The pattern of body growth and intestinal development of female Chinese native geese from 1 to 10 weeks of age

Chuang Liu, Jing Yang, Shufeng Liu, Wei Geng, Shi Wei, Wen Ce Wang, Lin Yang and Yongwen Zhu

ABSTRACT

The aim of this study was to investigate the pattern of body growth and intestinal development of female Chinese native geese from 1 to 10 weeks of age. At weekly intervals, from hatch through 10 weeks of age, ten geese were sampled to measure the absolute and relative weight and length of the intestinal segments and overall intestine of geese. The body weight of Bertalanffy ($R^2 = 0.989$), Gompertz ($R^2 = 0.990$), Logistic ($R^2 = 0.980$) and Richards ($R^2 = 0.982$) models showed an increase in the asymptotes at 1–10 weeks old, while the inflection points were at 30.53, 28.56, and 25.59 d, respectively. The relative weight and length of the intestinal segments and overall intestine were decreased linearly ($P < 0.01$), while the absolute weight and length of the intestinal segments and overall intestine were increased linearly ($P < 0.01$) during 1–7 weeks old, but significantly decreased ($P < 0.01$) during 8–10 weeks old, suggesting that the intestinal system was developing rapidly at the starter period based on the intestinal weight and length, but was declining at the later period. The knowledge of growth curve and intestinal development pattern could provide some useful information on the optimum management practices and breeding strategies in geese production.

Introduction

To meet the requirement of animal protein due to the increase of population, the production of poultry other than chicken and ducks, such as geese, was increasing year by year in China (Kozák 2021). The size of the geese population in China increased to 639 million heads in 2020 (Hou and Liu 2021). In addition, the meat products of geese were regarded as one of the most valuable protein co-products and were increasingly popular in the Chinese market. Growth traits were important characteristics of both economic profitability and population dynamics in poultry production (Kenny et al. 2018). Growth curve models can be used for predicting body weight (BW) changes with age, which provide a visual assessment of growth as a function of time (Narinc et al. 2017). Therefore, knowledge about the growth pattern of meat goose was necessary to optimize the digestive system (e.g. by selection, feeding management and marketing strategies) (Boz et al. 2017). For example, it was unclear how much of an impact on growth production was the semi-intensive and intensive production systems, instead of the free-range backyard type (Boz et al. 2021). Therefore, the relationship between body weight and age depended on the different breeds and sexes (Uhlířová et al. 2018). To explain the growth curve of poultry, Logistic, Bertalanffy and Gompertz models were often used in male and female chicken, turkeys and ducks (Rogers 1987; Cigdem and Hulya 2001; Maruyama et al. 2001; Vitezica et al. 2010; Thinh et al. 2021). Moreover, precision feeding was separately performed for geese according to gender, in China. These models were applied to Chinese native geese of mixed gender (Zhao et al. 2007; Liu et al. 2017), but rarely to female geese. The intestinal system is the primary site to perform the functions of digestion, absorption, and protection (de Carvalho et al. 2021). The intestinal developmental patterns had positive effects on growth performance in poultry (González-Alvarado et al. 2008; Wang et al. 2014; Zhang et al. 2020). The knowledge of growth curve and intestinal developmental patterns could provide some useful information on the design of optimum management practices and breeding strategies in geese production. However, little information was available concerning the pattern of intestinal development in geese. Therefore, the purpose of this study was to investigate the developmental pattern of body weight and intestinal tract of female native Magang geese under the intensive production system, in favour of the breeding strategy to modify the trajectory of growth.

Methods and materials

Animals, management and housing

All procedures of this study were approved by the animal care and welfare committee institute of South China Agricultural
University (SCAU-10564), and the study was performed following the Regulations for the Administration of Affairs Concerning Experimental Animals. The study was conducted at the South China Agricultural University Agricultural Faculty’s Experimental Farm.

