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Assessment of Rabbit Does' Growth under Different Building Conditions

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors designed the study, author WAL performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript and managed literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

The purpose of this research was to investigate does weights' performances during and at post-gestation periods at different building systems. Factors considered in the study were building orientations, BO, (45º and 90º to prevailing wind directions), ventilation openings, VO, (20, 40, 60 and 80% side openings) and different seasons of a year (dry and rainy seasons). The experimental set up was a 2 × 4 factorial design with a doe each in a pen (n=32). The control experiment building had 100% side opening with four does (n=4), each in a pen. Temperature-Humidity Index (THI) values, effectiveness of openings and airflow rates were computed in different pens. The weights' gains and losses were evaluated for does during and during post-gestation at different seasons and parities. The results showed that each of the pair of openings in an orientation was dissimilar to the other one in the other orientation in the same season (26.87±0.36, 27.09±0.43 respectively in dry and rainy seasons for 20% in first week). There were different airflow rates in different pens (3.975±0.03, 3.098±0.36 m^3/s for 90º orientation; 2.671±0.01 and 2.595±0.14 m^3/s respectively for 60 and 80% at 90º orientation) as a result of different openings' effectiveness. Weight gains in does during and at post-gestation at different ventilation openings and orientations were affected by

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seasons. Ventilation opening 80% at 90º orientation had average of 0.061 kg/day weight increase per doe with lesser weight profile fluctuations and could be adjudged the best combination to rearing does.

Keywords: Airflow; gestation; THI- temperature-humidity index; openings; orientations.

1. INTRODUCTION

Like other animals, rabbit requires thermo-comfort environment [1]. Such an environment may be provided through a choice via design and management of their housing systems. The building configuration can effectively be designed to produce suitable condition to positively affect the animal and thus give higher and better carcass yield to the farmer [2], through ample spaces for the doe, the litter to be produced and their feeding and drinking troughs. The building parameters like building shape, amount of openings and type of building's orientation, are needed for effective livestock production [3].

Growth is the total sum of the size increment of the component parts of the carcass. Some of the parameters used in the growth analysis of the animals are; the live weight in kg at the initial stage, periodic (may be three or four days interval or weekly) weight gain in kg and the cumulative weight in kg. Growth rate and patterns are affected by factors like breed, sex and age [4,2], they are also affected by type of management (housing methods and handling), seasons, psychological stage and type of modifying elements in the modification strategy. The above factors, excluding the management / housing systems are natural and cannot be altered; therefore housing methods / handling could be researched into for studying rabbits' growth pattern for more productivity for local farmers. Thus, the objective of the research was to investigate the growths in the rabbit does during and at post-gestation periods through different building ventilations brought about by different housing conditions.

2. MATERIALS AND METHODS

The research was carried out at the rabbitry section of the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife in the rain forest zone of Nigeria on latitude 07º 28' N and longitude 05º 33' E. Four adjoining identical buildings with dimensions 1.2 m × 4.8 m × 1.2 m (width × length × height, respectively) were constructed. The dimensions were selected based on an earlier experiment [5] where above same dimensions except that length= 9.6 m was used. Each building with eight pens was constructed with consideration of the orientation tested; floor area per pen was 1.2 m x 0.6 m and 30º roof slope, Figs. 1 and 2. Wood, wire mesh were used in the buildings, galvanised steel gauze as flooring and also iron roofing sheets. It had opening on long sides of the building at inlet, windward side and the outlet, leeward side. The existing buildings for rabbitry on the same farm are sheds with individual rabbit inside a pen of dimensions between the range 0.76-1.00 m; 0.54-0.80 m and 0.54- 0.80 m for length, breadth and height respectively. These pens were seemingly clustered with their feeding and water troughs, especially when a doe gave birth to more than two litters. The building sites used for this research were all at the same area of 15 m circumferentially.

Three factors were considered in the study; season of the year at two levels of dry and rainy seasons: building orientations (BO) at two levels of 45º and 90º to the directions of the prevailing wind and ventilation openings (VO) at four levels of 20%, 40%, 60% and 80% side openings at the windward side. The directions of the prevailing wind on daily basis were obtained from meteorological station on the farm, 250 m away. This is within the acceptable range of circumferential 2,500 m a meteorological station may still be effective; the data are shown in Table 1.

