DOI: 10.29050/harranziraat.386691
Harran Tarım ve Gıda Bilimleri Derg. 2018, 22(3):*316-325*

Research Article/Araştırma Makalesi

The effects of stocking density on growth performance of Pekin ducks

Pekin ördeklerinde yerleşim sıklığının yetiştirme performansına etkileri

Sabri Arda ERATALAR[1*], Nezih OKUR[1]

[1]Abant Izzet Baysal University, Faculty of Agriculture and Natural Sciences, Bolu, Turkey

To cite this article:
Eratalar, S.A. & Okur, N. (2018). The effects of stocking density on growth performance of Pekin ducks. *Harran Tarım ve Gıda Bilimleri Dergisi*, 22(3): 316-325. DOI: 10.29050/harranziraat.386691

Address for Correspondence:
Sabri Arda ERATALAR
e-mail:
ardaeratalar@ibu.edu.tr

Received

Date:
30.01.2018
Accepted Date:
17.05.2018

ABSTRACT

The experiment was designed to investigate the effects of actual stocking density on the growth performance parameters in Pekin ducks. A total of 240 mixed sex ducklings were used with stocking densities of 3, 5 and 7 poults m^{-2} during the 42 day growing period. Live weight, live weight gain, feed consumption, feed conversion ratio, mortality rate and productivity index parameters were investigated to determine growth performance. As the stocking density decreases, LW values were found to be increasing visibly after 3 weeks of age ($P<0.05$), live weight gain and total live weight values were found to be increasing from the first week ($P<0.05$). The achieved total live weight in unit area increased parallel to increasing stocking density catching the peak at 7 ducklings m^{-2} stocking density ($P<0.05$). Feed conversion values were found to be increasing in low stocking density groups from the first week ($P<0.05$). Therewithal, feed conversion ratio was found to be increasing with declining stocking density till the third week of age ($P<0.05$) but, hereafter this effect disappeared ($P>0.05$). Mortality occurred in the trial was found not to be affected by stocking density ($P>0.05$), whereas by declining stocking density, productivity index was found to be increasing however in parallel Live Weight per unit area was also found to be decreasing together ($P<0.05$). When a general revision is made from the research, increasing stocking density has a positive effect on performance parameters of Pekin ducks except total live weight per unit area.

Key Words: Duck, Stocking density, Live weight, Feed conversion ratio, Productivity index

ÖZ

Bu çalışma, Pekin ördeklerinde güncel yerleşim sıklığının ördeklerin gelişme performans kriterlerine etkilerini araştırmak üzere gerçekleştirilmiştir. Karışık cinsiyetten toplam 240 ördek palazı 3, 5 ve 7 palaz m^{-2} yerleşim sıklıklarında 42 gün süreyle yetiştirilmiştir. Canlı ağırlık, canlı ağırlık artışı, yem tüketimi, yem dönüşüm oranı, ölüm oranı ve üretkenlik indeksi yetiştirme performansını tespit etmek için üzerinde durulan kriterler olmuştur. Düşük yerleşim sıklığının olduğu gruplarda, özellikle 3. haftadan sonra canlı ağırlık gözle görülür şekilde yükselmiş ($P<0.05$), canlı ağırlık artışı ve toplam canlı ağırlık ise birinci haftadan itibaren artış

göstermiştir (P<0.05). Birim alandan elde edilen toplam canlı ağırlık yerleşim sıklığının artışına paralel olarak artış sergilemiş ve en yüksek seviyesini 7 palaz m^{-2} yerleşim sıklığında elde etmiştir (P<0.05). Yem dönüşüm oranının ilk haftadan itibaren yerleşim sıklığı düşük olan gruplarda artış gösterdiği tespit edilmiştir (P<0.05). Aynı zamanda, yem dönüşüm oranı yerleşim sıklığının düşüşüyle birlikte 3. haftaya kadar artış göstermiş (P<0.05) ancak, daha sonra bu etkinin ortadan kaybolduğu tespit edilmiştir (P>0.05). Gözlenen ölüm oranının üzerinde çalışılan yerleşim sıklığı düzeylerince etkilenmediği tespit edilmiş olup (P>0.05), düşük yerleşim sıklıklarında Üretkenlik İndeksi değerinin artış gösterdiği ancak, buna paralel olarak birim alanda elde edilen toplam canlı ağırlığın da düşüş gösterdiği bulunmuştur (P<0.05). Araştırma sonuçları genel olarak değerlendirildiğinde, yerleşim sıklığındaki artışın birim alanda elde edilen toplam canlı ağırlık değeri dışındaki saha performansıyla ilgili kriterleri olumlu yönde etkilediği görülmüştür.

