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Research Paper

Effects of horizontal distance between perches on perching behaviors of Lohmann Hens

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ABSTRACT

Perching is a highly-motivated natural behavior of laying hens that has been considered as one of the essential welfare requirements. The objective of the study was to evaluate perching behaviors of laying hens as affected by horizontal distance (HD) between parallel perches. A total of 48 Lohmann white hens in three groups (16 hens/group) were used, 68 weeks of age at the experiment onset. For each group, hens were housed in an enriched wire-mesh floor pen (120 cm L × 120 cm W × 120 cm H) equipped with two round galvanized tube perches (120 cm long × 32 mm diameter, an average of 15 cm perch space/hen). HD was varied sequentially at 60, 40, 30, 25, 20 and 15 cm and then in reverse order. A real-time monitoring system was developed to continuously record hen's perching behaviors. The number or proportion of perching hens, perching duration, and perching trip and frequency were analyzed using an automated VBA (Visual Basic for Applications) program developed in Microsoft Excel. Heading direction of the perching hens and pattern of the perch occupancy were determined manually by video observation. Results showed that reduction of HD to 25 cm did not restrain hens' perching behaviors, whereas HD of 20 or 15 cm restrained perching to some extent. Specifically, at HD of 25 cm, hens perched interlacing with one another to maximize use of the perches during the dark period. As a result, the proportion of perching hens and perching duration for HD of 25 cm were not reduced as compared to HD of 30–60 cm. However, the proportion of perching hens was significantly reduced at HD of 15 cm ($P = 0.001$–0.025). HD of 15 and 20 cm also significantly reduced daily perching time of the hens. In contrast, perching trip or frequency and heading direction of the perching hens were not influenced by HD (15–40 cm) except for HD of 60 cm. The results suggest that although 30 cm is the recommended minimum HD, 25 cm may be considered for situations where additonal perches are necessary to meet all hens' perching needs.

1. Introduction

Perching is a highly-motivated natural behavior of laying hens (Olsson and Keeling, 2002; Cooper and Albentosa, 2003; Weeks and Nicol, 2006); thus provision of perches in hen housing can accommodate hen's natural behavior, hence enhancing animal welfare. Consequently, perches are typically used in alternative hen housing systems, such as enriched colony and cage-free houses. Perching behaviors of laying hens have drawn extensive attention of researchers and egg producers over the past four decades. A number of studies have been conducted to investigate perch design (e.g., type, shape, texture and material) and spatial perch arrangement (e.g., height, angle and relative location). These studies mainly focused on the effects of perch provision on production performance (e.g., body weight, egg production and egg quality, feed usage and efficiency), health and welfare (e.g., skeletal and feet health, feather condition and physiological stress), and perching behaviors (e.g., perch use and preference) of laying hens (Struelens and Tuyttens, 2009; Hester, 2014).

Results of studies from both laboratory and commercial settings have shown benefits as well as detriments of providing perches to laying hens. For example, use of perches can stimulate leg muscle deposition and bone mineralization (Enneking et al., 2012; Hester et al., 2013a), increase certain bone volume and strength (Hughes et al., 1993; Appleby and Hughes, 1990; Barnett et al., 2009), reduce abdominal fat deposition (Jiang et al., 2014), and reduce fearfulness and aggression (Donaldson and O'Connell, 2012). However, keel bone deformities, foot disorders (e.g., bumble foot) and bone fractures have also been reported to be associated with perches (Appleby et al., 1993; Tauson and Abrahamsson, 1994; Donaldson et al., 2012). Moreover, controversies occur when contradictory results are derived from different experiments. For instance, some studies showed beneficial impacts of perches on feather condition or mortality of laying hens (Duncan et al., 1992; Glatz and Barnett, 1996; Wechsler and Huber-Eicher, 1998), whereas others showed detrimental impacts (Tauson,

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1984; Moinard et al., 1998; Hester et al., 2013b). More inconsistent results came from the studies that investigated perch use and preference of laying hens, especially when involving various perch shapes, sizes, textures, materials or spatial arrangements (Struelens and Tuyttens, 2009; Hester, 2014). To date, neither the egg industry nor the scientific community has designed a perfect perching system. Thus continually exploring proper perch design is warranted.

Switzerland first established legislation to improve welfare of laying hens in that conventional cages were banned in 1992 and all housing systems must provide at least 14 cm of elevated perches per hen (HÄne et al., 2000; Käppeliet al., 2011). Thereafter, the EU Directive set forth the minimum standards, which states that perch must have no sharp edges and perch space must be at least 15 cm per hen in alternative hen housing systems. In addition, horizontal distance between perches and between perch and wall should be at least 30 and 20 cm, respectively (Council Directive 1999/74/EC, 1999). However, ambiguities and debates exist due to unclear statement in perch design and lack of substantive scientific information. Some researchers criticized that this directive was more about satisfying public opinion than to meet laying hen's actual need (Savory, 2004). To meet the recommended minimum lineal space requirement of 15 cm, multiple parallel perches are typically used in alternative laying-hen facilities. However, a few recently published studies found that perches were not equally attractive to the hens in commercial aviary systems in that perches installed in higher tiers of the system were the most preferred, whereas perches in lower tiers were infrequently used at night (Brendler and Schrader, 2016; Campbell et al., 2016). Thus incorporating more perches to the higher tiers of multi-tier cage-free system by moderately reducing the horizontal distance between perches might still improve laying hen welfare by meeting more hens' perching needs. However, research does not exist in the literature that investigates the effects of horizontal distance between the parallel perches in meeting hen's actual perching needs.