The percent openings were got from product of total height 1.2 m and N as numerator and 5 as denominator, (5 is got from increments, there are 100% and the increment is 20%); where N = 1 for 20% opening---- N = 4 for 80% opening and N = 5 for 100% opening. The BO and VO factors were considered in different seasons of a year. The experimental set up was a 2 x 4 factorial design. Thirty two (n= 32) does of the same age bracket of 1.52±0.04 kg were individually housed in each pen. Each treatment was replicated four times.

An existing building housing rabbits at the Teaching and Research Farms of the University was used as control experiment with 100%

opening, it was completely opened from all sides (had only 90º orientation) measuring 22 m x 10 m (length x width) was used as control. It has four long rows stretched (two adjoined and separated from other by walkway) over the span of 18 m with 25 pens, each with dimensions 0.54 m x 0.76 m and height 0.54 m. All were built with galvanized steel for their droppings to fall underneath. To have the same environmental conditions for the buildings, the control building was at the same place within 15m circumferentially, Fig. 3.

Thirty-two (32) bucks own by the University, for servicing each of these does, were kept in the control building, each in different pens. They were introduced to the does as appropriate at the same time. The does were mated to produce litters at two parities consecutively per season. At age 5 months, they were stocked and were allowed to integrate with their new homes for one month before mating at 1.57±20.4 kg average weight. There were no pure breeds of rabbits, non standard breed or heterogeneous genotypes of rabbits were used. That is, there were possibilities that a rabbit may have genes of New Zealand White or Californian white or Chinchilla or any other genotypes. They had good health and had not yet parturate as ascertained by the veterinary doctor before the commencement of the experiment.

All the does were given the same treatments in terms of feeding and water throughout the period of the experiment. The concentrate feed was made by Guinea Feeds Nig. Ltd usually formulated/prepared for adult rabbits while same roughages were carefully weighed out equally for each of the rabbits once a day to supplement concentrates. Temperatures and relative humidities inside the pens of rabbits were measured twice per day in 10.00 hr and 14.00 hr. Triple Beam Balance MB with a capacity of 2610 $\pm$ 0.1 g was used to measure the weekly weight gain or loss of does.

Gestating rabbit does were weighed twice a week with a lot of care, each in a specially made basket of pre-weighed value and the difference was for a doe weighed. The same was done thoroughly for does throughout the research. Litters were weaned at 5-6 weeks after parturition for each of the parity. The growth parameter measured for determining growth performances in gestating and breastfeeding does were weights during both periods twice a week.

2.1 Measurement of Environmental Parameters

Temperature, humidity and wind speed values of the external air were obtained from meteorological station situated 250 m to the experimental site. The conditions of the internal air in the pens were measured: inside air velocity, temperature and relative humidity of the buildings were measured (daily) using anemometer, (microprocessor, model number AM-4812) and digital thermometer, (model SW-1189), made by Uniscope Nig Ltd and marketed by Jamot and Co, Osogbo, Nigeria and hygrometer of model M50.60101, No. 023460, made in France. The results were substituted in Equation 1.3 to estimate THI values, their mean values are shown in Tables 4-6 showing THI values at different orientations and openings.

Fig. 1. Back view of the 45º orientation building with eight pens showing leeward 20% opening ventilation

Fig. 2. One of the each of 45º and 90º orientation buildings, each with eight pens

Fig. 3. Existing rabbit pen on the farm showing 2 does in their pens

The ventilation Q values expressed as quantity of the resultant air inflow from the prevailing wind into each constructed pen were estimated using approximate results based on empirical data as given by [6,7] and written as

$$Q = E\,Av \tag{1.1}$$

where

Q = wind or airflow rate, m^3/s,

A = area of inlet opening; m^2 (the outlet openings are assumed to be equal in area)

v = wind or air velocity; m/s and

E = opening effectiveness, dimensionless

E may vary from 0.50 - 0.60 for perpendicular wind and 0.25 – 0.35 for diagonal wind; [8,9,10,5].