Anahtar Kelimeler: Ördek, Yerleşim sıklığı, Canlı ağırlık, Yem değerlendirme oranı, Verimlilik endeksi

Introduction

Ducks are easy to grow in comparison to other poultry species, especially chickens. They have a higher tolerance to hot, cold and humid climates and environment (Wright, 2008; Holderread, 2011; Anonymous, 2016a). During the last decades, duck meat industry has grown in parallel to the inclination in the demand for duck meat up to a 2.1 billion and a total production of 4.0 million tons of duck meat in 2010 (FAO, 2010). Some hybrid lines with high productivity have been evaluated from especially Pekin ducks (Ekarius, 2007). Pekin duck is an important waterfowl for the European Union (EU) market. Ducks are raised in especially Germany and France intensively where they are raised extensively in Poland and some other eastern countries of EU. As a result of long years of selection to improve genotype of the ducks for better field performance and carcass yield hybrid breeders with high performance and with low fat have been achieved (Wencek et al., 2012). After years of selective breeding the new lines evaluated by using Pekin ducks were grown by single or two types of feed at first, achieving 2.00-2.50 kg slaughter weight at 7 weeks of age (Sainsbury, 1980) which was obtained by 8 544 g feed consumed and a 2.675 feed conversion ratio (FCR) has improved in time as 3 195 g (Leeson and Summer 1982) and 3 342 g (Knizetova et al., 1991). Meanwhile it even got better as 2.50 FCR and 3 750 g of live weight (LW) at 42 days of slaughter age (Holderread, 2011).

The growing period is considered mostly as 7 to 9 weeks in meat type ducks and this period is divided into different portions as starter, growing and finishing. During the first two weeks starter diets and during 2-7 weeks as grower and finisher diets are used at the 7 week growing period (Knizetova et al., 1991).

Pekin ducks are told to be growing faster when they are kept free and given an open water source to swim (Reiter et al., 1997). In parallel to industrialization in poultry production environment controlled closed houses began to be used since meat type Pekin duck hybrid lines have been bred. Thus, ducks could have been raised in high stocking densities (SD) which are still getting more intensive and widespread. Different outcomes from several researches about stocking densities effect on performance of ducks were encountered. It has been reported that with a 5.19 ducklings m^{-2} stocking density at 48 days of slaughter age, mortality (M) was found as 5.20 %, mean live weight (MLW) was found as 3.35 kg and live weight gain LWG was found as 60.3 - 81.3 g day^{-1} and total live weight (TLW) was found

as 17.2 kg m^{-2} (Jones and Dawkins, 2010). From the findings of another research it was told that with a SD of 6 ducklings m^{-2} and in a growing period of 4 to 11 weeks, final live weight (FLW) was reported to be 3 111 g (Mucha et al., 2014). In another research where a SD of 6.7 ducklings m^{-2} was used, the LW of 57.5 g increased up to 3 518 g in males and 3 433 g in females giving a mean of 3 476 g in 49 days achieving an FCR of 2.47, feed consumption of 8.24 kg and a LWG of 69.9 g day^{-1} (Steczny et al., 2017). Another researcher outlined that the ducks' LW performance were found to be in SDs of 6, 9 and 12 duckling m^{-2} as 1 785 g, 1 768 g and 1 692 g respectively at 42 days of age (Isguzar, 2006).

At 10 weeks of age at 2, 4, 6 and 8 ducklings m^{-2} SDs; FLW were found to be 2 137 g, 1 996 g, 1 824 g and 1 567 g; feed consumption were found to be 5 567 g, 4 339 g, 3 961 g and 3 637 g, and FCRs were found to be 5.10, 4.39, 4.27 and 4.68 respectively in a research (Ahaotu and Agbasu, 2015). Another research was conducted twice with 10 200 mixed sex ducklings and 5 000 mixed sex ducklings with 5, 6, 7, 8 and 9 ducklings m^{-2} SD effect was put on trial at 14 - 42 days of rearing period, where the stocking densities were 13, 15, 17, 19 and 21 birds m^{-1} for the first two weeks. From the findings of this trial LW and LWG were found to be affected significantly ($P<0.01$), but FCR and M were found not to be affected by SD (Xie et al., 2014).

