Effect of Japanese quail eggs location in the setter on their weight loss and eggshell temperature during incubation as well as hatchability results

Einfluss der Position von Eiern Japanischer Wachteln im Brutapparat auf den Gewichtsverlust und die Schalentemperatur während der Brut sowie auf den Bruterfolg

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Introduction

Major factors affecting the appropriate course of bird embryogenesis during incubation include: temperature, humidity and egg turning. However, it appears that temperature is the most important parameter because it initiates the process of embryo development and, later on, it supports it (DECUYPERE and MICHELS, 1992). Moreover, embryo temperature is frequently considered to be a tool or an indicator of the proper course of the egg incubation process (LOURENS, 2008). Deviations of incubation temperatures, in particular, above its optimal level, can result in an impairment of organogenesis, embryo dying out or appearance of developmental defects during the pre- and postnatal periods of birds’ life (FRENCH, 1994; YILDIRM and YETISIR, 2004; BARACANOGLU et al., 2006; LERSRIOMPONG et al., 2007). Frequently, it is the result of incorrect water evaporation from eggs during incubation, although the cause is not always excessively high temperature during incubation but rather egg quality, including structure of their shells. In the case of pheasants, for instance, it was found that eggs of blue-coloured eggshells were characterised by the highest number of pores and, simultaneously, by the highest egg weight losses up to the 21st day of incubation and worse hatchability results (KRYSTIANIAK et al., 2005; KOZUSZEK et al., 2009a, b).

In modern incubators, it is not difficult to control the incubation temperature fairly precisely with the measuring system of the apparatus. However, air temperature in the setter is not identical in each of its places (VAN BRECHT et al., 2003). On the other hand, excessively high temperature inside the incubator, in combination with enhanced production of metabolic heat by the embryo during the middle and, especially, in the final period of embryogenesis, may contribute to the development of a phenomenon known as ‘embryo overheating’. This, in turn, leads to deterioration of hatchability. It can be said that heat transfer inside the incubator is, primarily, a resultant of the temperature difference between the egg and the setter environment and the air flow through eggs (MEUERHOF and VAN BEEK, 1993; VAN BRECHT et al., 2005). A considerable role can also be played here by the material from which the setting tray is made as well as its construction (ÖZCAN et al., 2010). Therefore, it appears that chick hatchability and their quality may depend on the construction of the incubator itself as well as the placement of eggs in it. For example, ELIBOL and BRAKE (2008), who compared hatching results of broiler chickens from eggs placed closer and further away from the pulsator airscrew, recorded better results from the first of the above-mentioned places. A similar experiment was conducted on turkeys by ÖZÇELİK et al. (2009) analysing hatchability from eggs placed differently in relation to their horizontal orientation (front and back of the incubator). Investigations were also carried out on the impact of location of goose eggs in the incubator on hatchability traits (MEISNERBOWSKA et al., 2002). The worst results were reported from the eggs placed on setting trays in the upper level of the setter.

The problem of embryo’s ‘overheating’ is commonly known in the case of incubation of water fowl eggs. In order to prevent duck or goose embryos, egg cooling and sparging treatment was introduced to decrease their temperature. It was demonstrated, in early studies carried out by ROMUN and LORHORST (1960), that in the case of chicken eggs, problems with excessively high temperature of eggs expressed by the temperature of the eggshell surface can also occur after the 9th–10th day of incubation. Therefore, the set temperature of the incubator should not be treated as the true temperature of eggs. It was found that although the air temperature inside the incubator on day 18 of chicken incubation was 37.2°C, yet in some places of the hatching compartment egg temperature was at the level of 39.0°C (LOURENS, 2001). Moreover, when analyzing many types of incubators used to hatch turkey eggs, FRENCH (1997) found that in majority of cases egg temperature during incubation was higher than the temperature of the air in those apparatuses.

So far, no articles were found in the literature on the subject concerning detailed temperature analysis of Japanese quail eggs during incubation and hatchability depending on their location in the incubator. The only exception was a paper in which the authors made an attempt at determining the impact of the arrangement of eggs on setting trays on the obtained hatchability results (MORAES et al., 2008). On the other hand, the optimization of Japanese quail eggs’ hatchings together with their multifaceted analysis is very important and should be continued in view of the fact that attempts are continually made to try and find methods of improvement of these birds’ reproduction results.
The aim of the performed experiment was to assess the impact of the location of Japanese quail eggs in the incubator on their temperature and weight losses in the course of the incubation process and hatchability results as well as chick weight.

