環境溫濕度指數對母兔哺育性能與仔兔生長性能之影響[(1)]

蔡銘洋[(2)] 柯瑋羚[(2)] 謝昭賢[(2)] 吳錫勳[(3)(4)]

收件日期：102 年 2 月 21 日；接受日期：102 年 7 月 30 日

摘 要

本試驗旨在探討環境溫濕度指數 (temperature-humidity index, THI) 對母兔哺育性能與仔兔生長性能之影響。試驗分別在涼季 (1 – 3 月) 及熱季 (5 – 7 月) 於行政院農業委員會畜產試驗所 (以下簡稱畜試所) 養兔場進行。分別選取 30 隻經產紐西蘭母兔，紀錄其哺育性能，包括仔兔出生窩仔數、出生窩重、3 週齡窩仔數、3 週齡窩重、離乳窩仔數、離乳 (4 週齡) 窩重、離乳體重及育成率。離乳後之仔兔，隨即進行生長試驗，每週測定飼料採食量、體重及存活數，並計算日增重、飼料轉換率及育成率等。試驗期間每隔 2 小時紀錄兔舍內溫、濕度一次，並換算成 THI，以作爲評估兔隻熱緊迫之依據。試驗結果顯示，涼季與熱季之兔舍內平均溫度分別為 21.0℃及 28.2℃，平均相對濕度分別爲 74.1% 及 83.9%，平均 THI 分別爲 20.4 及 27.4。在涼季僅 0.2% 時間處於輕微熱緊迫 (27.8 < THI < 28.9)，而其餘時間均無熱緊迫發生 (THI < 27.8)。在熱季有 16.0% 時間處於非常嚴重熱緊迫 (THI > 30)，11.0% 時間處於嚴重熱緊迫 (28.9 < THI < 30.0)，而 11.8% 時間處於輕微熱緊迫 (27.8 < THI < 28.9)，亦即在熱季全期有 38.8% 時間處於不同程度之熱緊迫情況。涼季之出生窩重 (476 ± 126 g *vs.* 399 ± 120 g)、3 週齡平均窩重 (2,385 ± 572 g *vs.* 1,748 ± 416 g)、離乳平均窩重 (5,103 ± 1,270 g *vs.* 4,279 ± 1,090 g)、出生平均體重 (68.1 ± 13.5 g *vs.* 58.6 ± 11.3 g) 及 3 週齡平均體重 (360 ± 98 g *vs.* 294 ± 91 g) 皆顯著高於熱季 (P < 0.05)。兔隻在離乳時之個別體重在兩季間並無顯著差異。雖然涼熱兩季之生長試驗起始體重無顯著差異，而涼季生長兔在 5 週齡與 6 週齡時之平均體重 (1078 ± 226 g *vs.* 953 ± 157 g; 1312 ± 265 g *vs.* 1158 ± 188 g) 顯著高於熱季 (P < 0.05)，但在 7 週齡與 8 週齡之平均體重 (1426 ± 302 g *vs.* 1342 ± 213 g; 1616 ± 345 g *vs.* 1491 ± 207 g) 則無顯著差異。涼季生長兔各週之平均採食量 (360 ± 98 g *vs.* 294 ± 91 g) 及全期飼料轉換率 (4.42 ± 2.03 *vs.* 3.12 ± 0.74) 均顯著地 (P < 0.05) 高於熱季，而各週平均日增重及全期之平均日增重則無顯著差異。綜上所述，夏季熱緊迫將顯著降低母兔哺育性能及仔兔之生長性能。

關鍵詞：兔、溫濕度指數、繁殖性能、生長性能。

緒 言

兔隻皮膚汗腺不發達，在高溫環境下無法有效排除體熱，必須藉由增加喘息速率與耳朵之血液循環速率以排除體熱 (Marai *et al.*, 1994)。高溫環境對兔隻生產之負面影響，包括：減低採食量、生長速率、出生體重及繁殖效率等 (Marai *et al.*, 2002)。臺灣位居亞熱帶，夏季高溫高濕，不利兔隻生產。李等 (1999) 分析畜試所養兔場 1990 年至 1997 之年之資料指出，於熱季 (8 月份)，仔兔之平均出生體重、3 週齡體重以及出生仔兔之 3 週齡存活率，顯著地低於涼季 (1 月份)，顯示高溫環境溫度確實會降低兔隻之生產效率。Marai and Habeeb (1994) 指出，當相對濕度提高時會加劇熱緊迫程度。因此，本試驗使用溫濕度自動記錄器，配合 Marai *et al.* (2004) 計算之 THI，用以比較畜試所開放式兔舍於在涼季 (1 – 3 月) 及熱季 (5 – 7 月)