From the findings of an experiment conducted on Pekin ducks (SM3) evaluating the effects of sex on performance the ducklings were kept under SD of 6.7 ducklings m^{-2}, the HLW 57.5 g increased to 3 476 g LW at 49 days of age with FCR of 2.47, feed consumption of 8.24 kg and LW of 69.9 g were achieved (Steczny et al., 2017).

The outcome of an experiment have stated that SD had significant effect on LW and LWG by groups of 17.0, 20.3, 23.6, 26.9 and 29.9 kg LW m^{-2} ($P<0.01$). Nevertheless, FCR and M were found not to be affected by SD (Xie et al., 2014). From the findings of another research conducted 4 and 8 ducks m^{-2}, thigh and breast yield were found to be declining in high SD (Osman, 1993).

In another research FCR was found not to be changing by SD changes (Ahaotu and Agbasu, 2015).

EU basic standards were published (Anonymous, 1999) and it was advised to keep the ducks at 23.5 kg m^{-2} SD to achieve LW of 3.35 kg (Defra, 2007). Nevertheless, the detailed information about the point is still unclear. In the light of the researches mentioned, this experiment was conducted to evaluate detailed information about the effects of actually applied SDs on field performance of Pekin ducks.

Material and methods

Equipment used in the trial

Day old, mixed sex (50 % male, 50 % female) 240 Grimaud Star 53 Pekin ducklings which were obtained from a private duck meat production company founded in Bolu were used in the experiment. All the data obtained about the field performance of ducklings were measured and collected in the research and development (R&D) house of a private duck growing facility.

There were 12 trial pens and 3 back-up pens housing compensatory birds in occasion of mortality in this fully automatic environment controlled R&D house. The R&D house was heated by 4 pieces of 3 000 W

electric oil radiator heaters (Flavel RI 3 000M, Turkey) and ventilated by a total of three tunnel fans, including 2 minimum ventilation fans with a flow of 1 100 m^3 h^{-1} (Bahcivan BPP 30, Turkey) and one cooling fan with a flow of 4 500 m^3 h^{-1} (Bahcivan BSM 400, Turkey) specially built for the volume of the R&D house to achieve minimum ventilation and cooling when needed.

In this research, as performance criteria live weight (LW) and feed consumption were primarily treated. LW measurements were done for the first 3 weeks by an (± 1 mg) analytical scale (Radwag AS 220.R2, Radwag Balance Scales, Poland), and afterwards with a normal (± 1 g) scale (TEM TNT 015D, Turkey) every week.

Trial design

The stocking densities used in the trial were decided to be as 3, 5 and 7 ducklings m^{-2} from former researches done as summarized to achieve better up-to-date results about general performance of Pekin ducks. The day old ducklings were weighed upon arrival at the farm's R&D house and then placed in the pens with an area of 4 m^2 according to the trial plan achieving 3, 5 and 7 ducklings m^{-2} SD randomly achieving 12, 20 and 28 ducklings per pen. 4 replicates for each treatment group were organized. Pan feeders with a capacity of 10 kg feed and duck and broiler nipple drinkers (3 nipples 50 cm^{-1} pipeline) connected to individual water tanks pre-partitioned for easy measurement of water consumption were used in every single trial pen individually. The pens were 2x2 m in dimensions. The lighting system of the house consisted of 12 led bulbs standing on each trial pen achieving a 75 lux maximum illumination at the beginning of the rearing period dimmed after 1st week to 30 lux and kept till the end of the rearing period. For the first 3 days of life lights were on and hereafter darkening was applied for 30 minutes per day and the dark period increased by 30 minutes every day till the dark period reached 10 hours at 23rd day and kept that way till the end of the rearing period. The temperature of the rearing house for the growing period was 32 ℃ at the beginning and decreased by 0.5 ℃ every day till 20 ℃ is reached at day 25 and kept till the end of the rearing period. The R&D house automation control system was built especially for the R&D house to keep the intra climate stable, controlling heaters, ventilation system, cooling system and lighting as well during the whole production term.