A total of one hundred and eighty female Magang goslings were assigned randomly to ten pens and eighteen birds per pen were raised in the environmental chambers under an intensive production system. Pens were separated by a wire mesh. Each pen contained one round feeder and one round drinker. The temperature started at 30 ± 1°C and was reduced by 3 ± 1°C each week until 21.1°C was attained at week 10. All birds were fed a starter diet from 0 to 4 weeks, and a grower diet from 4 to 10 weeks that met or exceeded the nutrient recommendations for geese (Table 1) by National Research Council (1994). Feed and water were provided ad libitum and economic white bulbs were used for lighting. The feeding and lighting programme were performed according to the guideline of management for Magang goose. The birds were weighed, and killed by carbon dioxide asphyxiation. One bird based on the average BW per pen was selected, weighed, and killed by carbon dioxide asphyxiation. The gastrointestinal tract and organs were carefully excised and determined with a modified method (Amerah et al. 2008). In brief, the empty weights of digestive tract segments from the duodenum to the caeca of each bird were determined. The length of each intestinal segment was determined with a flexible tape on a glass surface to prevent inadvertent stretching. After division and freeing of each intestinal segment, separating all connective tissue and fat, and removing the content with ice-cold saline flushing, empty weights (± 0.01 g) were determined. The relative values were calculated as a ratio of live body weight.

### Statistical analyses

The non-linear regression models of Logistic, Gompert, Bertalanffy, Richard, Brody and Weibull were fitted using the NLIN models of SAS software (SAS Institute 2000). The forms of equations (Table 2) for the Logistic, Gompert, Bertalanffy, Richard, Brody and Weibull models were: where W is the weight corresponding to age (t) with 3 parameters: A = asymptotic or maximum growth response, B = intercept, or weight when age (t) = 0 and K = rate constant. For digestive tract measurements, individual birds were considered as the experimental unit. All data were subjected to a one-way analysis of variance by using PROC GLM of SAS software. Orthogonal polynomials were applied for linear and quadratic effects on the parameters of intestinal development corresponding to age. Differences were considered to be significant at P < 0.05, and significant differences between means were separated by the least significant difference test.

### Results and discussion

The development of the meat goose industry requires further knowledge of the overall growth patterns for different breeds and sexes (Uhlířová et al. 2018). However, there was limited information on the growth curve for some native geese lines (Nder et al. 2017). In the present study, the growth curve analysis for female Chinese native Magang goose showed an increase in the asymptotes during the selection period of 1–10 weeks of age, and the age to reach the inflection point was estimated at 30.53, 28.56, 25.59, and 29.2 d, using the Logistic, Gompertz, Bertalanffy and Richards models, respectively (Table 1). The ages to reach the inflection points provided the estimates of maturity of the growth processes. In the current study, estimation of the inflection points was close to that reported in Chinese Sichuang white goose with mixed gender using the Gompertz model (27.51 d) (Liu et al. 2017) and female Turkish native geese using the Logistic model (32.9 d) (Nder et al. 2017) and shorter than that reported in Lion-head geese with mixed gender using the Gompertz model (52.5 d) (Zhao et al. 2007). In the present study, the accuracy of Bertalanffy ($R^2 = 0.990$) and Gompertz ($R^2 = 0.989$) models fitted body weights was higher than the Logistic ($R^2 = 0.980$) and Richards ($R^2 = 0.982$) models, indicating that the Gompertz and Bertalanffy models with high coefficients of determination could be suitable models for female Chinese native Magang goose growth. Laird (1966) reported that the Gompertz function has been preferred over the logistic

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### Sample collections

One bird based on the average BW per pen was selected, weighed, and killed by carbon dioxide asphyxiation. The

### Table 1. Composition and nutrient levels of the experimental diets (as-fed basis).

| Ingredient          | Starter (week 0–4) | Grower (week 5–10) |
|---------------------|--------------------|---------------------|
| CBC                  | 60.00              | 60.00               |
| Soybean meal        | 18.50              | 9.39                |
| Corn gluten meal    | 7.50               | 4.00                |
| Wheat bran          | 8.10               | 20.58               |
| Oil/Fat powder      | 1.25               | 1.85                |
| Lysine              | 0.35               | 0.25                |
| Sodium chloride     | 0.55 me             | 0.35 me              |
| DL-Methionine       | 0.12               | 0.13                |
| L-lysine.HCl (98.5%)| 0.78               | 0.35                |
| Vitamin and mineral premix<sup>1</sup> | 0.1               | 0.1                |
| Total               | 98.00              | 100                 |
| Nutrient composition|                    |                     |
| ME, MJ/kg           | 12.37              | 11.84               |
| Crude protein       | 19.8               | 15.3                |
| Lysine              | 1.33               | 0.8                 |
| Methionine          | 0.44               | 0.36                |
| Methionine + cysteine| 0.75            | 0.61                |
| Calcium             | 0.93               | 0.91                |
| Total phosphorus    | 0.75               | 0.81                |
| Non-phytic phosphorus| 0.5            | 0.53                |