(1) 行政院農業委員會畜產試驗所研究報告第 1917 號。
(2) 行政院農業委員會畜產試驗所產業組。
(3) 國立屏東科技大學動物科學與畜產系。
(4) 通訊作者，E-mail：hhwu@mail.npust.edu.tw。

間兔隻哺育性狀與生長性狀，並進一步評估環境溫濕度指數與兔隻熱緊迫反應之關係，以作爲改善動物福祉與規劃兔舍降溫措施之參考。

材料與方法

I. 溫濕度記錄及熱緊迫評估

試驗於畜試所開放式兔舍進行，畜舍建築爲東西向，南北兩側皆裝置可收放之帆布與遮蔭網，畜舍周邊種有大型喬木，夏天具遮蔭效果，且畜舍內裝置風扇，以改善通風。試驗期涼季於 1 – 3 月進行，熱季於 5 – 7 月進行，以自動溫濕度紀錄器 (Microlog EC 650) 測定畜舍內溫濕度 (1 次 /2 小時)，測得之溫、濕度資料依 Marai *et al.* (2004) 公式換算成 THI，以評估環境溫度與濕度對兔隻造成之熱緊迫程度。THI 公式爲：

THI = db℃ – [(0.31 – 0.31 RH) (db℃ – 14.4)]

公式中：db 表乾球攝氏溫度，RH 表相對濕度百分率。THI 值小於 27.8 表示無熱緊迫，27.8 – 28.9 表輕微熱緊迫，28.9 – 30.0 表嚴重熱緊迫，大於 30.0 表兔隻處於非常嚴重熱緊迫狀態 (Marai *et al.*, 2004)。

II. 母兔哺育性能測定

涼季及熱季期間分別選取 30 隻經產紐西蘭母兔 (胎次在 5 胎以上)，個別飼養於附有分娩箱之母兔籠，飼料及飲水採任食及任飲，飼料組成如表 1。試驗期間進行哺育性狀之測定，其項目包括：仔兔出生窩仔數、出生窩重、3 週齡窩仔數、3 週齡窩重、離乳 (4 週齡) 窩仔數、離乳窩重、離乳體重及育成率。

III. 離乳仔兔生長性能測定

經產紐西蘭母兔分娩之仔兔，在離乳後以窩爲單位飼養於肉兔籠，飼料及飲水採任食及任飲，以進行 4 週生長性能測定。試驗期間每週測定飼料採食量、體重及存活數，並計算日增重、飼料轉換率及育成率。

IV. 統計分析

試驗資料利用 SAS (2002) 統計套裝軟體之一般線性模式進行變方分析，並以 Ducan's Multiple Range Test 比較處理間差異之顯著性。

結果與討論

I. 試驗期間溫濕度及 THI 之變化

試驗期間涼季及熱季之兔舍溫度、濕度及 THI 之變化如圖 1，而涼季與熱季兔舍內之平均溫濕度及 THI 列於表 2。涼季之平均兔舍內溫度爲 21.0℃ (14.0 – 31.3℃)，平均相對濕度爲 74.1% (47.5 – 93.0%)，平均 THI 爲 20.4 (14.0 – 28.7)。熱季之平均兔舍內溫度爲 28.2℃ (21.3 – 36.0℃)，平均相對濕度爲 83.9 (44.0 – 100%)，平均 THI 爲 27.4 (20.9 – 33.2)。在圖 1 中，涼、熱季之兔舍內溫度均於上午 6 點逐漸升高，分別在中午 12 及 14 時達最高；而相對濕度則是於日出後逐漸地降低，至中午 12 點達最低，其後並逐步升高，至清晨 4 點爲最高。THI 隨溫濕度之提高而增加，其中溫度爲主要影響因子，相對濕度次之。在相同溫度時，較低的相對濕度具較低的 THI (圖 1)，亦即降低相對濕度可減緩熱緊迫程度。爲進一步探討兔隻於試驗期間，承受不同熱緊迫程度之時間，依照 Marai *et al.* (2004) 對不同熱緊迫程度之定義，分析如表 3，其中在涼季全期僅 0.2% 時間處於輕微熱緊迫，其餘時間均無熱緊迫，而熱季有 16.0% 時間處於非常嚴重熱緊迫，11.0% 時間處於嚴重熱緊迫，11.8% 時間處於輕微熱緊迫，亦即在熱季全期有 38.8% 時間處於不同程度之熱緊迫情況。由圖 1 可知，上午 10 時至下午 4 時，爲溫度較高之期間，而此時相對濕度則處於相對較低，但也是一天當中 THI 值最高的時段，此期間若使用水簾降溫，將可發揮較大之降溫功效 (吳，2008)，此可能是此階段舒緩兔隻之熱緊迫之較佳措施；惟在夜間