Rearing period

The total rearing period was divided into two main periods as 0-2 weeks as starter period and 3-6 weeks as the growing (grower) period. The ducks were given specially made feed formulated from Grimaud Star Broiler Duck catalogue (Anonymous, 2016b). The first 2 weeks the ducklings were given Starter feed and during 3-6 weeks (second period) the ducks were given grower-finisher diet ad-libitum (Table 1). The feed used in the trial was obtained from a special feed cooperation of a private company founded in Bolu.

In the experiment, to obtain actual LW values from the treatment groups, the poults were individually numbered by plastic special leg tags with numbers from 1 to 240. By the data obtained, weekly live weight gain (LWG) and total live weight (TLW) which is the total live weight obtained at the end of the rearing period per unit area at were calculated. In this experiment the weekly consumed feed

amount was calculated by extracting the amount of feed left in the feeder from the total amount of feed put in the feeder weeklong. From these data, total FCR and weekly FCR were calculated by feed consumption values (Formula 1).

Formula 1. The FCR calculation formula is as follows (Anonymous, 2014).

Eşitlik 1. Yem Dönüşüm Oranı (YDO) formülü aşağıdaki gibidir (Anonymous, 2014).

$$\text{FCR, } \textit{Yem Dönüşüm Oranı} = \frac{\text{Feed Consumed, } \textit{Yem Tüketimi}}{\text{Live Weight, } \textit{Canlı Ağırlık}}$$

Table 1. The nutrient specifications of the feed used in the experiment (Beypiliç© Yem).

Çizelge 1. Denemede kullanılan yemlerin besleme değerleri (Beypiliç© Yem).

	Starter *Başlangıç* 0-14 days, *gün*	Grower *Büyütme* 15 day, *gün* – Slaughter, *Kesim*
Metabolic Energy kcal kg^{-1}	2900	3100
Crude Protein, *Ham Protein* %	20.0	17.2
Crude Cellulose, *Ham Selüloz* %	4.00	4.05
Crude Fat, *Ham Yağ* %	4.13	5.81
Crude Ash, *Ham Kül* %	6.33	6.33
Lysine, *Lisin* %	1.00	0.80
Methionine, *Metiyonin* %	0.55	0.40
Calcium, *Kalsiyum* %	1.00	0.90
Phosphorus, *Fosfor* %	0.72	0.65
Sodium, *Sodyum* %	0.16	0.17
Vitamin A, IU	12000	12000
Vitamin D3, IU	5000	5000
Manganese, *Mangan* mg kg^{-1}	120.0	120.0
Zinc, *Çinko* mg kg^{-1}	110.0	110.0
Copper, *Bakır* mg kg^{-1}	16.0	16.0
Iodine, *İyot* mg kg^{-1}	1.50	1.50
Selenium, *Selenyum* mg kg^{-1}	0.30	0.30

Feed consumption and feed consumption per duckling values were also calculated from these data. Mortality was observed in the pens and daily, weekly and total mortality (M) rates were calculated. To ensure the effect of SD effect on the birds at the trial pens after any mortality occurred, immediately a replacement duckling was added to the pen in place of the dead duckling with same LW from replacement pens which were also built with smaller dimensions in the R&D house representing every SD.

At the end of the rearing period, gathering all the data acquired from the research Productivity Index (PI) was calculated (Formula 2).

Formula 2. Formula used to calculate Productivity Index (PI) (Anonymous, 2014).

Eşitlik 2. Üretkenlik İndeksi (PI) hesaplanmasında kullanılan formül (Anonymous, 2014).

$$\text{PI, } \textit{Üretkenlik İndeksi} = \frac{\text{Livability, } \textit{Yaşama Gücü} \text{ (\%)x LW, } \textit{Canlı Ağırlık} \text{ (kg)}}{\text{Age, } \textit{Yaş} \text{ (day, } \textit{gün}\text{) x FCR, } \textit{Yem Dönüşüm Oranı}}$$

Statistical analyses

The trials were arranged in the design of random parcels and the statistical analyses of the data acquired from the experiment were made by SPSS 22.0 statistical software (Anonymous, 2013). The data of the experiment were tested for homogeneity of variance at first and as they were found to be homogeneous they were put on detailed statistical analyses. In the experiment the statistical analyses of the treatments and the differences between the treatment groups' mean values were analyzed by Analyses of Variance (ANOVA) to obtain if there is any important difference between the treatment groups. To obtain if there is any important

difference between the groups, Tukey Test was applied. The data obtained from the experiment were given as Means ± Standard Error of the Means (M ± SEM).