Therefore, the objective of the study was to investigate the behavioral responses of Lohmann white laying hens to a range of horizontal distance (**HD**) between parallel perches (i.e., 15, 20, 25, 30, 40 and 60 cm) with regards to the proportion of hens perching during the dark period (**PHP**, %), perching duration (**PD**, i.e., time spent on the perch, min/hen), perching trip (**PT**, i.e., times of jumping on and off the perch, times/hen) and perching frequency (**PF**, i.e., number of perching trips per unit time, times/hen-hr), proportion of perching hens with heads toward the opposite perch (**PHO**, %), and the pattern of perch occupancy (**PPO**). The results will contribute to scientific evidence for setting or refining guidelines on HD of perches for laying hens in alternative hen-housing systems.

2. Materials and methods

The experimental protocol was approved by the Iowa State University Institutional Animal Care and Use Committee (Log # 5–12-7364-G).

2.1. Experimental animal and husbandry

The study was conducted in an environment-controlled animal research lab located at Iowa State University, Ames, Iowa, USA. A total of 48 Lohmann LSL White laying hens provided by a cooperative egg producer were used in the study. The hens had been housed in a commercial aviary house until onset of the experiment when they were 68 weeks of age. All the hens were considered to have had prior perching experience in the aviary house because they returned to the system at night and moved between the system and the litter floor during the day (as reported by the farm staff). The hens also had similar physiological and welfare conditions at the experiment onset, namely, comparable body weight (ranging from 1450 to 1550 g), feather coverage (slight to moderate feather damage/loss), feet health (no obvious foot disorders) and keel bone condition (slight to moderate keel bone deformity; keel bone fracture was not diagnosed). The hens were randomly assigned to three groups, 16 hens per group.

Three identical experimental pens (pen 1, 2 and 3) were used in the study. These experimental pens (Fig. 1), each measuring 120 cm L x 120 cm W x 120 cm H, had a wire-mesh (2.5 cm x 2.5 cm) floor (900 cm^2/bird space allowance), four wire-mesh (2.5 cm x 5.0 cm) sidewalls, an elevated nest box (120 cm L x 30 cm W x 40 cm H, 225 cm^2/bird; 45 cm above floor), two linear feeders (100 cm long, 12.5 cm per bird; installed outside the sidewalls), two nipple drinkers (1 nipple per 8 hens; 40 cm above floor, on the rear wall at 40 cm above floor), and two round galvanized tube perches (120 cm long x 32 mm diameter, 15 cm perch space per bird). The nest box had a door that only allowed hens to access it during the light period. The perches were designed to be adjustable so that HD between perches could be set accordingly. Both perches were installed at 30 cm above the floor which was within the height range in commercial aviary systems (19–32 cm above the floor). All the resource allowances, including perch, floor, feeder, nesting and nipple drinkers, were either higher than or comparable to those in the legislation or commercial guidelines for the hens.

Lighting scheme of the study followed the commercial management guidelines, namely, 16-h light at 15 lx (06:00 h-22:00 h), 7.5-h dark at 0 lx (22:15 h-05:45 h), and 0.5-h dim at 1–2 lx (05:45 h-06:00 h and 22:00 h-22:15 h). Light was provided by compact fluorescent lamps and light-emitting diode (LED) night lights for light and dim periods (i.e., dawn and dusk), respectively. Light intensity was measured using a light meter (0–20000 lx, model EA31, FLIR Systems Inc., Wilsonville, OR, USA[1]) and maintained at about 15 lx at bird head level (20 lx at perch height level) during the light period. The experimental room was equipped with mechanical ventilation and heating/cooling to maintain desired temperature of 21 °C. *Ad-lib* feed (commercial corn and soy diets) and water were available for hens throughout the test. Feeders were replenished and eggs were collected once a day at 18:00 h. The experiment pens were cleaned twice a week (i.e., removal of manure under the floor, feed waste, and dust or manure on the perch surface).

2.2. Testing system

A real-time vision-based monitoring system was built by incorporating three infrared night-vision cameras (GS831SM/B, Gadspot Inc. Corp., Tainan City, Taiwan, China) with a commercial surveillance software (MSH-Video surveillance system, S-VIDIA Inc., Santa Clara, CA, USA). It could record top-view images (Fig. 2a) from all three cameras simultaneously at 1 frame per second (FPS), and was used to record hen's perching behaviors during dark period to determine the heading directions and patterns of perch occupancy by hens.

A real-time sensor-based perching monitoring system was built by incorporating six pairs of load-cell sensors (5–100 kg ± 30 g, model 642C, Revere Transducers Inc., Tustin, CA, USA) supporting the six perches with a LabView-based data acquisition system (version 7.1, National Instrument Corporation, Austin, TX, USA). This monitoring system consisted of a compact FieldPoint controller (NI cFP-2020, National Instrument Corporation, Austin, TX, USA) and two 8-channel thermocouple input modules (NI cFP-TC-120, National Instrument Corporation, Austin, TX, USA) that was running at the sampling rate of 1 Hz. Each pair of load-cell sensors coupled with a tube perch made up a weighing perch (Fig. 2b). The analog voltage outputs of the load-cells were converted to weight values using pre-defined calibration curves (Fig. 2c, an example of the calibration curve). Consequently, real-time weight on the perch (i.e., total weight of perching birds) could be measured and recorded.

[1] Mention of product or company name is for presentation clarity and does not imply endorsement by the authors or Iowa State University, nor exclusion of other suitable products.