相對濕度提高，大幅降低水簾之降溫效果，而入夜後環境溫度降低，平均 THI 值亦在 27.8 以下，建議採自然通風，此也可減少能源之耗費。

表 1.　試驗飼糧組成

Table 1.　The composition of experimental diets

Ingredients	%
Yellow Corn	18.05
Soybean meal, CP 44%	17.0
Wheat bran	12.0
Alfalfa meal	46.0
Soybean oil	2.0
Molasses	3.0
Dicalcium phosphate	1
Salt	0.5
DL- Methionine	0.15
Vitamin premix[1]	0.2
Mineral premix[2]	0.1
Total	100
Analyzed value	
Moisture,%	11.7
GE, kcal/kg	3,965
ADF,%	14.8
NDF,%	23.8
Crude protein,%	18.9
Crude fiber,%	11.6
Ether extract,%	4.2
Calcium,%	1.2

[1] Mineral premix composition(g/kg): Fe, 80; Cu, 15; Mn, 80; Zn, 50; I, 0.85; Co, 0.25.

[2] Vitamin premix provided per kilogram of diet as follows: Vitamin A, 12,000 IU; Vitamin D_3, 3,125 IU; Vitamin E, 37.5 IU; Vitamin K_3, 1.5 g; Vitamin B_1, 1 g; Vitamin B_2, 4.8 g; Vitamin B_6, 3 g; Vitamin B_{12}, 0.01 g; Niacin, 25 g; Pantothenic acid, 10 g; Folic acid, 0.5 g; Biotin, 0.2 g.

表 2. 涼季與熱季兔舍內平均溫濕度及平均 THI

Table 2. Average temperature, relative humidity and THI of rabbitry in cool season and hot season

Items	Average temperature	Average RH	Average THI
Cool season（1/9-3/23）	21.0℃	74.1%	20.4
Hot season（5/9-7/31）	28.2℃	83.9%	27.4

THI = db℃ – [(0.31 – 0.31 RH) (db℃ – 14.4)], db℃ = dry bulb temperature in Celsius and RH = relative humidity percentage/100

表 3. 涼季與熱季兔舍內 THI 分佈

Table 3. THI distribution of rabbitry in cool season and hot season

Items	Very severe heat stress THI > 30	Severe heat stress 28.9 < THI < 30.0	Moderate heat stress 27.8 < THI < 28.9	Absence of heat stress THI < 27.8
Cool season (1/9 – 3/23)	0%	0%	0.2%	99.8%
Hot season (5/9 – 7/31)	16.0%	11.0%	11.8%	61.2%

THI = db℃ – [(0.31 – 0.31 RH) (db℃ – 14.4)], db℃ = dry bulb temperature in Celsius and RH = relative humidity percentage/100.