Results and Discussion

From the findings of the experiment, when the effect of SD on LW was investigated the LWs at the end of the rearing period were found to be 3 263 ± 74 g, 2 726 ± 24 g and 2 117 ± 43 g at SDs of 3, 5 and 7 ducklings m^{-2} respectively at 42 days of age. From the 1st week of age, the differences between the groups started to show up and after 3 weeks of age became clearer. It can be told that conversely to decreasing SD, ducklings' LW increases and the maximum LW was found at 3 ducks m^{-2} SD (Table 2). Therefore, with regard to LW, the differences between the trial groups were found to be statistically important after 3 weeks of age ($P<0.05$).

The LW values achieved from the research were in line with the reported LW of some other researches (Leeson and Summer, 1982; Kinizetova et al., 1991), also found to be higher than LW reported by some researchers (Sainsbury, 1980; Isguzar, 2006; Ahaotu and Agbasu, 2015) and also lower than some others (Jones and Dawkins, 2010; Holderread, 2011; Mucha et al., 2014; Steczny et al., 2017).

A similar situation was seen when LWG and FLW (final live weight) values were investigated to evaluate LW data more elaborately. From the 1st week LWG decreased as the increasing FLW in contrast to increasing SD and the differences were found to be statistically important ($P<0.05$).

Withal, considering final total live weight per unit area (TLW) it was clearly seen that the TLW was increasing parallel to increasing SD, taking its peak value at 7 duckling m^{-2} SD ($P<0.05$).

Numerical differences between LW values of the treatment groups were found to be visible after 3rd week of age and also it was found that with decreasing SD LW values were found to be increasing ($P<0.05$). Consequently, LWG and TLW values were also found to be increasing after 1st week ($P<0.05$). Those data obtained from the research is in line with other researchers' work (Osman, 1993; Xie et al., 2014; Ahaotu and Agbasu, 2015; Steczny et al., 2017). SD conditions implemented in this experiment were within the suggested SD levels of EU standards (Anonymous, 1999; Defra, 2007) and achieved results were detected to be in line with other researchers (Jones and Dawkins, 2010; Xie et al., 2014).

It was clearly seen that there was a difference between the groups in terms of feed consumption and FCR in relation to SD (Table 2). After the 1st week of age, both weekly feed consumption (WFC) and total feed consumption (TFC) were found to be increasing in contrast to decreasing SD and the differences between the groups were found to be important statistically ($P<0.05$).

The outcome of the research about feed consumption were found to be higher than the ones found in some other researches (Ahaotu and Agbasu, 2015), where they were found to be lower than the outcome of some others (Leeson and Summer, 1982; Holderread, 2011; Steczny et al., 2017). In contrast FCR values were found to be lower than the FCR values achieved by other researchers (Sainsbury, 1980; Leeson and Summer, 1982; Holderread 2011; Ahaotu and Agbasu, 2015; Steczny et al., 2017).

Table 2. The effects of SD on field performance of Pekin ducks. (Mean ± SEM).
Çizelge 2. Yerleşim Sıklığının (YS) Pekin ördeklerinin saha performansına etkileri (Ort ± OSH).