Material and methods

The experimental material comprised eggs of Japanese quails (*Coturnix coturnix japonica*) of laying type in their first year of laying derived from a commercial farm. Up to week 6 of their age, chicks were kept on rye or triticale litter in a rearing chamber of 40 m² area. During the growing period, Japanese quails were fed *ad libitum* complete diets which contained: 12.1 MJ/kg ME, 24.0% crude protein, 7.1% crude fat, 3.0% crude fibre and 1.0% calcium. Experimental birds began laying in the 7th week of age at mean body weight of 157 g (SD = 22.4). During the entire laying period, the birds were kept in cages at 35 birds/m² stock- ing rate with 6:1 ratio of females to males. Adult Japanese quails were fed *ad libitum* complete diets which contained: 11.6 MJ/kg ME, 20.5% crude protein, 5.0% crude fat, 3.0% crude fibre and 3.1% calcium. Complete mixture used in the nutrition of reproductive quails contained 1% share (i.e. 10 g/kg) of IHR premix which contains: vitamin A – 1500000 IU/kg; vitamin D₃ – 450000 IU/kg; vitamin E – 5500 mg/kg; vitamin K – 500 mg/kg; vitamin B₁ – 350 mg/kg; vitamin B₂ – 2000 mg/kg; vitamin B₆ – 600 mg/kg; vitamin B₁₂ – 3.0 mg/kg; folic acid – 250 mg/kg; biotin – 50.0 mg/kg; nicotinic acid – 9000 mg/kg; calcium pantothenate – 2500 mg/kg; choline – 100000 mg/kg; manganese (Mg) – 15000 mg/kg; zinc (Zn) – 9000 mg/kg; copper (Cu) – 1500 mg/kg; iodine (J) – 100 mg/kg; selenium (Se) – 30.0 mg/kg and cobalt (Co) – 2.0 mg/kg.

Incubation of Japanese quail eggs was conducted in a single-stage incubator (AVN type) of Jamesway Company (Figure 1). The total of five experimental incubations (replications) was carried out. Eggs for incubation were collected for the period of 1–2 days on week: 10, 17, 27, 30 and 45 of life of Japanese quails. During storage, eggs were kept in the following conditions: temperature – 15 to 16°C, relative humidity – about 55%. The total of 2,400 eggs was set (480 for each incubation). Eggs selected for incubation weighed from 10.5 to 12.5 g. After weighing, marking and disinfection (75% ethanol) of all eggs, they were set into the incubator using, for this purpose, 6 wooden setting trays, two trays on each: top, middle and bottom levels of the incubator (Figure 2). Each tray comprised four rows in which 80 eggs were placed (20 eggs in each row, Figure 3). Using a Braun Company ThermoScan thermometer, during each incubation eggshell temperature was controlled on days: 2, 4, 6, 8, 10, 12 and 14 of incubation (10 eggs in each row, every second in the row). Setting trays were selected in a different order (each time) to eggshell temperature evaluation. In addition, time intervals were kept (about 20 minutes) after every two trays to offset the impact of declining temperature inside the incubator due to its opening. Measurements were taken half through the shell length – equator (Guo, 2011).

Up to the 14th day of incubation, eggs were kept on setting trays. At this time, air temperature in the incubator was set at 37.6°C, and relative humidity – at about 55–60%. Trays were turned by the angle of 45° once every 30 minutes. On the 14th day of hatching, prior to transferring them into hatching trays, eggs were weighed. During the last three days of incubation, the hatching temperature was maintained at the level of 37.4°C, and relative humidity – at 65–70%.
On the basis of the data gathered in the course of the experiment from eggs in which temperature was measured, their weight losses were calculated (g and %) and changes in shell temperature up to the 14th day of hatching were analysed. Results obtained from the top, middle and bottom levels of setting trays were compared. The presented number of eggs used for calculations (egg weight loss) differed from the number of initially set eggs due to the rejection of unfertilised eggs as well as eggs with embryos which died in early stages of incubation as they could distort the obtained results and make their interpretation difficult.