E values on the building were calculated according to the equation given by [11]:

$$E = 16.33\left[\frac{0.21\rho v}{\mu}\right]^{-0.3515} \times \mathrm{Sin}(\phi)^{1.201} \times \left(\frac{4z}{l}\right)^{-0.1213} \times (\mathrm{Sin}\ \theta)^{-0.1531} \quad (1.2)$$

where

- ρ = air density / (kg/m^3) = 1.65 kg/m^3 at 30ºC
- v = air velocity, m/s
- μ = absolute air viscosity Ns/m^2 = 0.0000248 Ns/m^2 at 30ºC
- ϕ = wind flow angle of incidence, degrees
- z / l = ratio of opening height to opening length, dimensionless
- θ = roof slope, (=30 degrees in the research building)

THI was estimated for the stocked pen using equation further developed and improved upon by [12] for humid tropical regions to become

$$\mathrm{THI} = db^{o}C - \{[0.31 - 0.31\left[\frac{RH}{100}\right]](db^{o}C - 14.4)\} \quad (1.3)$$

where db^{o}C = dry bulb temperature, ºC and RH = relative humidity, %

Daily THI, airflow rate, V, m^3/s and opening's effectiveness, E, dimensionless, were calculated based on morning and afternoon average values, their weekly values were estimated based on daily averages for the whole week, Tables 4-6.

The data collected were subjected to two-way analysis of variance (ANOVA) to determine the effects of orientations (Or) and openings (Op) on both the internal and external environmental parameters (temperature, relative humidity, THI_{in}, THI_{out} and ventilation rate) of the rabbits' pens. The data were also used to determine the effects of orientations (Or) and openings (Op) on the reproductive parameters in the does. Where significance was indicated, Duncan Multiple Range Test was used to establish the differences among the treatments. The relationships between parameters were determined by regression analysis. All statistical analyses were performed using the Statistical Analysis System [13] software. Descriptive statistics was used in THI and weights' profiles of does during and at post-gestation periods in graphical forms. Duncan multiple range tests were used to separate the means [13].

3. RESULTS AND DISCUSSION

3.1 THI under Different Building Conditions

In both the dry and rainy seasons, building orientation and ventilation opening and their interactions have no significant effect (P = 0.1085, 0.6652, dry season and P = 0.9477, 0.9082, rain season) on THI inside the pen. The building orientation and ventilation openings were statistically different from each other according to their classifications in both seasons (Tables 2 and 3). In the dry season, the mean values showed that 90º building orientation had the lowest THI recorded. Building openings 20% and 60% have lowest THI_{in} mean values respectively of 26.07±0.11 and 26.96±0.14 recorded. The R^2 values were higher (0.93, 0.92) thereby establishing stronger correlations between the THI which is could be an indicator of heat stress possibility in the animals and could have been caused by the interactions between the building openings and orientations. The animals could result in loss of weights, thus the eventual fluctuating weight profile in Figs. 4 and 5.

At 45º orientation, the lowest weekly mean value of THI [using equation (1.3)] in the dry season was 23.90±0.07 and was found at 60% opening in the rainy season. The highest weekly mean value was 27.42±0.17 for 20% opening; this could be high for thermo-comfortability in rabbits [1].

When lowest and highest values of THI were compared in rainy season, their weekly mean values were 23.9±0.07 (lowest) for 60% opening and 27.41±0.17 (highest) for 20% opening, the higher opening (60%) with lesser THI values could indicate lesser heat loads on rabbits in that pen. During rainy season, at 90^{o} orientation, the lowest weekly mean values of THI were 24.07±0.18 and 24.12±0.24 were respectively found at 40 and 60% openings, they also could signify lesser heat loads on the rabbits in their respective pens. There were lower THI mean values in 80% and 100% pens; this could be surmised to be because of the high ventilation due to increased size openings. The lower THI mean values in 90º orientation than 45º revealed the fact that the rainy season had some influence on the low THI values when compare to dry season values. Besides, presence of rabbits in the pens could have added to the level of warmth as a result of their breathing, level of CO_2 and other gases emitted from their waste. Added to this was the direction of the building to the prevailing wind direction which could be responsible for the temperature inside 90° orientation to be less than in the 45° orientation. The higher ventilation rates (Tables 4-6) in the 90° orientation than 45° on daily and weekly bases at both seasons testifies to the fact that the entering wind speed to the pens were affected by building openings and orientations.