<sup>1</sup>Provided per kilogram of diet for geese at week 0–4: vitamin A, 10,000 IU; vitamin D3, 1, 500 IU; vitamin E, 10 IU; thiamine, 1.8 mg; riboflavin, 3.6 mg; pyridoxine, 3.0 mg; vitamin B12, 0.003 mg; calcium pantothenate, 10 mg; folate, 0.25 mg; niacin, 35 mg; biotin, 0.10 mg; choline (Choline chloride), 500 mg; Cu (CuSO4·5H2O), 8 mg; Fe (FeSO4·7H2O), 100 mg; Zn (ZnSO4·7H2O), 100 mg; Mn (MnSO4·H2O), 50 mg; Se (NaSeO3), 0.5 mg; I (KI), 0.3 mg.

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### Table 2. Non-linear regression models for body weight growth of female Chinese native Magang goose.

| Model               | Regression equations | Parameters (as-fed basis) | Coefficient of determination ($R^2$) |
|---------------------|----------------------|---------------------------|-------------------------------------|
| Logistic            | $y = \frac{A}{1 + e^{-(t-K)/B}}$ | A, B, K | 0.980 |
| Gompertz            | $y = A e^{-K^{B/K}e^{-t/(B/K)}}$ | A, B, K | 0.990 |
| Bertalanffy         | $y = A (1 - e^{-t/\sqrt{K}})$ | A, K | 0.982 |
| Richards            | $y = \frac{A}{1 + \left(\frac{B}{t-K}\right)^{1/\alpha}}$ | A, B, C, \alpha | 0.989 |

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### Footnotes

1 Provided per kilogram of diet for geese at week 0–4: vitamin A, 10,000 IU; vitamin D3, 1,500 IU; vitamin E, 10 IU; thiamine, 1.8 mg; riboflavin, 3.6 mg; pyridoxine, 3.0 mg; vitamin B12, 0.003 mg; calcium pantothenate, 10 mg; folate, 0.25 mg; niacin, 35 mg; biotin, 0.10 mg; choline (Choline chloride), 500 mg; Cu (CuSO4·5H2O), 8 mg; Fe (FeSO4·7H2O), 100 mg; Zn (ZnSO4·7H2O), 100 mg; Mn (MnSO4·H2O), 50 mg; Se (NaSeO3), 0.5 mg; I (KI), 0.3 mg.
function for fitting monophasic growth curves of chickens. When analysed by growth curves derived from the Bertalanffy model, the body weight of Magang geese during the periods of 2–4 weeks (521 g/week) and 7–8 weeks (483 g/week) of age was faster than the other growth period (Figure 1). The greatest body weight gain appeared at 4 weeks of age (581 g/week), which was similar to the data obtained from female Bohemian and Italian White geese (Knizetova et al. 1994). As reported in ducks, the age of the inflection point that remained constant was 26 d for Pekin ducks, 21 d for Mallard ducks and 37 d for Muscovy ducks (Gille and Salomon 1994). It was inferred that the geese were characterized by an early maturing rate, nearly as early as ducks (Knizetova et al. 1991b) and earlier than chickens (Knizetova et al. 1991a). It was apparent that the selection programme, without a delay in maturity, reduced the time to reach the market weight to achieve more efficient goose production.

The intestinal system was the primary site of entry for any orally administered compound, including dietary ingredients. There was a growing interest on the influence of diet on the development of the gastrointestinal tract in poultry (González-Alvarado et al. 2008; Jiménez-Moreno et al. 2009; Wang et al. 2014; Zhang et al. 2020). In the present study, the relative weight and length of the intestinal segments and overall intestine decreased linearly with the increased week of age (Tables 3 and 4). The greatest relative weight and length of the intestine were observed during the first three weeks. It was suggested that the intestinal system of a hatchling must undergo tremendous change before it was capable of efficiently digesting the dietary nutrients. Previous studies demonstrated that the growth of the intestinal system may exceed that of the rest of the body by as much as five-fold in chickens during the first 5–7 days of post-hatch (Uni et al. 1999; Sklan 2001). A previous study reported that avian species with high growth rate capacities at the starter period were also characterized by a rapid development of the digestive organs (Lilja 1983), which was confirmed in geese of the current study. The absolute weight and length of the duodenum, jejunum and ileum segments and overall intestine were increased quadratically in response to the increased age (Tables 5 and 6). The absolute length of the intestinal segments and overall intestine was increased as observed over the 1–5 week period in geese, which was in agreement with those reported in broilers from post-hatching to 21 days old (Uni et al. 1999). No significant changes were observed in the absolute length of the intestine during 6–10 weeks of age. It was suggested that the intestines tend to be mature by 5–6 weeks of age. Some interesting patterns were observed in the absolute weight of the digestive system during the growth period. The absolute weight and length of the intestinal segments and overall intestine increased linearly during 1–7 weeks and the age to reach the inflection points was at 7 weeks of age. However, there was a significant decrease in the absolute weight of the duodenum, jejunum and ileum segments and overall intestine during 8–10 weeks old. It was implied that the shrinking of gastrointestinal system development occurred during the later growth period, which resulted in the lower growth rate capacity in geese during 8–10 weeks. The reduced weight of the small intestine was in line with the results that the absolute mass of the small intestine

