farms (A-E) during four seasons: (a) summer, Jun - Aug 2017; (b) autumn, Sept - Nov 2017; (c) winter, Dec 2017- Feb 2018; (d) spring, Mar - May 2018. Abhur Alshamaliyah (A), Alhamadaniyah (B), Bryman (C), Bahrah (D) and Khumrah (E)

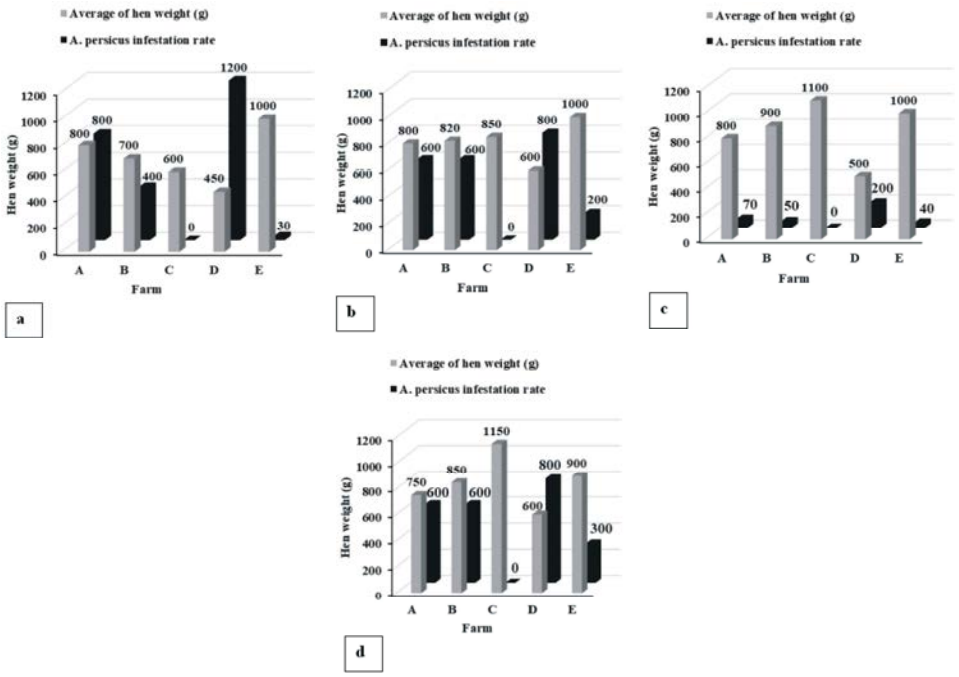

Fig. 8: The infestation rate of *A. persicus* (Tick number /30 traps) and the hen weight in five chicken farms (A-E) during four seasons: (a) summer, Jun - Aug 2017; (b) autumn, Sept - Nov 2017; (c) winter, Dec 2017- Feb 2018; (d) spring, Mar - May 2018. Abhur Alshamaliyah (A), Alhamadaniyah (B), Bryman (C), Bahrah (D) and Khumrah (E)