The average THI value of 24.12±0.242 that was observed for 80% opening at rainy season in the 4th week, this could be surmised to have resulted from the expanse of the opening and in-coming wind at normal direction to the pen.

3.2 Effectiveness of Openings, E and Ventilation Rates, V under Different Building Conditions

The E values that resulted in different airflow rates were higher because of the building dimensions, the more the VO and wind speed and prevailing direction, the more the results got from opening effectiveness, E. This shows that building at 90° to wind direction at higher opening of 60 and 80% have higher airflow rate compare to higher opening at 45° orientation, [14,15]. The different airflow rate in the pens was as a result of the different magnitudes of the openings' effectiveness (Tables 4-6). This could be surmised to be because of the changes in the magnitude and direction of the wind which could have allowed a slight decrease in the temperature inside the building [11]. It could also be because of some physiological responses of the rabbits inside the pens. The extent of the airflow into and out of the pens (V values in Tables 4-6) could have affected rabbits' metabolic activities. It could also be because of the prevailing wind that changes the ambient temperatures and relative humidities in the pens as a result of different ventilation openings and their effectiveness on the building.

The magnitudes of V and E values on daily or weekly basis kept changing, sometimes the higher value is the weekly and in other occasions the daily, this was because of the different wind speeds, different prevailing wind directions and the building orientations. The 90° orientation had higher values for V, (3.975±0.032, 3.098±0.020, 2.568±0.223 m^3/s, Tables 4, 6) than the 45^0 orientation (1.267±0.123, 0.597±0.123 m^3/s);

Table 1. Wind speed, temperature at certain days measured meteorologically during different seasons

Months	Wind speed, knot			Temperature,°C				Humidity, mm	
	Average	Height, 1.5 m	Dominating direction	Mean Max.	Mean Min.	Mean	Departure from normal	Max. obs. day	Min. obs. day
1st	2.1	16.9	SW	33.9	10.8	22.3	0.0	68.1	48.6
2nd	2.4	17.8	SW	30	10	20	57.8	30.1	20
3rd	2.8	18.3	SW	28.7	16.2	22.5	68.1	17.6	-
4th	2.7	15.7	NE	33.9	18.5	25.2	57.8	30.1	-
5th	2.8	16.5	SSW	34.2	19.7	26.0	0.0	0.2	-
6th	4.7	30.4	SW	35.5	22.7	27.9	0.0	12.8	-
7th	4.3	35.7	SSW	34.7	23.4	27.9	0.0	18.2	-
8th	5.3	42.6	SSW	34.2	23.1	27.7	0.0	78.8	40.3
9th	4.3	40	SW	31	22.6	26.2	0.0	44.6	33
10th	4.1	36.5	SW	30	22.1	25.2	0.0	64.8	32.4
11th	4.1	31.3	SW	30	20.9	-	0.0	-	-
12th	4.1	36.5	SW	31	20.9	-	0.0	-	-
13th	3.1	31.3	SW	29.1	20.9	23.8	0.0	67.8	33.4
14th	2.5	37.4	SW	27.8	21.1	24.2	0.0	38.0	18.0
15th	2.1	36.5	SW	31.7	21.1	25.1	0.0	16.0	-
16th	1.2	18.3	NE	33	17.3	24.3	0.0	0.4	-
17th	2.5	20.9	NE	32.9	16.5	23.9	0.0	0.0	-
18th	3.5	34.8	SW	33	21.6	26.2	0.0	46.8	38
19th	4.2	47.0	SW	33.2	22.9	26.8	0.0	25	-
20th	4.3	35.7	SW	32.2	22.3	26.4	0.0	30.0	-

Mean Max. – Mean Maximum; Mean Min.- Mean Minimum; Max .obs. day- Maximum observed day; Min. obs. day- Minimum observed day, Source: Meteorological Station at the Farm also, 60 and 80% openings at 90º orientation respectively had 2.671±0.011 and 2.595±0.142 m^3/s air flow rate into the pen resulting from different higher E values, Tables 5 and 7.