### Table 2. Growth curve parameters in different models for Magang geese (n = 10).

| Model | Function | Weight at point of inflection (kg) | Age of maximum growth (d) | Mean squared residue | Adjusted coefficient of determination |
|-------|----------|-----------------------------------|---------------------------|---------------------|---------------------------------------|
| Logistic | $W_t = A/(1 + Be^{-kt})^n$ | 3.827 | 0.980 | 0.013 | 296.065 |
| Gompertz | $W_t = Ae^{-Be^{-kt}}$ | 3.522 | 0.990 | 0.031 | 29.224 |
| Bertalanffy | $W_t = A(1 - Be^{-kt})^3$ | 4.181 | 0.745 | 0.031 | 296.065 |
| Brody | $W_t = A(1 - Be^{-kt})^{1/2}$ | 5.193 | 1.038 | 0.006 | 29.224 |
| Weibull | $W_t = A - Be^{-kt}$ | 5.043 | 5.159 | 0.002 | 296.065 |
| Richards | $W_t = A/(1 + Be^{-kt})^n$ | 3.827 | 0.980 | 0.013 | 296.065 |

Notes: MSR, mean squared residue, calculated by dividing the sum of the squares of the residue by the number of observations; $R^2$, adjusted coefficient of determination.
Figure 1. Predicted average body weight and observed growth curves for the Logistic, Gompertz, Bertalanffy, Richard, Brody and Weibull models.

Table 3. Effect of age on the relative weight of intestine of Magang geese from 1 to 10 weeks of age (g/kg)\textsuperscript{A}.

| Age (week) | Duodenum | Jejunum | Ileum | Caecum | Rectum | Overall intestine |
|-----------|-----------|---------|-------|--------|--------|------------------|
| 1         | 10.03\textsuperscript{a} | 20.48\textsuperscript{a} | 18.91\textsuperscript{a} | 2.09\textsuperscript{dea} | 4.82\textsuperscript{a} | 56.33\textsuperscript{a} |
| 2         | 7.61\textsuperscript{b}  | 18.24\textsuperscript{b} | 16.47\textsuperscript{b} | 3.11\textsuperscript{b}  | 4.47\textsuperscript{a} | 49.89\textsuperscript{b} |
| 3         | 6.29\textsuperscript{c}  | 15.49\textsuperscript{c} | 13.90\textsuperscript{c} | 3.69\textsuperscript{d}  | 3.61\textsuperscript{b} | 43.92\textsuperscript{c} |
| 4         | 4.25\textsuperscript{d}  | 8.38\textsuperscript{d}  | 9.09\textsuperscript{d}  | 2.17\textsuperscript{dea} | 2.58\textsuperscript{c} | 26.03\textsuperscript{d} |
| 5         | 5.45\textsuperscript{e}  | 13.48\textsuperscript{e} | 10.25\textsuperscript{e} | 2.71\textsuperscript{bc} | 2.57\textsuperscript{de} | 34.46\textsuperscript{e} |
| 6         | 4.07\textsuperscript{f}  | 9.36\textsuperscript{f}  | 7.72\textsuperscript{f}  | 2.34\textsuperscript{bcd} | 2.34\textsuperscript{c} | 25.82\textsuperscript{f} |
| 7         | 4.64\textsuperscript{g}  | 11.43\textsuperscript{g} | 8.09\textsuperscript{g}  | 2.54\textsuperscript{bc} | 2.66\textsuperscript{c} | 29.35\textsuperscript{g} |
| 8         | 3.16\textsuperscript{h}  | 7.24\textsuperscript{h}  | 5.06\textsuperscript{h}  | 1.62\textsuperscript{dea} | 2.34\textsuperscript{c} | 19.18\textsuperscript{h} |
| 9         | 3.00\textsuperscript{h}  | 6.65\textsuperscript{h}  | 5.01\textsuperscript{h}  | 1.93\textsuperscript{dea} | 1.54\textsuperscript{d} | 18.02\textsuperscript{h} |
| 10        | 2.76\textsuperscript{h}  | 6.91\textsuperscript{h}  | 4.89\textsuperscript{h}  | 1.44\textsuperscript{h}  | 1.42\textsuperscript{d} | 17.42\textsuperscript{h} |
| SEM       | 0.25      | 0.44    | 0.65  | 0.25   | 0.14   | 1.14            |
| P value   | <0.01     | <0.01   | <0.01 | <0.01  | <0.01  | <0.01          |
| Linear    | <0.01     | <0.01   | <0.01 | <0.01  | <0.01  | <0.01          |
| Quadratic | <0.01     | <0.01   | <0.01 | <0.01  | <0.01  | <0.01          |