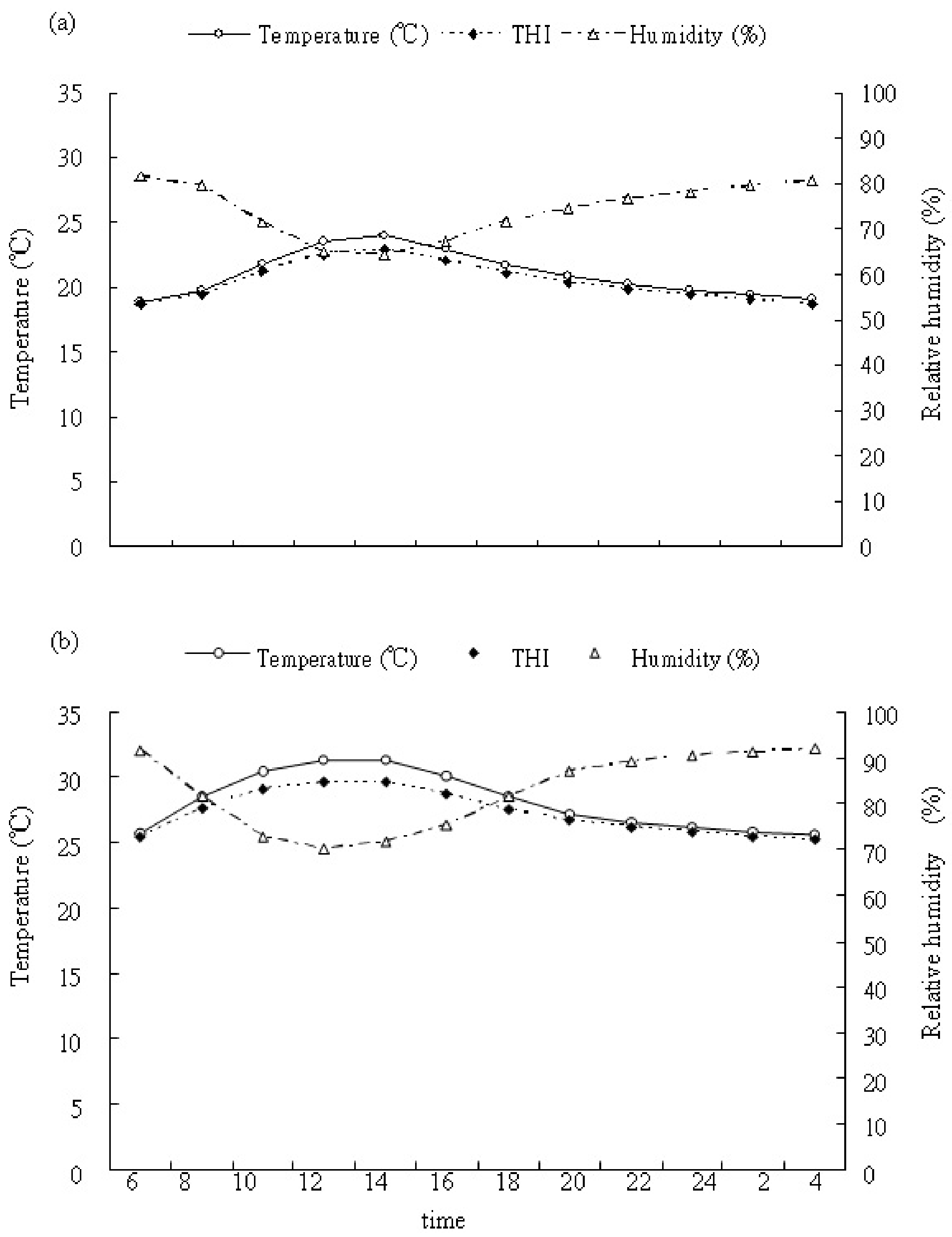

圖 1. 兔舍溫度、濕度及 THI 之變化 (a) 涼季。(b) 熱季。

Fig. 1. Temperature, relative humidity scale and THI of rabbitry in (a) cool season. (b) hot season.