	Stocking Density (SD) ducks m^{-2} *Yerleşim SIklığı, ducks m^{-2}*			
	3	5	7	p Value
Live Weight, g $duck^{-1}$ per pen *Canlı Ağırlık, bölme başı g ördek^{-1}*				
Initial Weight *Başlangıç Ağırlığı*	51 ± 1	52 ± 1	52 ± 1	0.753
1. Week, *hafta*	255 ± 6	251 ± 4	245 ± 4	0.399
2. Week, *hafta*	632 ± 27	675 ± 14	606 ± 21	0.119
3. Week, *hafta*	1358 ± 17^{a}	1219 ± 14^{b}	1123 ± 32^{c}	0.000
4. Week, *hafta*	2096 ± 31^{a}	1795 ± 16^{b}	1504 ± 30^{c}	0.000
5. Week, *hafta*	2805 ± 54^{a}	2310 ± 32^{b}	1730 ± 34^{c}	0.000
6. Week, *hafta*	3263 ± 74^{a}	2726 ± 24^{b}	2117 ± 43^{c}	0.000
Live Weight Gain, g day^{-1} *Canlı Ağırlık Artışı, g gün^{-1}*				
1. Week, *hafta*	29 ± 1^{a}	28 ± 0^{ab}	28 ± 0^{b}	0.013
2. Week, *hafta*	42 ± 1^{b}	45 ± 0^{a}	40 ± 0^{c}	0.000
3. Week, *hafta*	62 ± 1^{a}	56 ± 0^{b}	51 ± 1^{c}	0.000
4. Week, *hafta*	73 ± 1^{a}	62 ± 0^{b}	52 ± 0^{c}	0.000
5. Week, *hafta*	79 ± 1^{a}	65 ± 0^{b}	48 ± 0^{b}	0.000
6. Week, *hafta*	76 ± 1^{a}	64 ± 1^{b}	49 ± 1^{c}	0.000
Total Live Weight (TLW), kg m^{-2} *Toplam Canlı Ağırlık, kg m^{-2}*	9.79 ± 0.22^{c}	13.63 ± 0.12^{b}	14.82 ± 0.30^{a}	0.000

^{abc} The differences on the same line with different superscript letters are statistically important ($p<0.05$).

Similarly, FCR values were also found to be increasing after 1st week of age in contrast to decreasing SD taking its peak value at 3 duckling m^{-2} SD was identified. Therewithal, it was found that the differences between the groups were statistically important for the first 3 weeks ($P<0.05$) afterwards the differences were statistically not important.

Those results obtained from the research were found to be in line with the results of other researches (Xie et al., 2014; Ahaotu and Agbasu, 2015).

PI values of the treatment groups were calculated to evaluate LW, LWG and FCR values all together. Investigating the PI values, it was found that PI values increased as the SD decreased taking the peak PI value at 3 ducks m^{-2} SD ($P<0.05$).

Whereas, by decreasing SD, PI was identified to be increasing in opposition ($P<0.05$), nevertheless the mortality rates were found not to be changing with SD ($P>0.05$). These gathered data were found to be in harmony with the results reported by other researchers (Xie et al., 2014).

Examining the weekly mortality (M), it was seen that the mortality rates were increasing in parallel to increasing stocking density. However, the differences between the treatment groups were found not to be statistically important ($P>0.05$).

Table 3. The effect of SD on feed consumption and FCR in Pekin ducks. (Mean ± SEM).
Çizelge 3. Yerleşim Sıklığının Pekin ördeklerinde yem tüketimi ve yem dönüşüm oranına etkileri (Ort ± OSH).