\textsuperscript{A}Lacking common letters (a or h) significant differences at \( P < 0.05 \).
\textsuperscript{B}Mean represented the average value of 10 replicates (\( n = 10 \)).

Table 4. Effect of age on the relative length of the intestine of Magang geese from 1 to 10 weeks of age (cm/kg)\textsuperscript{A}.

| Age (week) | Duodenum | Jejunum | Ileum | Caecum | Rectum | Overall intestine |
|-----------|-----------|---------|-------|--------|--------|------------------|
| 1         | 86.44\textsuperscript{a} | 177.2\textsuperscript{a} | 162.08\textsuperscript{a} | 32.35\textsuperscript{a} | 23.63\textsuperscript{a} | 481.72\textsuperscript{a} |
| 2         | 44.34\textsuperscript{b} | 100.0\textsuperscript{b} | 90.98\textsuperscript{b} | 20.35\textsuperscript{b} | 12.41\textsuperscript{b} | 268.08\textsuperscript{b} |
| 3         | 27.68\textsuperscript{c} | 62.33\textsuperscript{c} | 53.95\textsuperscript{c} | 13.14\textsuperscript{c} | 7.91\textsuperscript{c} | 161.40\textsuperscript{c} |
| 4         | 23.09\textsuperscript{d} | 43.61\textsuperscript{d} | 45.36\textsuperscript{d} | 10.80\textsuperscript{d} | 6.04\textsuperscript{d} | 126.24\textsuperscript{d} |
| 5         | 18.34\textsuperscript{e} | 37.83\textsuperscript{e} | 37.43\textsuperscript{e} | 6.89\textsuperscript{e} | 5.56\textsuperscript{e} | 113.06\textsuperscript{e} |
| 6         | 18.22\textsuperscript{f} | 36.10\textsuperscript{f} | 32.79\textsuperscript{f} | 9.3\textsuperscript{f} | 4.34\textsuperscript{f} | 102.21\textsuperscript{f} |
| 7         | 15.17\textsuperscript{g} | 31.65\textsuperscript{g} | 27.98\textsuperscript{g} | 7.51\textsuperscript{g} | 3.99\textsuperscript{g} | 86.31\textsuperscript{g} |
| 8         | 12.34\textsuperscript{h} | 26.39\textsuperscript{h} | 23.81\textsuperscript{h} | 6.88\textsuperscript{h} | 3.81\textsuperscript{h} | 73.22\textsuperscript{h} |
| 9         | 12.43\textsuperscript{i} | 25.65\textsuperscript{i} | 22.63\textsuperscript{i} | 7.29\textsuperscript{i} | 3.63\textsuperscript{i} | 71.62\textsuperscript{i} |
| 10        | 11.05\textsuperscript{j} | 23.78\textsuperscript{j} | 19.97\textsuperscript{j} | 5.74\textsuperscript{j} | 3.44\textsuperscript{j} | 64.16\textsuperscript{j} |
| SEM       | 1.43      | 2.80    | 2.05  | 0.97   | 0.63   | 5.83            |
| P value   | <0.01     | <0.01   | <0.01 | <0.01  | <0.01  | <0.01          |
| Linear    | <0.01     | <0.01   | <0.01 | <0.01  | <0.01  | <0.01          |
| Quadratic | <0.01     | <0.01   | <0.01 | <0.01  | <0.01  | <0.01          |

\textsuperscript{A}Lacking common letters (a or h) significant differences at \( P < 0.05 \).
\textsuperscript{B}Mean represented the average value of 10 replicates (\( n = 10 \)).
in domesticated ducks declined by 38% at 5 weeks post-hatching (Watkins et al. 2004). This reduction of the intestinal segments can be due more to the changes in the intestinal thickness rather than the intestinal length, which could be associated with the alteration of bioavailability and utilization of nutrients. There is no obvious explanation for this decline because it does not appear to optimize digestion.