**Statistical analysis**

Statistical analysis was performed using SAS® v.9.1 statistical package. In order to compare egg weight losses and their shell temperature during incubation from the top, middle and bottom levels, two-way ANOVA was applied which took into consideration the impact of birds’ age (hatching/replication) and the position of setting trays. In turn, to compare hatchability results and weight of one-day old chicks, three-way ANOVA was used which took into consideration the impact of birds’ age (hatching/replication) and the position of setting and hatching trays. The significance of differences between means for egg groups was verified by the Fisher’s test. Spearman’s phenotypic correlation coefficients were calculated for egg weight and its loss during incubation as well as for temperatures on individual examined days.

**Results**

Results presented in Table 1 failed to demonstrate any significant impact of the placement of Japanese quail eggs in the incubator with regard to their vertical (top, middle, bottom) location on egg weight loss up to the 14th day of hatching. The analysis of eggshell temperature changes during incubation revealed that it increased gradually from day 2 to day 12 (Figure 4). The recorded temperature difference for all eggs between the 2nd and 12th day of incubation in average amounted to 0.87°C. On the other hand, on day 14 of the incubation process, mean eggshell temperature was found to decrease. The lowest temperature was recorded for setting trays situated on the bottom level of the incubator (Figure 4). Significant differences between these eggs and eggs situated on the top trays of the setter were recorded on each of the examined days with the exception of the second day of incubation. Also, shells of eggs situated on trays from the middle levels were characterised by lower temperatures in comparison with eggshells from trays on the top level but in this case differences concerned only days 4, 6 and 8 of incubation. Higher temperatures of eggshells, in comparison with the temperature set in the setter, were recorded from days 6, 10 and 12 of incubation for trays on top, middle and bottom levels, respectively (Figure 4).

| Table 1. Effect of eggs vertical location in incubator on their weight lost during incubation
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Trait</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Egg weight at day of set (g)</td>
</tr>
<tr>
<td>Egg weight loss up to 14 d (g)</td>
</tr>
<tr>
<td>Egg weight loss up to 14 d (%)</td>
</tr>
</tbody>
</table>

No significant differences between levels of the incubator.

Figure 4. Effect of eggs vertical location in the setter on their temperature during incubation

Einfluss der vertikalen Lage der Eier im Brutapparat auf den Temperaturverlauf während der Brut

Mean values with different letters (within day) differ significantly at the level p ≤ 0.05
Figure 5 shows proportions of all eggs in individual temperature intervals. It turned out that days 2 and 4 were similar to each other and eggshells with temperatures ranging from 37.0–37.9°C constituted the greatest proportion. Beginning with day 6 until day 12 of incubation, proportions of eggs with shell temperatures exceeding 38°C were found to increase, while those of the above mentioned temperature range declined.

Phenotype correlation coefficients indicate a significant positive correlation between egg initial weight and its loss expressed in grams until day 14 of incubation ($r_p = 0.200; p \leq 0.0001$). A reverse, negative correlation was found for eggs initial weight and its percentage loss in the course of hatching ($r_p = -0.094; p \leq 0.005$). No significant correlations were observed between egg initial weight and their temperatures at each of the examined dates.

The results presented in Table 2 indicate that the placement of Japanese quail eggs in the incubator (setting trays) in relation to its vertical orientation (top, middle, bottom) exerted a significant effect on some hatchability results. In comparison with the top trays, worse results of chick hatchability from set and fertilised eggs were recorded for middle and bottom trays. This difference was confirmed statistically and amounted, respectively, to 7.5 and 8.5 percentage points. Moreover, the lower the eggs in the setting trays were placed, the more unhatched chicks were recorded. The difference ($p \leq 0.05$) between the top and bottom levels amounted to 8.1 percentage points. Although no significant differences between the examined vertical egg orientation were demonstrated with respect to embryo mortality, embryos which died up to day 10–11 of the incubation period always constituted majority (72.4 against 27.6%). No impact of egg location on one-day old chick’s body weight after hatching was observed (Table 2).

