ARTICLE IN PRESS

Applied Animal Behaviour Science xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

Laying hens' preferences for nest surface type are affected by enclosure

M.E. Hunniford, G.J. Mason, T.M. Widowski*

Department of Animal Biosciences, Campbell Centre for the Study of Animal Welfare, University of Guelph, 50 Stone Rd. E., Guelph, Ontario, N1G 2W1, Canada

ARTICLE INFO

Keywords:
Furnished cage
Nesting behaviour
Laying hen
Preference
Enclosure
Surface material

ABSTRACT

The nest surfaces preferred by hens are inconsistent with those typically provided in commercial settings. However, little research has explored hens' preferences for commercially available nest surfaces. Our objective was to compare hens' preferences for two such surfaces – red smooth and yellow mesh plastic– either enclosed or unenclosed with curtains. We predicted that enclosed nests would be preferred, but that this may be offset by any preferences hens have for different surface types. After conventional rearing, 996 pullets were placed in 24 furnished cages (FC) at 15 weeks of age (large: 41,296 cm^2; small: 20,880 cm^2). In Phase 1, each FC had two nests, one with a yellow mesh plastic surface and one with a red smooth plastic surface (3368 cm^2). In half of the FCs, both surfaces were enclosed with plastic red curtains (ENCL, n = 12). The remainder had both open surfaces (OPEN, n = 12). In Phase 2, all FCs were subsequently modified at week 28 to have one enclosed and one open surface, allowing us to titrate how much hens preferred surface against enclosure. Preference was inferred from where eggs were laid, the location of sitting, and the amount of time spent on each surface. Egg location was recorded from the first egg to week 36. Sitting behaviour was scan sampled during weeks 25–26 (Phase 1) and 34–35 (Phase 2). Focal hens were selected at week 20 and observed from week 22–24 (Phase 1) and 31–33 (Phase 2). Results were unexpected: in Phase 1, hens laid more eggs on red smooth mats than yellow mesh when they were OPEN (66.8 ± 1.8% vs. 31.2 ± 1.8%; $P < 0.0001$), but more on yellow mesh mats than red smooth if they were ENCL (62.1 ± 2.1% vs. 36.7 ± 2.1%; $P < 0.0001$). In Phase 2, when all FCs had one open and one enclosed nest, hens preferred to lay in the enclosed nest (59.5 ± 2.0% vs. 39.5 ± 1.9%; $P < 0.0001$) but more so if they also had previous experience of an enclosed nest ($P < 0.0001$). In Phase 2, individual hen behaviour did not show that one surface was preferred over the other, but did indicate preference for enclosure. Hens changed their preferred nesting site from Phase 1 when enclosure was modified to favour the enclosed nests. This demonstrates that nest enclosure is important regardless of surface or hens' previous experiences, and that preference for a commercial nest surface depends on whether it is enclosed.

1. Introduction

Furnished cages (FCs) for laying hens are a compromise between conventional cages, which generally provide good health and hygiene, and non-cage systems, which provide more space and resources to support highly motivated activities (LayWel, 2006; Lay et al., 2011; Widowski et al., 2013). The materials and structures used to furnish FCs should therefore ideally maintain cage hygiene while also best helping hens satisfy their behavioural needs. Nesting has been well established as a particularly highly motivated behaviour pattern (Weeks and Nicol, 2006), and a hen's ability to fully express her nesting behavioural repertoire depends on the quality and design of the nest resources provided.