3.3 Effects of THI and Ventilation Rates on Does' Weights during and at Post Gestation Periods

There were correlations between THI and the weights of the does recorded in Figs. 4 (a, b) and 5 (a, b) with high R^2 = 0.78, 0.62, 0.58, 0.57, 0.58 values respectively for openings 100, 80, 60, 40 and 20% in both seasons. Tables 4-6 revealed the statistical differential relationships between different orientations and openings and between different opening effectiveness (E) and airflow rate (V) values calculated from measured data.

Pen opening at 80% and at 90º orientation to the wind with angle 60º roof top to the vertical gave the highest weight gains by doe (0.061 kg/day and lowest weight loss recorded of 0.022 kg/day, 100% had 0.063 kg/day and lowest loss of 0.016 kg/day). However, 80% opening had lesser weight's profile fluctuations during the gestation and lactating periods.

The weight gains were as a result of the development of foetus, nevertheless, there were fluctuations signifying weight losses, this could be attributed to the THI or other physiological or metabolic processes that resulted in either heat or cold stresses. These heat and cold stresses that could not have allowed the rabbits to stay at their thermo-comfort zone anymore than for them to stay at thermo-neutral zone [1]. Since these same age-bracket animals were fed in the same manner and experimented upon same way, and at the same season of rearing, some other factors in addition to the building conditions could have been responsible to have contributed to the fluctuating weight profiles noted, Figs. 4 a, b and 5 a, b.

Again, strong correlations between the THI and the weights of the does could be because the temperatures were high with low humidities in the afternoon, not only in the dry season but also in the rain which made the THI to be high, as high as 32.48 (Temperature = 35.5ºC; Humidity = 54.7%). And according to [16], when the THI is more than 30ºC in rabbits in the sub-tropical region of Egypt, heat prostration sets in, since rabbits would not be able to regulate their internal temperature and there would be weights losses. Such could be true of Nigeria, though tropical but with room temperature between 27 and 30ºC and may be up to 34ºC in dry season. This was shown by the non-uniform losses or gains in the weights of rabbits as shown by Figs. 4 a, b and 5 a, b at different orientations and openings.

Table 2. Daily and weekly mean values (±STDEV) for THI at different orientations in different seasons

Parameters	seasons	Orientations (º)	
		45º	90º
THI_{daily}	Dry	27.06^{ab}±0.10	26.93^{ac}±0.02
THI_{weekly}	Dry	28.00^{a}±0.02	27.80^{b}±0.04
THI_{daily}	Rainy	27.57^{ab}±0.09	27.45^{c}±0.06
THI_{weekly}	Rainy	28.50^{ab}±0.06	28.50^{ab}±0.04

Mean values with same superscript(s) (along the row for each parameter) are not statistically different at (P ≤ 0.05)

Table 3. Daily and weekly mean values (±STDEV) for THI at different openings in different seasons

Parameter	Season	Openings (%)				
		20	40	60	80	100
THI_{daily}	Dry	26.47^{abc}±0.12	27.00^{bc}±0.20	26.96^{c}±0.14	27.03^{b}±0.04	27.09^{a}±0.13
THI_{weekly}	Dry	26.07^{abc}±0.11	27.70^{ac}±0.03	27.80^{ac}±0.12	27.93^{ab}±0.11	27.07^{c}±0.10
R^2_{daily}	Dry	0.72	0.91	0.92	0.82	0.72
R^2_{weekly}	Dry	0.71	0.51	0.62	0.82	0.93
THI_{daily}	Rainy	27.48^{abc}±0.11	27.51^{ac}±0.10	27.51^{ac}±0.10	27.55^{b}±0.08	28.45^{a}±0.11
THI_{weekly}	Rainy	28.48^{ac}±0.10	28.47^{bc}±0.08	28.51^{b}±0.09	28.55^{a}±0.12	28.44^{abc}±0.10
R^2_{daily}	Rainy	0.70	0.72	0.92	0.78	0.76
R^2_{weekly}	Rainy	0.67	0.72	0.70	0.83	0.64