**Discussion**

Although no significant impact of the location of Japanese quail eggs in the incubator on losses of their weight until day 14 of incubation was demonstrated, it can be said that mean values of this parameter were correct. MORAES et al. (2008) carried out incubations of this species and analysed the impact of the placement of eggs on setting trays on hatchability results and on chick body weight after hatching and reported a total egg weight loss at the level of 6.8 to 10.4%. On the other hand, NOWACZEWSKI et al. (2010) investigated relationships between the size of Japanese quail eggs and hatchability and found that their loss of weight until the 15th day of incubation ranged from 9.5 to 11.0%.

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**Table 2. Effect of eggs vertical location in the incubator on hatchability results and chicks weight**

<table>
<thead>
<tr>
<th>Trait</th>
<th>Top level</th>
<th>Position of setting trays</th>
<th>Bottom level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>SEM</td>
<td>mean</td>
</tr>
<tr>
<td>Hatchability from set eggs (%)</td>
<td>64.0</td>
<td>2.32</td>
<td>56.7</td>
</tr>
<tr>
<td>Hatchability from fertilised eggs (%)</td>
<td>74.0</td>
<td>2.17</td>
<td>65.8</td>
</tr>
<tr>
<td>Dead embryos up to 10–11 day (%)</td>
<td>76.5</td>
<td>4.94</td>
<td>66.8</td>
</tr>
<tr>
<td>Dead embryos after 10–11 day (%)</td>
<td>23.5</td>
<td>4.42</td>
<td>33.2</td>
</tr>
<tr>
<td>Dead embryos (%)</td>
<td>17.8</td>
<td>1.77</td>
<td>20.9</td>
</tr>
<tr>
<td>Unhatched chicks (%)</td>
<td>4.73</td>
<td>0.90</td>
<td>8.74</td>
</tr>
<tr>
<td>Crippled chicks (%)</td>
<td>3.52</td>
<td>0.63</td>
<td>4.62</td>
</tr>
<tr>
<td>Weight of one-day old chicks (g)*</td>
<td>7.85</td>
<td>0.02</td>
<td>7.36</td>
</tr>
</tbody>
</table>

Mean values in rows with different letters differ significantly at the level $p \leq 0.05$

* ($n = 527, 492$ and $452$ for top, middle and bottom level, respectively)
Similar egg weight losses in Japanese quail were reported by ROMAO et al. (2008). Our results are contained within the above-mentioned intervals. In addition, we observed positive and negative correlations between egg initial weight and loss of their weight expressed, respectively, in grams and percent. This is in accordance with the results obtained by NOWACZEWSKI et al. (2010) for Japanese quails. Heavier eggs were characterised by greater (g) and smaller (b) loss of weight during hatching. Also LOURENS et al. (2006) reported that eggs of broiler breeders of higher initial weight (70.4 g) exhibited higher weight loss during hatching than lighter eggs (55.7 g). The difference amounted to 1.4 percentage units.

In our studies, a significant impact was observed of the location of eggs in the incubator on the temperature of eggshells during incubation. Setting trays from the highest level of the incubator up to the 10th day of incubation were characterised by higher temperature of eggs in comparison with the eggs from the trays on the bottom level. Slightly different results were reported by MEIJERHOF (2000). He also observed the temperature differences between hatching eggs can depend on various factors, such as the number of eggs in the same tray, the position of the egg, the position of the tray, and the position of the incubator. However, the results were different for trays situated on the top and middle levels of the setting compartment reached only 0.6°C. On the other hand, LOURENS (2001) reported higher temperatures of eggshells depending on their placement in the setter, although, in his studies, the highest temperature (between day 12 and 17 of incubation) was recorded for eggs from the middle of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C). On the other hand, LOURENS (2001) reported higher temperatures of chicken eggs on the 18th day of incubation for eggs located at the top and middle levels of the setting compartment. However, the results were different for trays situated on the top level of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C). On the other hand, LOURENS (2001) reported higher temperatures of chicken eggs on the 18th day of incubation for eggs located at the top and middle levels of the setting compartment. However, the results were different for trays situated on the top level of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C). On the other hand, LOURENS (2001) reported higher temperatures of chicken eggs on the 18th day of incubation for eggs located at the top and middle levels of the setting compartment. However, the results were different for trays situated on the top level of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C). On the other hand, LOURENS (2001) reported higher temperatures of chicken eggs on the 18th day of incubation for eggs located at the top and middle levels of the setting compartment. However, the results were different for trays situated on the top level of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C). On the other hand, LOURENS (2001) reported higher temperatures of chicken eggs on the 18th day of incubation for eggs located at the top and middle levels of the setting compartment. However, the results were different for trays situated on the top level of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C).