Enclosure is considered to be the most important attribute of a nest site. Hens not only prefer enclosed nests to open nests (Appleby and McRae, 1986), they will also overcome obstacles to reach and enter enclosed nest "boxes" (Cooper and Appleby, 1996, 1997) and show more signs of behavioural satisfaction – more "settled" forms of nesting behaviour (Nicol, 2015; also explored in a companion study, Hunniford and Widowski, 2018 *accepted*) – if nest areas are enclosed (Struelens et al., 2008). Another attribute of a nest site is the material used to line it. From observations of a population domestic fowl returned to wild conditions, Duncan et al. (1978) described a great variety of nests in terms of site and construction. While the most common feature of nearly all of the nest sites was concealment, nest construction consisted mainly of shallow depressions with surfaces ranging from bare earth or a few pieces of dead vegetation and feathers to a natural lining of vegetation. Previous research investigating different types of linings for nest boxes suggest that friable litter like straw, peat or wood-shavings are preferred (e.g. Struelens et al., 2005; Clausen and Riber, 2012); however, none of these are practical in large-scale commercial systems. Turning to more commercially-relevant materials, hens given a choice

* Corresponding author.
E-mail address: twidowsk@uoguelph.ca (T.M. Widowski).

https://doi.org/10.1016/j.applanim.2017.12.020
Received 25 August 2017; Received in revised form 26 December 2017; Accepted 31 December 2017

prefer to lay on plastic turf surfaces compared to plastic mesh (Guesdon and Faure, 2004; Guinebretière et al., 2012) or coated wire (Struelens et al., 2008). However, plastic turf tends to become soiled (Wall, 2011; Wall and Tauson, 2013) and so is being replaced in many commercial models of FC by linings that are more hygienic, despite being less attractive to hens (e.g. plastic mesh; Tuyttens et al., 2013). Few studies have investigated how type of nest surface interacts with enclosure to affect nesting behaviour, and no studies have done this in fully stocked large FCs.

In previous studies, we found that some hens preferred to lay in the open "scratch area" of a FC, which had a red smooth plastic surface rather than in the nest that was lined with mesh (Hunniford et al., 2014; Hunniford and Widowski, 2016). In the experiment reported here, we directly compared hens' relative preferences to lay on the two different surfaces and then titrated their preference for surface against their preference for enclosure. The experiment thus had two phases. We assessed the consistency of hens' surface preferences when both nest-sites were either enclosed or open (Phase 1), and then enclosed just one of each of the two surfaces types (Phase 2) to determine how hens would weigh their preferences for enclosure over their established preference for surface-type. Like most previous researchers (e.g. Clausen and Riber, 2012; Riber and Nielsen, 2013; Ringgenberg et al., 2015a,b), we used the sites selected for nesting and laying as indicators of relative preference between the two options. If a nest site was preferred, hens would visit the site more often, sit longer at the site, and eventually lay their eggs there.

2. Materials and methods

2.1. Animals and housing

2.1.1. Rearing

Day-old Lohmann LSL-lite chicks (n = 1100) were placed in conventional rearing cages (76.2 cm × 71.1 cm; 32 birds/cage) with a space allowance of 69.3 cm^2/bird. From 0 to 6 weeks of age, chicks were fed a standard commercial poultry chick starter diet (crumbles) with grit. At week 7, pullets were vaccinated according to standard procedures and re-distributed so there were 16 birds/cage (338.6 cm^2/bird). From 7 to 16 weeks of age, pullets were fed a standard commercial pullet grower diet (crumbles). The room was lit with LED bulbs (12 W, 750 Lumens; Think Green Solutions; Guelph, ON, Canada). From week 2 to 14, 100 pullets were weighed bi-weekly and room temperature was adjusted as necessary to ensure their growth matched target weight in breeder guidelines.

2.1.2. Adult

At 15 weeks of age, 996 pullets were randomly allocated to two sizes of furnished cage (FC) that had been modified for this experiment (Farmer Automatic Enrichable; Clark Ag Systems, Caledonia, Ontario, Canada): large (LFC: 41,296 cm^2; n = 12, 55 birds/cage; 750.8 cm^2/bird) and small (SFC: 20,880 cm^2; n = 12, 28 birds/cage; 745.7 cm^2/bird). The FCs were evenly distributed between two rooms, with two banks of three tiers of cages per room. Each furnished cage had white polyamide-coated wire floors and was equipped with perches (LFC: 17 cm/bird; SFC: 12.8 cm/bird) that ran parallel to the feeder and nipple drinkers above a central auger (Fig. 1). The nest and scratch areas were modified to create the experimental treatments (described below).