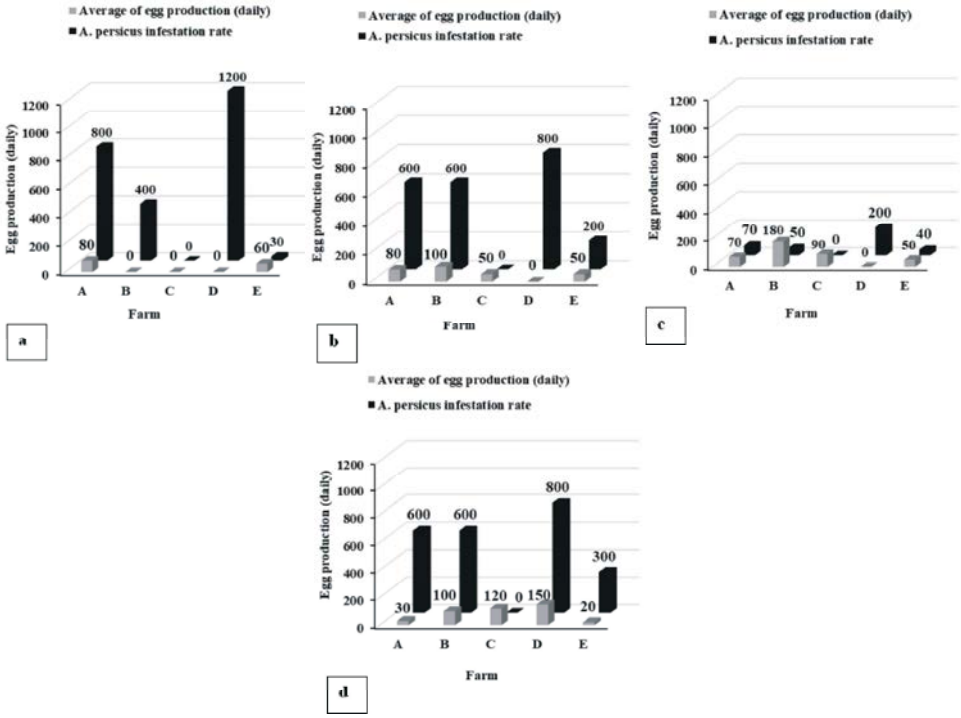

Fig. 9: The infestation rate of *A. persicus* (Tick number /30 traps) and the daily egg production in five chicken farms (A-E) during four seasons: (a) summer, Jun - Aug 2017; (b) autumn, Sept - Nov 2017; (c) winter, Dec 2017- Feb 2018; (d) spring, Mar - May 2018. Abhur Alshamaliyah (A), Alhamadaniyah (B), Bryman (C), Bahrah (D) and Khumrah (E)

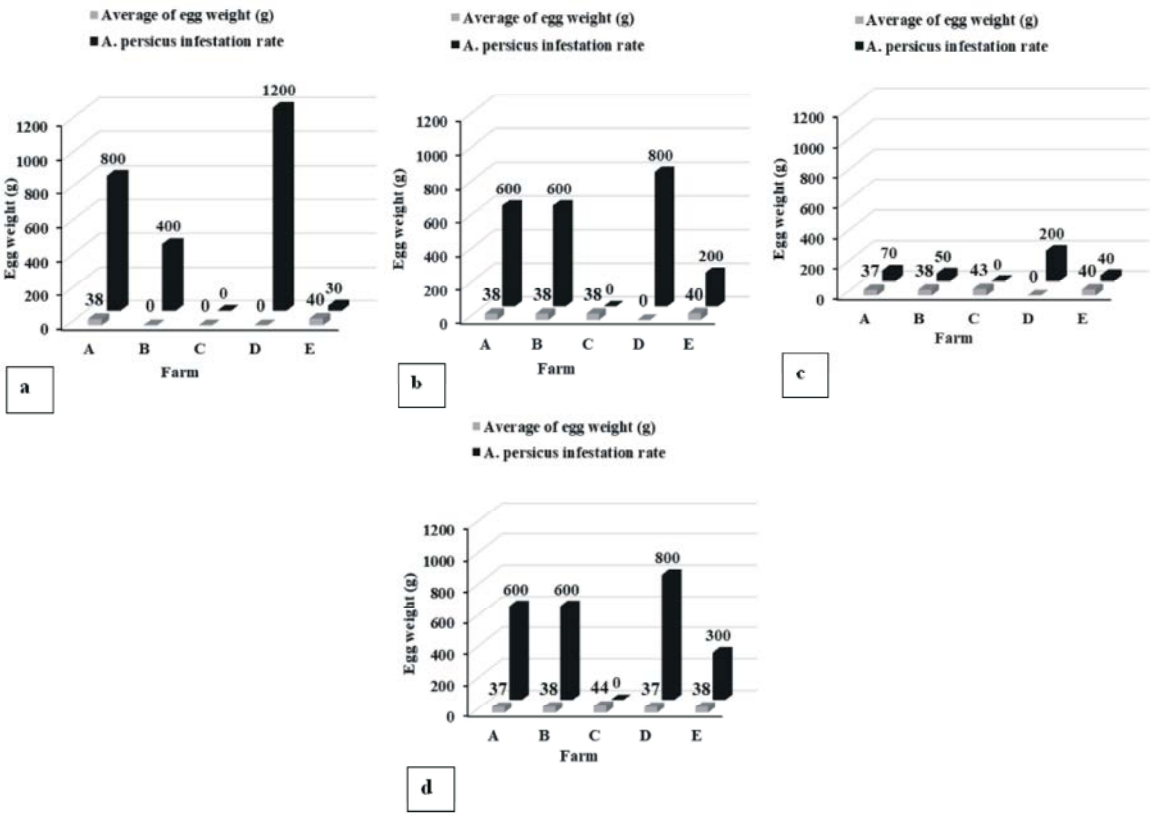

Fig. 10: The infestation rate of *A. persicus* (Tick number /30 traps) and the egg weight in five chicken farms (A-E) during four seasons: (a) summer, Jun - Aug 2017; (b) autumn, Sept - Nov 2017; (c) winter, Dec 2017- Feb 2018; (d) spring, Mar - May 2018. Abhur Alshamaliyah (A), Alhamadaniyah (B), Bryman (C), Bahrah (D) and Khumrah (E)