II. 母兔之哺育性能測定

試驗期間母兔之哺育性能，如表 4。在涼季與熱季出生之平均窩仔數 (7.3 ± 2.4 *vs.* 7.1 ± 2.7、3 週齡平均窩仔數 (7.1 ± 2.4 *vs.* 6.4 ± 2.2)、平均離乳之窩仔數 (6.8 ± 2.3 *vs.* 6.4 ± 2.3) 及育成率 (94.1 ± 10.4% *vs.* 91.0 ± 12.7%) 間，均無顯著差異。惟涼季之出生窩重 (476 ± 126 g *vs.* 399 ± 120 g)、3 週齡平均窩重 (2,385 ± 572 g *vs.* 1,748 ± 416 g)、平均離乳窩重 (5,103 ± 1,270 g *vs.* 4,279 ± 1,090 g)、平均出生體重 (68.1 ± 13.5 g *vs.* 58.6 ± 11.3 g) 及 3 週齡平均體重 (360 ± 98 g *vs.* 294 ± 91 g) 均顯著高於熱季者 ($P < 0.05$)，此結果與 Marai *et al.*, (2006) 之報告相似，顯示夏季熱緊迫會因降低母兔之採食量，而影響其哺育能力，導致哺育期間之窩重與仔兔平均體重降低，但兔隻離乳時之個別體重 (792 ± 199 g *vs.* 714 ± 162 g) 在兩季間並無顯著差異，其原因可能在離乳前仔兔藉由自行採食，以彌補母兔哺育能力之不足。Pascual *et al.* (2000) 指出，飼糧中添加脂肪，可提高母兔攝取熱量，且添加的脂肪，可用於乳汁及乳脂合成，以提高母兔產乳量及哺育能力，使仔兔在離乳時可獲得較高的體增重，本試驗中使用之飼糧含 2% 大豆油，此亦可能提高母兔哺育能力導致兩季離乳兔體重無顯著差異。

表 4. 涼季與熱季母兔哺育性能
Table 4. Suckling performance of does in cool season and hot season

Items	Cool season (1/9 – 3/23)	Hot season (5/9 – 7/31)
Average litter size at birth, g	7.30 ± 2.4*	7.10 ± 2.7
Average litter size at 3-week-old, g	7.10 ± 2.4	6.40 ± 2.2
Average litter size at weaning, n	6.80 ± 2.3	6.40 ± 2.3
Survival rate, %	94.1 ± 10.4	91.0 ± 12.7
Average litter weight at birth, g	476 ± 126[a]	399 ± 120[b]
Average litter weight at 3-week-old, g	2,385 ± 572[a]	1,748 ± 416[b]
Average litter weight at weaning, g	5,103 ± 1,270[a]	4,279 ± 1,090[b]
Average body weight at birth, g	68.1 ± 13.5	58.6 ± 11.3[b]
Average body weight at 3-week-old, g	360 ± 98[a]	294 ± 91[b]
Body weight at weaning, g	792 ± 199	715 ± 162

* Mean ± SD.
a, b Means within the same row without the same superscripts are significantly different ($P < 0.05$).

III. 離乳仔兔之生長性能測定

試驗期間生長兔使用之完全飼料與母兔料相同。離乳仔兔之生長測定結果，如表 5。測定開始時之窩仔數在兩季間無顯著差異，而試驗期間在兩季各週之平均窩仔數及全期育成率亦無顯著差異。在試驗開始時，兩季離乳仔兔之體重無顯著差異 (792 ± 199 g *vs.* 715 ± 162 g)，而涼季生長兔在 5 週齡與 6 週齡時之平均體重顯著高於熱季 ($P < 0.05$)，但在 7 週齡與 8 週齡時則無顯著差異。Marai *et al.* (1999) 以玉米、大豆粕、苜蓿爲基礎飼糧，調製粗蛋白質 16.3%、粗纖維 13.2% 之飼糧，並再添加 10% 棕櫚油以提高能量進行生長試驗；試驗結果顯示，5 週齡仔兔飼養至 8 週齡時，涼季、熱季及熱季添加 10% 棕櫚油對仔兔之體重並無顯著影響，但飼養至 12 週齡時則以涼季之仔兔體重顯著高於熱季 (1998 ± 44.8 g *vs.* 1716 ± 66.8 g *vs.* 1812 ± 81.8 g)。在本試驗中生長兔於試驗期間，涼季各週之平均採食量均顯著高於熱季 ($P < 0.05$)，但各週平均日增重及全期平均日增重 (29.4 g *vs.* 27.7 g) 則無顯著差異。Marai *et al.* (1999) 之試驗結果，以涼季之平均日增重優於熱季，5 至 8 週之平均日增重在涼季爲 23.21 g，熱季則爲 18.44 g，而熱季添加 10% 棕櫚油後則可提高平均日增重至 23.96 g。Marai *et al.* (1999) 之試驗中，生長兔於 5 週齡至 12 週齡之全期飼料轉換率分別爲 4.005 (涼季) 、4.951 (熱季) 與 3.055 (熱季添加 10% 棕櫚油)，其中添加 10% 棕櫚油，雖然降低採食量 (95.2 *vs.* 64.0g)，但可顯著改善飼料轉換率。在本試驗中，熱季之採食量亦顯著低於涼季，5 – 8 週涼季與熱季平均飼料轉換率分別爲 4.42 與 3.12，