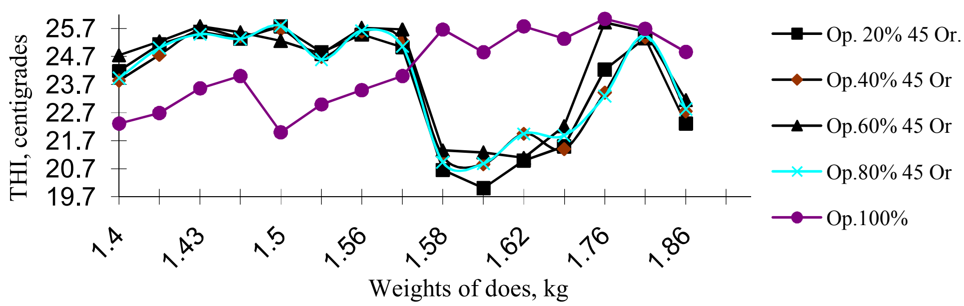
Mean values with same superscript(s) (along the row for each parameter) are not statistically different at (P ≤ 0.05)

Table 4. Daily and weekly mean values (±STDEV) for opening's effectiveness, E and airflow rate, V (m^3/s) at different seasons for different orientations during gestation

Parameters	Seasons	Orientations (º)	
		45º	90º
E_{daily}	Dry	0.504^{b}±0.022	0.548^{a}±0.001
E_{daily}	Rainy	0.425^{b}±0.49	0.653^{a}±0.412
V_{daily}	Rainy	0.366^{ac}±0.010	3.098^{a}±0.02
V_{daily}	Dry	0.354^{ab}±0.02	0.308^{b}±0.01
E_{weekly}	Dry	0.5^{b}±0.0001	0.543^{a}±0.02
E_{weekly}	Rainy	0.293^{ab}±0.205	0.0457^{c}±0.041
V_{weeky}	Dry	0.316^{a}±0.42	0.001^{d}±0.022
V_{weeky}	Rainy	0.597^{abc}±0.123	2.568^{b}±0.223

Mean values with same superscript(s) along the same row are not statistically different at (P ≤ 0.05)

a).



b).

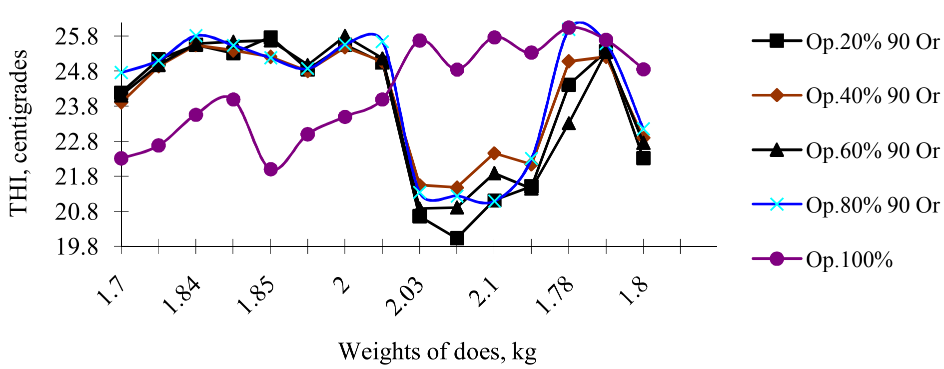


Fig. 4. THI values and weights of does during and at post-gestation periods in dry season (a) 45º orientation and (b) 90º orientation

Table 5. Daily and weekly mean values (±STDEV) for opening's effectiveness, E and airflow rate, V (m^3/s) at different seasons for different openings during gestation