The third hen trait was the hen weight (g) that recorded the range 450 - 1000, 600 - 1000, 500 - 1000 and 600 - 1150 g in summer, autumn, winter and spring, respectively. There is a negative correlation between the average of hen weight and the average of tick number in summer, Jun - Aug 2017 (r= - 0.551), autumn, Sept - Nov 2017 (r= -0.738), winter, Dec 2017- Feb 2018 (r= -0.981) and spring, Mar - May 2018 (r= -0.963) (Fig. 8).

Egg Traits and Their Relation to Tick Infestation: (Table 2) shows two egg traits (Daily egg production and egg weight) in the five Baladi chicken farms in Jeddah Governorate, during the period from Jun 2017 to May 2018. The range of daily egg production was 60 - 80, 50 - 100, 50 - 180 and 20 -150 eggs in summer, autumn, winter, and spring, respectively. The correlation (r) was negative between daily egg production and tick number recording (-0.280, -0.101, - 0.606 and -0152) in summer, autumn, winter, and spring, respectively (Fig. 9). The range of average egg weight was (37 - 44) g for all farms during the four seasons. The correlation (r) between egg weight and tick number was negative recording (-143, -0.625, -0.977 and -0.877) in summer, autumn, winter and spring, respectively (Fig. 10).

DISCUSSION

A total number of poultry farms in Saudi Arabia was 805 in 2015, 537 of which for meat production and others for egg production [33]. Most projects of Baladi chickens which found in Makkah, Jeddah, and Al-Madinah are small to medium-size farms (250 - 600 birds); however, few projects may raise more than a thousand birds. The purpose of raising Baladi chickens especially for large farms was for their price in the market. Although owners believe that many consumers prefer Baladi chicken more than any other breeds for their meat and eggs, less attention is paid to the Baladi poultry farms. For example,

there is a lack of statistical information about chicken and Baladi farms in Saudi Arabia. Moreover, most owners choose Baladi chickens because of their ability to survive in such rough weather in Saudi Arabia. About 75% of the owners prefer Baladi birds for their low cost of rising and relatively good quality of production. Baladi chicken houses do not usually require many expensive equipment and materials. Raising many exotic breeds may require special and environmental controlled building. Statistics show that 12% of the owners believed that Baladi chickens can resist different types of diseases more than any other exotic breed. Small owners prefer the following of supplemented types of food: concentrate mixture (42%), Barley (45%), Rice (33%), Maize (20%), Alfalfa (19%), Wheat bran (7%), Animal protein (1%) [34].

The results of the current study indicated that chicken farms in Jeddah Governorate, Saudi Arabia were infested by *A. persicus* which is known as an obligate ectoparasite on poultry worldwide. This finding agrees with previous records by Al-Khalifa *et al.* [35], Swai *et al.* [36], Bhat *et al.* [37], Rezaei *et al.* [38] and Shemshadi *et al.* [39]. One argasid soft tick *A. persicus* on chicken and pigeons was found in Saudi Arabia [35]. Three hundred and (n=373) indigenous chickens from 88 households in 9 administrative localities of northern Tanzania were examined. Of those, 83.9% had ectoparasites infestation. Among the ectoparasites, *A. persicus* (23.9%) [36]. In Kermanshah province, west of Iran, Rezaei *et al*. [38] found that of the total of 600 free-range backyard chickens, 389 (64.83 %) were infested by one or more parasites., 78.66 % *A. persicus*) were found in the backyard chickens. Shemshadi *et al.* [39] found that prevalence of *A. persicus* in domestic ducks in Gilan Province, Northern Iran was 75% and they also found *A. persicus* on the feathers and body surface.