參照 Marai *et al.* (1999) 添加 10% 棕櫚油組之結果，推測本試驗中飼糧添加 2% 之大豆油可能與 Marai *et al.* (1999) 所述添加 10% 棕櫚油具有改善兔隻熱季飼料轉換率之效果。

表 5. 涼季與熱季離乳仔兔生長性能

Table 5. Growth performance of weaning rabbits reared in cool season and hot season

Items	Cool season（1/9 – 3/23）	Hot season（5/9 – 7/31）
Litter size, n		
weaning	6.8 ± 2.3*	6.4 ± 2.3
5-week-old	6.8 ± 2.3	6.4 ± 2.3
6-week-old	6.7 ± 2.3	6.3 ± 2.3
7-week-old	6.6 ± 2.3	6.3 ± 2.3
8-week-old	6.3 ± 2.3	6.2 ± 2.3
Survival rate	92.9 ± 13.7	97.1 ± 8.1
Body weight, g		
weaning	792 ± 199	715 ± 162
5-week-old	1,078 ± 226^a	953 ± 157^b
6-week-old	1,312 ± 265^a	1,158 ± 188^b
7-week-old	1,426 ± 302	1,342 ± 213
8-week-old	1,616 ± 345	1,491 ± 207
Feed intake, g		
5-week-old	92.6 ± 23.0^a	67.4 ± 13.6^b
6-week-old	115.0 ± 22.3^a	86.1 ± 26.6^b
7-week-old	126.0 ± 42.3^a	95.9 ± 27.5^b
8-week-old	135.3 ± 35.1^a	90.9 ± 67.0^b
Average daily gain, g		
5-week-old	40.9 ± 11.2	34.2 ± 8.2
6-week-old	33.4 ± 12.9	29.3 ± 8.0
7-week-old	16.3 ± 22.5	26.3 ± 7.2
8-week-old	27.0 ± 15.2	21.3 ± 7.3
5 to 8 week-old	29.4 ± 9.0	27.7 ± 4.1
Feed conversion rate (Gain / Feed) in the whole period	4.42 ± 2.03^a	3.12 ± 0.74^b

* Mean ± SD.

a, b Means within the same row without the same superscripts are significantly different ($P < 0.05$).

結　　論

臺灣夏季高溫高濕，由 THI 之公式與數值計算可知，高 THI 條件下確實會加重兔隻之熱緊迫。實驗結果亦顯示，兔隻在涼季僅 0.2% 時間處於輕微熱緊迫 (27.8 < THI < 28.9)，而其餘時間均無熱緊迫發生 (THI < 27.8)。在熱季有 38.8% 時間處於不同程度之熱緊迫情況。涼季兔隻之出生窩重、3 週齡平均窩重、離乳平均窩重、出生平均體重及 3 週齡平均體重皆顯著高於熱季。雖然兔隻在離乳時之個別體重在兩季間並無顯著差異，但涼季生長兔在 5 週齡與 6 週齡時之平均體重均顯著高於熱季。顯示夏季熱緊迫將顯著降低哺育兔及離乳仔兔之生長性能。

參考文獻

李茂盛、李世昌、張秀鑾、吳明哲。1999。紐西蘭白兔分娩月份和窩仔數對哺乳仔兔體重之影響。中畜會誌 28 (2)：195–202。

吳明哲、黃瓊姿、李世昌、張秀鑾。1998。紐西蘭白兔產仔性能與其在夏季之低落現象。中畜會誌 27 (3)：395–408。

吳錫勳。2008。水簾畜舍應用於兔隻生產評估。畜產專訊 65：13–14。

Ayyat, M. S. and I. F. M. Marai. 1997. Effects of heat stress on growth, carcass traits and blood components of New Zealand White rabbits fed various dietary energy-fibre levels, under Egyptian conditions. J. Arid Environments 37: 557–568.

Marai, I. F. M. and A. A. M. Habeeb. 1994. Thermoregulation in rabbits. Opt. Med. 8: 33–41.