**Conclusion**

Considering that the $R^2$ values of the Gompertz and Bertalanffy models were higher than for the Logistic and Richards models, Gompertz and Bertalanffy models with high coefficients of determination could be suitable models for female Chinese native Magang goose growth, and the age of the infection points was estimated at 30.53 and 28.56 d, respectively. It was suggested that the intestinal system was well developed during 1–7 weeks old in terms of the intestinal weight and length, but displayed a decline in geese during 8–10 weeks old. The knowledge of growth curve models and intestinal development pattern could provide some useful information on the design of optimum management practices and breeding strategies in goose production.

**Disclosure statement**

No potential conflict of interest was reported by the author(s).

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**Table 5. Effect of age on the absolute weight of the intestine of Magang geese from 1 to 10 weeks of age (g/kg)**

| Age (week) | Duodenum | Jejunum | Ileum | Caecum | Rectum | Overall intestine |
|------------|-----------|---------|-------|--------|--------|------------------|
| 1          | 2.33f     | 4.75g   | 4.37a | 0.48f  | 1.11a  | 13.03f           |
| 2          | 3.96a     | 9.51i   | 8.59f | 1.62a  | 2.33d  | 26.01a           |
| 3          | 6.14d     | 15.22a  | 13.63ab| 3.62d  | 3.55c  | 41.15c           |
| 4          | 6.51d     | 12.88b  | 14.25a| 3.32d  | 4.16bc | 50.48b           |
| 5          | 9.58b     | 22.34a  | 18.33ab| 4.79bc | 4.53b  | 61.12b           |
| 6          | 7.51c     | 17.19d  | 14.09g| 4.31cd | 4.26bc | 47.36aw          |
| 7          | 11.53a    | 28.42a  | 20.19g| 6.20a  | 6.58a  | 72.93a           |
| 8          | 9.14g     | 20.61bc | 14.68b| 4.66bc | 6.45a  | 55.53bc          |
| 9          | 8.76bc    | 19.45bc | 14.67b| 5.55bc | 4.45b  | 51.96cd          |
| 10         | 8.90ac    | 20.61bc | 15.75bc| 4.66bc | 4.59b  | 56.22bc          |
| SEM        | 0.37      | 0.92    | 0.64  | 0.24   | 0.22   | 2.25             |

*P* value <0.01 <0.01 <0.01 <0.01 <0.01 <0.01

**Table 6. Effect of age on the absolute length of the intestine of Magang geese from 1 to 10 weeks of age (cm/kg)**

| Age (week) | Duodenum | Jejunum | Ileum | Caecum | Rectum | Overall intestine |
|------------|-----------|---------|-------|--------|--------|------------------|
| 1          | 19.96d    | 40.96d  | 37.50c| 7.47d  | 5.44g  | 111.33d          |
| 2          | 23.01d    | 52.08c  | 47.43a| 10.60a  | 6.47g  | 139.65a          |
| 3          | 27.18     | 61.20b  | 49.10b| 12.91cd | 7.08d  | 158.50a          |
| 4          | 35.75ab   | 66.90a  | 70.41b| 14.54bc | 9.02cd | 198.13bc         |
| 5          | 34.37ab   | 77.05a  | 65.92b| 11.69de | 9.38bc | 198.40bc         |
| 6          | 33.16ab   | 66.08b  | 62.40a| 17.05ab | 7.96de | 186.65           |
| 7          | 37.67ab   | 78.25a  | 69.17b| 18.40ab | 9.82ab | 213.30           |
| 8          | 35.73ab   | 76.33a  | 68.97b| 19.79a  | 11.08a  | 211.91ab        |
| 9          | 36.05ab   | 74.37a  | 65.55a| 21.08a  | 10.42ab | 207.47ab        |
| 10         | 36.67a    | 76.67a  | 64.33a| 18.50ab | 10.67ab | 206.83ab        |
| SEM        | 0.86      | 1.18    | 1.59  | 0.70   | 0.28   | 0.54             |

*P* value <0.01 <0.01 <0.01 <0.01 <0.01 <0.01

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**Data availability**

The data that support this study are available in the article.

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