The weather in Jeddah was temperate and dry thought the year (Jun 2017 to May 2018). The range of temperature and humidity thought the year was (20 - 42°C) and (30 - 70%), respectively. This indication to *A. persicus* could tolerate and survive under the dry and hot weather in Jeddah. This finding agrees with Mungube [10] who stated that poultry ectoparasites were more frequent during the dry season. In agreement with our results, González-Acuña *et al*. [40] who studied the developmental biology of the tick *Argas neghmei* under laboratory conditions. They found that females did not lay eggs at 27 ± 5 ºC and 80 ± 5% RH. The developmental biology of the *Argas neghmei* was acquired only at 30 ± 5ºC and 35 ± 5% RH. It is possible that 85% relative humidity was too high, considering that this tick is found in dry environments. *Argas cucumerinus*, another Neotropical tick, was also reported to be unable to develop biologically under those same conditions of temperature and relative humidity.

This study shows that summer is the highest season of infestation by *A. persicus*, followed by spring and autumn. However, the winter season has the least infestation by ticks in all farms. For example, 1200 ticks were collected from around 30 traps placed in farm D in the summer, while only 200 ticks were collected from the same farm but in winter season. Ticks collected from farm E shows that the small number of ticks was collected in summer compared to higher number collected in winter from the same farm can be explained. According to the owner of Farm E, he confirmed that he has just started to build the farm few months before investigation. This could be true since the number of collected ticks were increased immediately in the following season from 30 to 200 ticks. It is important to note that one farm out of five was recorded as uninfested farm. It didn't show any infestation during the four seasons. This farm was strictly controlled with chemical pesticides and regular surface cleaning. For this reason, the chicken weight, egg production, and weight are higher than those in other farms.

The present study indicated that the sticky trap is a good tool for monitoring the tick population in the investigated farms in Jeddah governorate. There was a correlation between tick numbers collected by the sticky traps and some traits of hens and eggs. There is a positive correlation between average number of ticks and average number of hens (r=0.589 - 0.953). The correlation between the average of chicken age and the average of tick number was not calculated because we believe that this factor might not affect the *A. persicus* population due to it is preferable all chicken-ages and a chicken farm may contain mixed chicken-ages at the same time. Furthermore, a negative correlation was recorded between the average number of ticks and between of the following traits: hen weight (r= -0.551 to -0.981), daily egg production (r= -0.101 to - 0.606), egg weight (r= -0.143 to -0.977). This indication of these findings with the statement of Bhat *et al*. [37] who reported that the production of backyard poultry is generally affected by ecto and endo-parasites due to their free-range feeding habit and housing practices.

In conclusion, the study confirms the distribution of *A. persicus* through different seasons in many private Baladi chicken farms at Jeddah Governorate, Saudi Arabia. The highest infestation was in summer and the lowest was

in winter (e.g, no larva found in winter). Infested birds produced lower egg number, lower egg weight and gained lower body weight than uninfested birds.

ACKNOWLEDGMENTS

Authors would like to thank all poultry farm owners for their collaboration in tick collection and other poultry farm collected data. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