Parameters	Seasons	Openings (%)				
		20	40	60	80	100
E_{daily}	Dry	0.48^{c}±0.012	0.403^{abc}±0.020	0.51^{bc}±0.000	0.515^{ab}±0.02	0.5^{ac}±0.006
E_{daily}	Rainy	0.0479^{ab}±0.004	0.082^{ac}±0.016	0.087^{c}±0.051	0.1436^{abc}±0.40	0.497^{ab}±0.489
V_{daily}	Rainy	0.466^{abc}± 0.002	0.271^{d} ±0.014	2.671^{ab}±0.011	2.258^{c}±0.201	2.057^{bc}±0.221
V_{daily}	Dry	0.0513^{abc}±0.003	0.094^{ac}±0.055	0.135^{c}± 0.786	0.1733^{bc}±0.101	0.39^{a}±0.2
E_{weekly}	Dry	0.427^{ac}±0.012	0.41^{abc}±0.022	0.456^{bc}±0.002	0.459^{c}±0.010	0.51^{ab}±0.001
E_{weekly}	Rainy	0.041^{bc}±0.007	0.09^{ac}±0.032	0.0146^{abc}±0.071	0.174^{b}±0.072	0.412^{a}±0.491
V_{weeky}	Dry	0.0228^{abc}±0.032	0.0814^{ac}±0.003	0.155^{b}±0.051	0.198^{ab}±0.063	0.0424^{c}±0.15
V_{weeky}	Rainy	0.766^{bac}±0.032	1.135^{bc}±0.320	2.211^{ac}±0.0202	2.856^{a}±0.213	2.519^{ab}±0.321

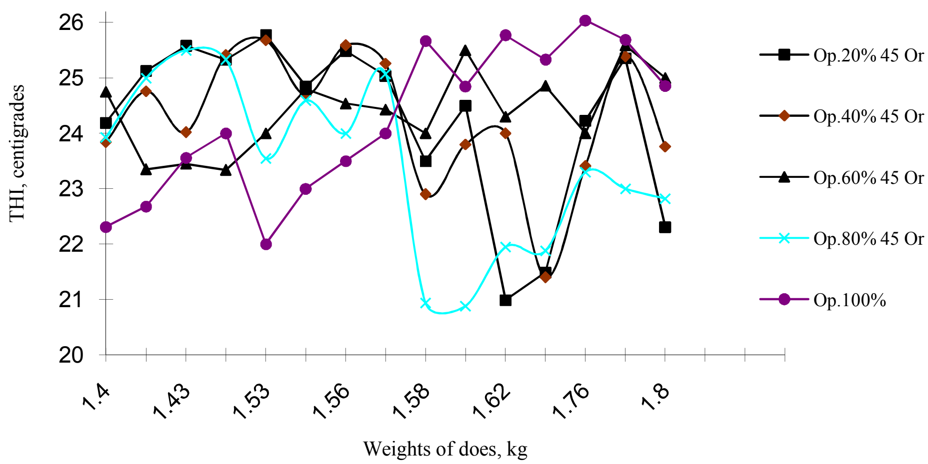
Mean values with same superscript(s) along the same row are not statistically different at (P ≤ 0.05)

Table 6. Daily and weekly mean values (±STDEV) for opening's effectiveness, E and airflow rate, V (m^3/s) at different seasons for different orientations at post gestation

Parameters	Seasons	Orientations (º)	
		45º	90º
E_{daily}	Dry	$0.468^{d}\pm0.01$	$0.51^{bcd}\pm0.101$
E_{daily}	Rainy	$0.412^{b}\pm0.049$	$0.174^{ab}\pm0.072$
V_{daily}	Dry	$0.544^{ab}\pm0.398$	$0.584^{a}\pm0.048$
V_{daily}	Rainy	$0.746^{b}\pm0.213$	$2.48^{a}\pm0.113$
E_{weekly}	Dry	$0.54^{ab}\pm0.1$	$0.592^{a}\pm0.121$
E_{weekly}	Rainy	$0.425^{a}\pm0.152$	$0.0228^{d}\pm0.032$
V_{weekly}	Dry	$0.256^{b}\pm0.003$	$0.104^{ac}\pm0.020$
V_{weekly}	Rainy	$1.267^{bc}\pm0.003$	$3.975^{a}\pm0.032$

Mean values with same superscript(s) along the same row are not statistically different at (P ≤ 0.05)

a).



b).