	Stocking Density (SD) duckling m^{-2} *Yerleşim Sıklığı, ducks m^{-2}*			
	3	5	7	p Value
Feed Consumption, g duckling^{-1} *Yem Tüketimi, g ördek^{-1}*				
1. Week, *hafta*	368 ± 26^{a}	298 ± 7^{b}	217 ± 4^{c}	0.000
2. Week, *hafta*	743 ± 53^{a}	601 ± 14^{b}	438 ± 8^{c}	0.000
3. Week, *hafta*	1117 ± 80^{a}	905 ± 21^{b}	659 ± 23^{c}	0.000
4. Week, *hafta*	1329 ± 95^{a}	1076 ± 25^{b}	784 ± 14^{c}	0.000
5. Week, *hafta*	1485 ± 106^{a}	1203 ± 28^{b}	876 ± 15^{c}	0.000
6. Week, *hafta*	1635 ± 117^{a}	1324 ± 31^{b}	964 ± 17^{c}	0.000
Total, *Toplam*	6677 ± 477^{a}	5406 ± 125^{b}	3938 ± 69^{c}	0.000
Total Feed Consumption (TFC), g per duckling *Toplam Yem Tüketimi, g ördek^{-1}*				
1. Week, *hafta*	368 ± 26^{a}	298 ± 7^{b}	217 ± 4^{c}	0.000
2. Week, *hafta*	1111 ± 79^{a}	899 ± 21^{b}	655 ± 12^{c}	0.000
3. Week, *hafta*	2228 ± 159^{a}	1804 ± 42^{b}	1314 ± 23^{c}	0.000
4. Week, *hafta*	3557 ± 254^{a}	2880 ± 66^{b}	2097 ± 37^{c}	0.000
5. Week, *hafta*	5042 ± 360^{a}	4082 ± 94^{b}	2973 ± 52^{c}	0.000
6. Week, *hafta*	6677 ± 477^{a}	5406 ± 125^{b}	3938 ± 69^{c}	0.000
Feed Conversion Ratio (FCR) *Yem Dönüşüm Oranı*				
1. Week, *hafta*	1.442 ± 0.088^{a}	1.186 ± 0.020^{b}	0.885 ± 0.018^{c}	0.000
2. Week, *hafta*	1.761 ± 0.127^{a}	1.334 ± 0.044^{b}	1.085 ± 0.033^{b}	0.001
3. Week, *hafta*	1.643 ± 0.130^{a}	1.479 ± 0.017^{a}	1.172 ± 0.024^{b}	0.006
4. Week, *hafta*	1.698 ± 0.126	1.604 ± 0.042	1.396 ± 0.029	0.061
5. Week, *hafta*	1.799 ± 0.128	1.767 ± 0.029	1.721 ± 0.056	0.804
6. Week, *hafta*	2.046 ± 0.140	1.984 ± 0.045	1.863 ± 0.058	0.390
Productivity Index (PI) Üretkenlik İndeksi	375.20 ± 30.60^{a}	327.72 ± 8.18^{ab}	271.60 ± 12.80^{b}	0.015

^{abc} The differences on the same line with different superscript letters are statistically important ($p<0.05$).

Table 4. The effect of SD on Mortality in Pekin ducks (Mean ± SEM).
Çizelge 4. Yerleşim sıklığının Pekin ördeklerinde ölüm oranına etkileri (Ort ± OSH).

	Stocking Density (duckling m^{-2}) *Yerleşim Sıklığı (ördek m^{-2})*			
	3	5	7	p Value
Mortality (M), % Ölüm Oranı, %				
1. Week, *hafta*	0.00 ± 0.00	0.00 ± 0.00	0.89 ± 0.89	0.405
2. Week, *hafta*	0.00 ± 0.00	0.00 ± 0.00	0.89 ± 0.89	0.405
3. Week, *hafta*	0.00 ± 0.00	0.00 ± 0.00	0.89 ± 0.89	0.405
4. Week, *hafta*	0.00 ± 0.00	1.25 ± 1.25	0.89 ± 0.89	0.608
5. Week, *hafta*	0.00 ± 0.00	1.25 ± 2.50	1.79 ± 1.03	0.419
6. Week, *hafta*	0.00 ± 0.00	1.25 ± 2.00	2.68 ± 1.71	0.345

^{abc} The differences on the same line with different superscript letters are statistically important ($p<0.05$).

Conclusions

The study was conducted to evaluate the appropriate stocking density for Pekin ducks (Star 53 line) in a closed system, broiler type rearing house where wood shavings were used as litter material and without swimming access to the birds.

The LW was found to be adversely affected by increasing SD as found to be 3 263 ± 74 g, 2 726 ± 24 g and 2 117 ± 43 g at SDs of 3, 5 and 7 respectively.

In addition LWG was also found to be negatively affected by increasing SD where the outcome was determined as 76 ± 10 g, 64 ± 10 g and 49 ± 10 g at SDs of 3, 5 and 7 ducklings m^{-2} seriatim.

Controversially the TLW (total kg live weight produced m^{-2}) were identified to be increasing with increasing SD. The results were as 9.79 ± 0.22 g, 13.63 ± 0.12 g and 14.82 ± 0.30 g at SDs of 3, 5 and 7 ducklings m^{-2} in order.

Even the feed consumption and TFC were found to be increasing with increasing SD, the change in FCR was found to be unimportant statistically stating that the change in feed consumption and TFC may not be taken into consideration at the point of feed conversion. Further economical calculations and trials should be made to obtain more detailed data about this point to evaluate the relevance of these values.

Productivity index values seem to be declining with increasing SD. The results were as 375.20 ± 30.60 g, 327.72 ± 8.18 g and 271.60 ± 12.80 g at SDs of 3, 5 and 7 ducklings m^{-2} in order. The mortality was found to be similar in all trial groups.