1. Reeves, W., L. Durden and W. Wills, 2002. New records of ticks (Acari: Argasidae, Ixodidae) from South Carolina. Journal of Agricultural and Urban Entomology, 19(4): 197-204.
2. Petney, T.N., R.H. Andrews, L.A. McDiarmid and B.R. Dixon, 2004. *Argas persicus* sensu stricto does occur in Australia. Parasitology Research, 93(4): 296-299.
3. Sylla, M., X. Pourrut, N. Faye, K. Bâ, J.P. Cornet and J.L. Camicas, 2004. Argasidae (Acari: Ixodida) parasites of wild and domestic animals in Senegal: 1 - Review and distribution. Acarologia, 44(3-4): 137-150.
4. Abdel-Shafy, S., 2005. Scanning electron microscopy and comparative morphology of argasid larvae (Acari: Ixodida: Argasidae) infesting birds in Egypt. Acarologia, 45(1): 3-12.
5. Nava, S., M. Lareschi, C. Rebollo, C. Benítez Usher, L. Beati, R.G. Robbins, L.A. Durden, A.J. Mangold and A. A. Guglielmone, 2007. The ticks (Acari: Ixodida: Argasidae, Ixodidae) of Paraguay. Annals of Tropical Medicine and Parasitology, 101(3): 255-270.
6. Dube, S., P. Zindi, J. Mbanga and C. Dube, 2010. A study of scavenging poultry gastrointestinal and ecto-parasites in rural areas of matebeleland province, Zimbabwe. International Journal of Poultry Science, 9(9): 911-915.
7. Pantaleoni, R.A., M. Baratti, L. Barraco, C. Contini, C.S. Cossu, M.T. Filippelli, L. Loru and M. Romano 2010. *Argas* (*Persicargas*) *persicus* (Oken, 1818) (Ixodida: Argasidae) in sicily with considerations about its Italian and west-mediterranean distribution. Parasite, 17(4): 349-355.
8. Cutler, S., A. Abdissa, H. Adamu, T. Tolosa and A. Gashaw, 2012. *Borrelia* in Ethiopian ticks. Ticks and Tick-borne Diseases, 3(1): 14-17.
9. Barker, S.C. and A.R. Walker, 2014. Ticks of Australia. The species that infest domestic animals and humans. Zootaxa, 3816(1): 1-144.
10. Mungube, E.O., S.M. Bauni, B.A. Tenhagen, L.W. Wamae, S.M. Nzioka, L. Muhammed and J.M. Nginyi, 2008. Prevalence of parasites of the local scavenging chickens in a selected semi-arid zone of Eastern Kenya. Tropical Animal Health and Production, 40(2): 101-109.
11. Koc S., L. Aydın and H. Cetin, 2015. Tick species (Acari: Ixodida) in Antalya City, Turkey: species diversity and seasonal activity. Parasitology Research, 114(7): 2581-2586.
12. Davari, B., F.N. Alam, H. Nasirian, M. Nazari, M. Abdigoudarzi and A. Salehzadeh, 2017. Seasonal distribution and faunistic of ticks in the Alashtar county (Lorestan Province), Iran. Pan African Medical Journal, 27, art. no. 284.
13. Lafri, I., W. Benredjem, F. Neffah-Baaziz, R. Lalout, K. Abdelouahed, B. Gassen, S. Bakhouch, M. Chergui, M. Karakellah, H. Adjmi-Hamoudi and I. Bitam, 2018. Inventory and update on argasid ticks and associated pathogens in Algeria. New Microbes and New Infections, 23: 110-114.
14. Muñoz-Leal, S., J.M. Venzal, S. Nava, M. Reyes, T.F. Martins, R.C. Leite, V.L.R. Vilela, H.R. Benatti, D. Ríos-Rosas, D.M. Barros-Battesti, D. González-Acuña and M.B. Labruna, 2018. The geographic distribution of *Argas* (*Persicargas*) *miniatus* and *Argas* (*Persicargas*) *persicus* (Acari: Argasidae) in America, with morphological and molecular diagnoses from Brazil, Chile and Cuba. Ticks and Tick-borne Diseases, 9(1): 44-56.
15. Hoogstraal, H., 1985. Argasid and Nuttalliellid ticks as parasites and vectors. Advances in Parasitology, 24: 135-238.
16. Keirans, J. E. and L.A. Durden, 2001. Invasion: Exotic ticks (Acari: Argasidae, Ixodidae) imported into the United States. A review and new records. Journal of Medical Entomology, 38(6): 850-861.
17. Walker, A.R., 2003. Ticks of domestic animals in Africa: a guide to identification of species (pp: 3-210). Edinburgh: Bioscience Reports.
18. Nicholson, W.L., D.E. Sonenshine R.S. Lane and G. Uilenberg, 2009. Ticks (Ixodida), in: Medical and veterinary entomology. 2nd Edition. Mullen G.R and Durden L.A. (eds), Academic Press, pp: 483-532.