Analysing in our own investigations temperature changes during incubation, we found that it increased in all cases up to the 12th day of experiments and then it decreased by approximately 0.5°C. Embryo temperature and production of heat by embryos were reported to increase paralellly and linearly during incubation also in experiments carried out by NICHIELMANN et al. (1998) and JANKE et al. (2002). In chickens, a decline of eggshell temperature was observed on the 17th day of hatching (MEURERHOFF, 2000) with its highest drop amounting to 0.8°C recorded in the case of eggs located at the bottom level of the setter. On the other hand, the decline of eggshell temperature from trays in the middle level of the setting compartment reached only 0.1°C. YILDIZIM and YEŞİL (2004) examined changes in egg temperatures during incubation (between days 17 and 20) derived from broiler breeders (Ross 308) and found they declined from day 18 of the process. In the case of turkey eggs, the temperature drop of eggshells was recorded from day 23 of incubation (FRENCH, 1997). The difference between this day and day 27 of incubation was also at the level of 0.6°C.

It is worth mentioning that in our own experiments, no significant correlation was found between egg initial weight and their temperature during incubation. On the other hand, LOURENS et al. (2006) suggested that egg weight exerts some influence on heat produced by them but their investigations were conducted on a different species – domestic chicken. In the period from day 15 to 18 of incubation, heavier eggs generated more heat than lighter eggs. The difference between them on day 18 amounted to 18 mW/egg.

The hatching results of Japanese quail from fertilised eggs (t = 68.3%) determined in our investigations were similar to those reported by UDDIN et al. (1994), KHURSHID et al. (2004) and SİKER et al. (2005). However, some researchers indicate the possibility of obtaining better results of up to about 10–15 percentage points (IPEK et al., 2004; PETEK et al., 2005; ALKAN et al., 2008). Distinctly much worse hatchability results of Japanese quails in comparison with those of the above-mentioned authors were reported by LACIN et al. (2008). The value of this feature fluctuated between 42.2 and 53.9%.

In the performed experiment, hatching indices were demonstrated to be affected by the location of eggs in the setting compartment. The best results were achieved for eggs placed closer and further away from the ventilator. However, this phenomenon could have been caused by higher temperature of eggshells placed closer and further away from the ventilator. In our studies, a significant impact was observed of the location of eggs in the incubator on the temperature of eggshells during incubation. Setting trays from the highest level of the incubator up to the 10th day of incubation were characterised by higher temperature of eggs in comparison with the eggs from the trays on the bottom level. Slightly different results were reported by MEIJERHOF (2000). He also observed the temperature differences between hatching eggs can depend on various factors, such as the number of eggs in the same tray, the position of the egg, the position of the tray, and the position of the incubator. However, the results were different for trays situated on the top and middle levels of the setting compartment reached only 0.6°C. On the other hand, LOURENS (2001) reported higher temperatures of eggshells depending on their placement in the setter, although, in his studies, the highest temperature (between day 12 and 17 of incubation) was recorded for eggs from the middle of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C). On the other hand, LOURENS (2001) reported higher temperatures of eggshells depending on their placement in the setter, although, in his studies, the highest temperature (between day 12 and 17 of incubation) was recorded for eggs from the middle of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C). On the other hand, LOURENS (2001) reported higher temperatures of eggshells depending on their placement in the setter, although, in his studies, the highest temperature (between day 12 and 17 of incubation) was recorded for eggs from the middle of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C). On the other hand, LOURENS (2001) reported higher temperatures of eggshells depending on their placement in the setter, although, in his studies, the highest temperature (between day 12 and 17 of incubation) was recorded for eggs from the middle of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C). On the other hand, LOURENS (2001) reported higher temperatures of eggshells depending on their placement in the setter, although, in his studies, the highest temperature (between day 12 and 17 of incubation) was recorded for eggs from the middle of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C). On the other hand, LOURENS (2001) reported higher temperatures of eggshells depending on their placement in the setter, although, in his studies, the highest temperature (between day 12 and 17 of incubation) was recorded for eggs from the middle of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C). On the other hand, LOURENS (2001) reported higher temperatures of eggshells depending on their placement in the setter, although, in his studies, the highest temperature (between day 12 and 17 of incubation) was recorded for eggs from the middle of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C). On the other hand, LOURENS (2001) reported higher temperatures of eggshells depending on their placement in the setter, although, in his studies, the highest temperature (between day 12 and 17 of incubation) was recorded for eggs from the middle of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C). On the other hand, LOURENS (2001) reported higher temperatures of eggshells depending on their placement in the setter, although, in his studies, the highest temperature (between day 12 and 17 of incubation) was recorded for eggs from the middle of the incubator (over 38.9°C), while the lowest temperature of eggshells was recorded in the case of trays from the highest level of the setter (below 37.8°C).
Conclusions