Marai, I. F. M., M. S. Ayyat, H. A. Gabr and U. M. Abdel-Monem. 1999. Growth performance, some blood metabolites and carcass traits of New Zealand White broiler male rabbits as affected by heat stress and its amelioration under Egyptian conditions. The 2nd International Conference on Rabbit Production in Hot Climates, Adana, Turkey. Cahiers Options Mediterraneennes 41: 35–42.

Marai, I. F. M., A. A. M. Habeeb and H. E. Gad. 2002. Rabbit's productive, reproductive and physiological traits as affected by heat stress: A review. Livestock Prod. Sci. 78: 71–90.

Marai, I. F. M., A. A. M. Habeeb and H. E. Gad. 2004. Growth performance traits and the physiological background of young doe rabbits as affected by climatic conditions and lighting regime, under sub-tropical conditions of Egypt. The 8th World Rabbit Congress, Pueblo City, Mexico.

Marai, I. F. M., A. A. Askar and L. B. Bahgat. 2006. Tolerance of New Zealand White and Californian doe rabbits at first parity to the sub-tropical environment of Egypt. Livest. Sci. 104: 165–172.

Pascual, J. J., C. Cervera and J. Fernandez-Carmona. 2000. The effect of dietary fat on the performance and body composition of rabbits in their second lactation. Anim. Feed Sci. Technol. 86: 191–203.

SAS. 2002. SAS procedure guide for personal computers. Version 6th Ed. SAS Institute Inc. Cary, NC. U.S.A.

Effects of temperature humidity index on nursing performance of breeding does and growth performance of growing rabbits(1)

Ming-Yang Tsai (2) Wei-Ling Kho (2) Chao-Hsien Hsieh (2) and Hsi-Hsun Wu (3) (4)

Received: Feb. 21, 2013; Accepted: Jul. 30, 2013

Abstracts

The purpose of the study was to investigate the effect of temperature humidity index (THI) on the suckling performance of breeding does and growth performance of growing rabbits. The trials were conducted in cool season (January to March) and hot season (May to July), in the rabbit farm of Livestock Research Institute. Thirty New Zealand White (NZW) does were selected respectively, reproduction performance were recorded, including litter size (LS), litter weight (LW) , the body weight (BW) at birth, 3-wk-old and weaning (4-wk-old) and survival rate. Growth performance trial was started after weaning. Feed intake (FI), BW and numbers alive were recorded every week until eight-week old. Average daily gain (ADG), feed conversion rate (FCR), and survival rate were calculated. Temperature and relative humidity (RH) in the house were recorded every two hours and transformed to temperature–humidity index (THI) . Degrees of heat stress for the rabbit were evaluated based on THI. The results showed that only 0.2% of duration in cool season rabbits were suffered from moderate heat stress ($27.8 < THI < 28.9$) . No heat stress ($THI < 27.8$) occurred in the other period. In hot season, 16.0% of duration rabbits were under very severe heat stress ($THI > 30$) , 11.0% of duration rabbits were under severe heat stress ($28.9 < THI < 30.0$) , 11.8% of duration rabbits were suffered from moderate heat stress ($27.8 < THI < 28.9$) . It showed that 38.8% of duration in the hot season rabbits were suffered from different degrees of heat stress. Average LW and BW at birth, 3-week old and weaning of cool season were higher than those of hot season ($P < 0.05$) . The individual BW at weaning were no significant difference between the two seasons. BW of growing rabbits in cool season at 5-week old and 6-week old were significant ($P < 0.05$) higher than those of hot season. But no significant difference were found between two seasons at 7-week old and 8-week old. Weekly average FI and FCR in the whole period of cool season were significant ($P < 0.05$) higher than those of hot season. Weekly ADG and ADG in the whole period were no significant difference. In conclusion, heat stress in hot season significantly reduced nursing performance of breeding does and growth performance of their pulps.

Key words: Rabbit, Temperature-humidity index, Reproduction performance, Growth performance.

(1) Contribution No.1917 from Livestock Research Institute, Council of Agriculture, Executive Yuan.
(2) Animal Industry Division, COA-LRI, Hsinhua, Tainan 71246, Taiwan, R.O.C.
(3) Deparment of Animal Science, National Pingtung Science and Techology University, Pingtung 91201, Taiwan, R.O.C.
(4) Corresponding author, E-mail: hhwu@mail.npust.edu.tw.