As the findings of the research are generally evaluated, it can be concluded that with an increase in SD effects field performance criteria positively except PI. From the results of the experiment it can be reported that with increasing SD, total production increases where individual performance decreases. Therewithal, field performance and PI should be taken into consideration and paid attention, and the optimum SD should be verified by more detailed, larger scaled research done including economical evaluation, meat quality and carcass parameters as well.

References

Ahaotu E.O., Agbasu C.A., 2015. Evaluation of the stocking rate on growth performance, carcass traits and meat quality of male Pekin ducks. *Sci. J. of Biolog. Sci*., 4: 23-29.

Anonymous, 1999. Standing committee of the European convention for the protection of animals kept for farming purposes. Recommendations concerning domestic ducks (*Anas platyrhynchos*), adopted by the standing committee on 22 June 1999.

Anonymous, 2014. Ross broiler management handbook. Aviagen Ltd. Newbridge Midlothian EH28 8SZ. Scotland, UK.

Anonymous, 2016a. Hot to raise strong & healthy ducks. HTE Books. Lexington KY, USA.

Anonymous, 2016b. Rearing guide roasting Pekin ducks. Grimaud Freres Selection S.A.S. La Corbiére 49850, Roussay, France.

Defra, 2007. Codes of recommendation for the welfare of livestock-ducks. *Defra Publications*, Admail 6000, London, UK.

Ekarius C., 2007. Storey's illustrated guide to poultry breeds. Storey Publishing 210 MASS MoCA Way North Adams, MA 01247 USA.

Holderread D., 2011. Storey's guide to raising ducks: breeds, care, health. Storey Publishing 210 MASS MoCA Way North Adams, MA 01247 USA.

Isguzar E., 2006. Domestic duck genotypes in Isparta location and effects of stocking density on growing and carcass parameters of Pekin ducks. *Suleyman Demirel Uni. J. of Natural and App. Sci*. 10: 56-60.

Jensen W.K., Devine C., Dikeman M., 2004. Encyclopedia of meat science. Elsevier Publication, 1353, New Zealand.

Jones T.A., Dawkins M.S., 2010. Environment and management factors affecting pekin duck

production and welfare on commercial farms in the UK. *Brit. Poult. Sci*. 51: 12-21.

Knizetova H., Hyanek, B., Knize B., Prochaskova H., 1991. Analyses of growth curves of fowl. II. Ducks. *Brit. Poult. Sci*. 32: 1039-1053.

Leeson S., Summers JD., 1982. Production and carcass characteristics of the duck. *Poult. Sci*. 61: 2456-2464.

Mucha S., Gornowicz E., Lisowski M., Grajewski B., Radziszewska J., Szwaczkowski T., 2014. Genetic parameters of carcass traits in ducks from a crossbred population. *Ann. Anim. Sci*. 14: 43-53.

Osman A.M.A., 1993. Effect of stocking rate on growth performance, carcass traits and meat quality of male Pekin ducks. *J. Agric. Rural. Dev. Trop*. 94: 147–156.

Sainsbury D., 1980. Poultry Health and Management. Granada Publishing Ltd. USA.

SPSS, 2013: SPSS Release 22.0 Statistical packet program, SPSS for Windows. SPSS Inc., Chicago, IL, USA.

Steczny K., Kokoszynskı D., Bernackı Z., Wasılewskı R., Saleh M., 2017. Growth performance, body measurements, carcass composition and some internal organ characteristics in young Pekin ducks. *S. Afr. J. of Anim. Sci*. 47: 399-406.

Wencek E., Kałużna I., Koźlecka M., Prokopiak H., Adamski M., 2012. Results of poultry performance recording in 2011 (in Polish). Pages, 7–22. *National Poultry Council*. Warsaw, Poland.

Wright L., 2008. Choosing and keeping ducks and geese. THF Publications Inc., One TFH Plaza, Third and Union Avenues, Neptune City, NJ 07753, USA.

Xie M., Jiang Y., Tang J., Wen Z.G., Huang W., Hou S.S., 2014. Effects of stocking density on growth performance, carcass traits and foot pad lesions of White Pekin ducks. *Poult. Sci*. 93: 1644–1648.