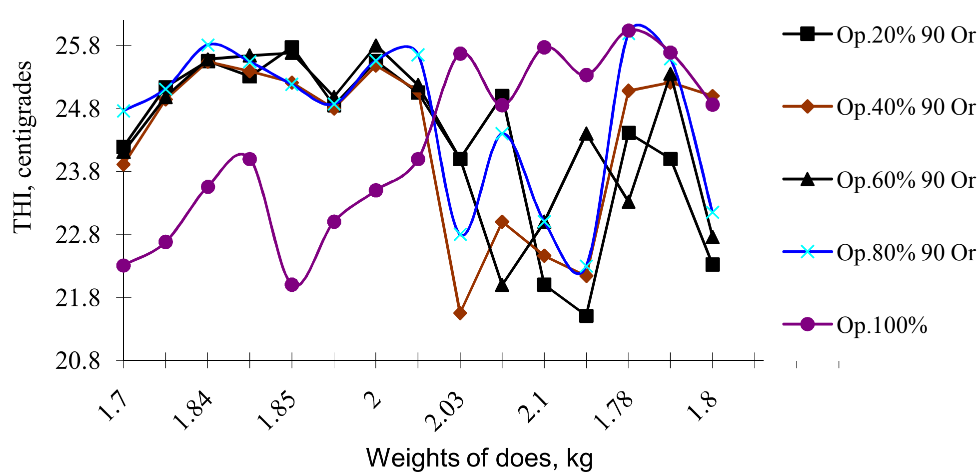


Fig. 5. THI values and weights of does during and at post-gestation periods in rainy season (a) 45º orientation and (b) 90º orientation

Table 7. Daily and weekly mean values (±STDEV) for opening's effectiveness, E and airflow rate, V (m^3/s) at different seasons for different openings at post gestation

Parameters	Seasons	Openings (%)				
		20	40	60	80	100
E_{daily}	Dry	0.482^{c}±0.031	0.531^{bc}±0.011	0.621^{b}±0.010	0.67^{ab}±0.011	0.676^{a}±0.021
E_{daily}	Rainy	0.049^{abc}±0.022	0.10^{ac}±0.052	0.174^{ab}± 0.119	0.205^{bc}±0.125	0.549^{a}±0.003
V_{daily}	Rainy	0.048^{abc}±0.028	0.088^{ac}±0.052	0.127^{c}± 0.074	0.163^{b}±0.095	0.39^{bc}±0.20
V_{daily}	Dry	1.898^{c}±0.121	2.266^{ac}±0.012	1.975^{bc}±0.011	2.188^{abc}±0.0123	2.230^{ab} ±0.031
E_{weekly}	Dry	0.471^{ac}±0.111	0.454^{c}±0.021	0.542^{ab}±0.111	0.55^{b}±0.0211	0.592^{a}±0.013
E_{weekly}	Rainy	0.045^{abc}±0.398	0.0447^{ac}±0.013	0.108^{b}± 0.012	0.114^{ab}±0.039	0.0424^{bcd}±0.015
V_{weeky}	Dry	0.034^{abc}±0.02	0.0965^{bc}±0.014	0.190^{c}± 0.089	0.2098^{ab}±0.065	0.5^{a}±0.006
V_{weeky}	Rainy	1.466^{abc}±0.027	2.131^{c}±0.220	2.424^{b}±0.141	2.595^{ab}±0.142	2.245^{ac}±0.115

Mean values with same superscript(s) along the same row are not statistically different at (P ≤ 0.05)

4. CONCLUSION

Seasons affect weight and weight gain in does at different ventilation openings and different orientations. Rabbits have increased weight gain at lesser heat load. Pen opening at 80% and at 90º orientation to the prevailing wind gave the highest weight gains by doe and lesser weight profile fluctuations during and at post-gestation periods.

ETHICAL APPROVAL

All authors hereby declare that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the Ethics Committee of the University.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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