Hens were fed a standard commercial layer diet. Calcium was supplemented in week 29 to address some concerns with early-onset cage-layer fatigue. Lighting was set at 10 lx (30% intensity).[1] Lights came on at 07:30 h and lights-off was at 19:30 h when the birds were 18 weeks (12L:12D); lights-off changed to 21:30 h when the birds were 21 weeks (14L:12D). There was a 15-min sunrise after lights-on and a 15-min sunset before lights-off. Animal use was approved by the University of Guelph Animal Care Committee (Animal Utilization Protocol #3387).

2.2. Experimental design

Each FC had two nest areas (45.7 cm × 73.7 cm each; 240.6 cm^2/bird in SFC, 122.5 $cm^{2/}$/bird in LFC), one with a yellow plastic mesh surface and one with a red smooth plastic surface (Fig. 2). In commercially available models of the cages, the yellow mesh mats were used in the nest and the red smooth mats were used in the scratch area. In our previous experiments, we were not able to determine whether some hens' choice to lay their eggs in the scratch area was due to attraction to the mat itself (e.g. Hunniford et al., 2014; Hunniford and Widowski, 2017). Therefore we wanted to make a direct comparison between these two mats in the current experiment, and for the purposes of this experiment, there was no designated scratch area. In half of the FCs, the two surfaces were enclosed with red plastic curtains (ENCL). In the other half, the two surfaces did not have curtains (OPEN). For both treatments, each nest surface was bisected by a metal feed auger pipe onto which a wire partition was attached. The distribution of treatments within the room and among tiers was balanced, as was the orientation of surface material within each cage. This part of the experiment is referred to as "Phase 1".

When hens were 28 weeks of age, each FC was modified so as to include one enclosed nest and one open nest. Furnished cages from the ENCL treatment had one set of curtains removed; FCs from the OPEN treatment had one set of curtains added. This part of the experiment is referred to as "Phase 2". The modifications were balanced so that each type of enclosed surface (yellow mesh vs. red smooth) was equally represented in each tier and cage size.

2.3. Data collection: group behaviour measures

2.3.1. Egg location

Egg location (two nest areas and middle of the cage) was recorded daily from the first egg (week 16) until week 36 and analyzed from week 20 (when focal birds were selected; 84% production) to week 36. Egg location was defined as the placement of each egg on the egg belt adjacent to the red smooth mat, yellow mesh mat or middle of the cage. Eggs laid on the two surfaces could not be distinguished from eggs laid in the corner of the cage between the surface and the feeder.

2.3.2. Sitting behaviour

Each FC was instantaneously scan sampled to count the number of hens sitting in different areas of the cage. Sitting was operationally defined as when a hen's body is flush (keel parallel) to the bottom of the cage, their wings tucked, and head erect with eyes open. Observers would not count a hen as sitting if they were sleeping, dustbathing or preening. Beginning when the lights were fully on (07:40 h), two observers, one on each side of the cage, counted the number of hens sitting in each of four locations in the cage (Fig. 1). A hen was defined as being inside the location if both of their feet (or the majority of their body) were inside the bounds of the area indicated in Fig. 1. Scan observations were repeated every 20 min until 13:00 h. Twelve cages were sampled during each scan, six per room. One full set of scans took two days, and was repeated the following week during both Phase 1 (week 25 and 26) and Phase 2 (week 34 and 35). Thus, there were four observation days in total per phase, and the replicates were averaged before subsequent analysis (Table 1). Only sitting behaviour performed on the red smooth or yellow mesh mats was analyzed.

[1] The birds were photostimulated while in the furnished cages to ensure egg laying began when nests were provided, to avoid unintentionally affecting nest preferences (Sherwin and Nicol, 1993).