It can be concluded on the basis of the obtained results that location of Japanese quail eggs in the incubator exerts impact on their temperature in the course of incubation and some hatchability results. The highest temperature was recorded in the case of eggs placed on the top level of the setter. On the other hand, however, no significant differences were found in egg weight losses during incubation depending on their location in the incubator. The observed differences in hatchability (the lower the location of eggs in the incubator, the worse the obtained results) in the case of such a small incubator may indicate differences in its internal microclimate (temperature and air flow) during incubation and sensitivity of Japanese quail eggs to excessively low incubation temperature. We believe that this result may have some application significance and be particularly useful for amateur breeders who usually use small-size setters to hatch eggs of different bird species.

Summary

The objective of the performed trial was to evaluate the influence of the location of Japanese quail eggs in the incubator on their temperature and weight losses during incubation as well as hatchability results. The total of 5 experimental incubations (replications) was performed for which eggs were collected for the period of 1–2 days on week: 10, 17, 27, 30 and 45 of life of Japanese quails. All eggs were set into the incubator on 6 setting trays, two at each top, middle and bottom level of the setter. Each tray comprised four rows in which 80 eggs were placed (20 eggs in each row). During each incubation, eggshell temperature was controlled on days: 2, 4, 6, 8, 10, 12 and 14 of incubation (10 eggs in each row). On day 14 of the incubation process, i.e. when eggs were transferred onto hatching trays, those eggs whose shell temperature was measured were weighed. Up to the 14th day of incubation, no impact on egg weight loss of the placement of Japanese quail eggs in the incubator was found. Eggshell temperature was found to increase gradually from day 2 to day 12 of incubation. On the other hand, however, no significant differences were found in eggshell temperature in comparison with eggshells from eggs placed on the top level but in this case differences concerned only days 4, 6 and 8 of the incubation. A significant positive correlation between egg initial weight and its loss expressed in grams was observed. A reverse, negative correlation was demonstrated for egg initial weight and its percentage loss in the course of incubation. The location of Japanese quail eggs on setting trays in the incubator in relation to vertical orientation (top, middle, bottom) exerted a significant impact on some hatching indices. Worse hatchability results were recorded for trays located on middle and bottom levels. In addition, the lower the eggs on setting trays were placed, the more unhatched chicks were recorded. No impact of the eggs location in the incubator on one-day old chick body weight was demonstrated. It was further shown that the placement of Japanese quail eggs in the incubator exerted impact on their temperature during incubation. The highest eggshell temperature was recorded for eggs located at the top level of the incubator. No significant differences in egg weight losses during incubation were found depending on their location in the incubator. The recorded differences in hatching indices (the lower the eggs were located, the worse the results were obtained) in the case of such a small incubator may indicate differences in the microclimate inside it during incubation (temperature and air flow) and sensitivity of Japanese quail eggs to excessively low incubation temperature.

Key words

Japanese quail, eggshell temperature, egg weight loss, incubation, hatchability

Zusammenfassung

Einfluss der Position von Eiern Japanischer Wachteln im Brutapparat auf den Gewichtsverlust und die Schalentemperatur während der Brut sowie auf den Bruterfolg

ermittelt, bei denen vorher die Schalentemperatur gemes- sen worden ist.

Stichworte

Japanische Wachtel, Temperatur der Eischale, Gewichtsverlust, Brut, Schlupferfolg

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