19. Abdel-Shafy, S., 2000. Microbiological and control studies on ticks infesting farm animals and poultry. Phd Thesis, Fac. Agr. Cairo Univ.
20. Sawale, G.K., S.C. Gupta, S.S. Sawant, S. Pratik and G.P. Bharkad, 2012. Occurrence of spirochetosis in commercial layer birds. Indian Veterinary Journal, 89(8): 144-145.
21. Aslam, B., I. Hussain, M.A. Zahoor, M.S. Mahmood and M.H. Rasool, 2015. Prevalence of *Borrelia anserina* in Argas ticks. Pakistan Journal of Zoology, 47(4): 1125-1131.
22. Hosseini-Chegeni A., Z. Telmadarraiy, M. Tavakoli and F. Faghihi, 2017. Molecular detection of *Borrelia anserina* in *Argas persicus* (Acari: Argasidae) ticks collected from Lorestan province, west of Iran. Persian Journal of Acarology, 6(4): 287-297.
23. Pader, V., J.N. Buniak, A. Abdissa, H. Adamu, T. Tolosa, A. Gashaw, R.R. Cutler and S.J. Cutler, 2012. Candidatus *Rickettsia hoogstraalii* in Ethiopian Argas persicus ticks. Ticks and Tick-borne Diseases, 3(5-6): 338-345.
24. Lafri, I., B. El-Hamzaoui, I. Bitam, H. Leulmi, R. Lalout, O. Mediannikov, M. Chergui, M. Karakellah, D. Raoult and P. Parola, 2017. Detection of relapsing fever *Borrelia* spp., *Bartonella* spp. and Anaplasmataceae bacteria in argasid ticks in Algeria. PLoS Neglected Tropical Diseases, 11(11), art. no. e0006064.
25. Nemova, N.V., A.N. Alekseev, M.A. Kostiukov, Z.E. Gordeeva and A.U. Kuima, 1990. An experimental study of the reproduction of the Hissar virus. Meditsinskaya Parazitologiya i Parazitarnye Bolezni, 1: 35-36.
26. Gothe, R., 1971. Tick paralysis in chickens caused by *Argas (Persicargas) persicus*-larvae - I. Influence of state of engorgement and infestation rate on clinical symptoms. Zeitschrift für Parasitenkunde, 35(4): 298-307.
27. Mungube, E.O., S.M. Nzioka and L.W. Wamae, 2014. Effect of deltamethrin on *Argas persicus* within selected sites in Machakos and Kitui Counties, Semi-arid Eastern Kenya. Livestock Research for Rural Development, 26(12).
28. Hien, O.C., B. Diarra, R. Dabire, J. Wangrawa and L. Sawadogo, 2011. Effects of external parasites on the productivity of poultry in the traditional rearing system in the sub-humid zone of Burkina Faso. International Journal of Poultry Science, 10(3): 189-196.
29. Diab, F.M., M.S. Al-Khalifa, N.A. Al-Asgah, H.S. Hussein and G.M. Khalil, 2006. Ticks (Acari: Argasidae, Ixodidae) infesting livestock in Saudi Arabia. Fauna of Arabia, 22: 233-242.
30. Nordenfors, H. and J. Chirico, 2001. Evaluation of a sampling trap for *Dermanyssus gallinae* (Acari: Dermanyssidae). Journal of Economic Entomology, 94(6): 1617-1621.
31. Lindquist, E.E. and K.W. Wu, 2016. A handbook to the ticks of Canada (Ixodida: Ixodidae, Argasidae) (pp: 317). Ottawa: Biological Survey of Canada.
32. Hoogstraal, H., 1956. African Ixodoidea Ticks of the Sudan (Res Rep NM 005 050.29. 07). Cairo, US Nav Med Res Unit, pp: 3.
33. M.E.W.A., 2015. Agricultural Production Statistics. Annual Report, 74. Riyadh, Kingdom of Saudi Arabia: Ministry of Environment, Water and Agriculture.
34. Al-Yousef, Y.M., 2007. A survey study on the distribution of Saudi Baladi chickens and their characteristics. Int. J. Poult. Sci., 6(2).
35. Al-Khalifa, M.S., F.M. Diab and G.M. Khalil, 2007. Man-threatening viruses isolated from ticks in Saudi Arabia. Saudi Medical Journal, 28(12): 1864-1867.
36. Swai, E.S., M. Kessy, P. Sanka, S. Bwanga and J.E. Kaaya, 2010. A survey on ectoparasites and heamoparasites of free-range indigenous chickens of Northern Tanzania. Livestock Research for Rural Development, 22(9).
37. Bhat, S.A., M.Y. Wani, J.K. Khojuria, R. Katoch and K. Dhama, 2014. A rare report of ectoparasites in backyard poultry in Jammu Region: Prevalence study and economic importance. Asian Journal of Animal and Veterinary Advances, 9(11): 727-731.
38. Rezaei, F., M. Hashemnia, A. Chalechale, S. Seidi and M. Gholizadeh, 2016. Prevalence of ectoparasites in free-range backyard chickens, domestic pigeons (Columba livia domestica) and turkeys of Kermanshah province, west of Iran. Journal of Parasitic Diseases, 40(2): 448-453.
39. Shemshadi, B., S. Ranjbar-bahadori and M. Delfan-abazari, 2017. Prevalence and intensity of parasitic infection in domestic ducks (*Anas platyrhynchas*) in Gilan Province, Northern Iran. Comparative Clinical Pathology, 26(1): 165-167.
40. González-Acuña, D., P. Vargas, K. Ardiles, L. Parra and A. Guglielmone, 2010. Developmental biology of *Argas neghmei* Kohls and Hoogstraal (Acari: Argasidae) under laboratory conditions. Neotropical Entomology, 39(2): 160-162.