Paper ISSN 0189-0514
Online ISSN 1427-4410
J. Anim. Prod. Res. (2022) 34(1):1-7

National Animal Production Research Institute
Ahmadu Bello University
P.M.B 1096, Shika-Zaria,
Kaduna State, Nigeria.
Email: japr@napri.gov.ng Url: journal.napri.gov.ng

INFLUENCE OF SEASON ON POSTPARTUM REPRODUCTIVE PERFORMANCE OF RABBIT DOES AND GROWTH RATE OF KITS IN A SUBHUMID ENVIRONMENT

[*1]Yahaya, H. K., [1]Dim, N. I., [2]Abubakar, B. Y. and [2]Iyeghe-Erakpotobor, G. T.
[1]Department of Animal Science, Ahmadu Bello University Zaria, Nigeria
[2]National Animal Production Research Institute Shika, Zaria, Nigeria
[*]Corresponding Author: hkyahaya@hotmail.co.uk

ABSRACT

Records on 258 kits obtained from 65 does consisting of twenty-two (22) New Zealand White (NZW), eighteen (18) Californian (CC) and twenty-five (25) Chinchilla (CH), were analyzed to evaluate seasonal influence on gestation length, litter size, litter birth weight, mean kit birth weight, number weaned, percent mortality at weaning and kit weights at 2, 4, 6 and 8 weeks postpartum. Thirty-two (32) sires consisting of 11NZW, 10 CC and 11 CH were used interchangeably to minimize inbreeding. Matings were carried out during the hot-dry (February-May) and cool-wet (June-September) seasons of the year. Results obtained revealed non-significant ($p>0.05$) influence of season on gestation length, litter size, litter birth weight, mean kit birth weight, number weaned and percent mortality at weaning. Season had significant ($p<0.05$) effect on number of kits that survived, total percent kit mortality ($p<0.05$), and kit body weight at 2, 4, 6 and 8 weeks ($p<0.001$) postpartum. More of the kits born during the cool-wet season survived compared to those born during the hot-dry season. Total kit mortality was higher in the hot-dry than cool-wet seasons. Rabbit kits born in the cool-wet season had significantly ($p<0.001$) higher weight at 2, 4, 6 and 8 weeks of age than in the hot-dry season. It was concluded that adult breeding rabbits and their kits were exposed to heat stress during the hot dry season which impaired their reproductive performance and kits growth. Breeding and selection of rabbits for heat tolerance and resistance would improve rabbit productivity in the tropics.

Keywords: Season, Rabbit does, Reproductive performance, Kits growth

INTRODUCTION

The genetic make-up of the animal, nutrition, temperature, photoperiod and stress are factors that interact to determine success of animal production and reproduction (Tsavkar *et al*., 2019). Season played significant role in relation to the reproduction of rabbit does even when the environmental conditions of the rabbitary were regulated (Tůma *et al*., 2010). Although heredity dictates the maximum amount of growth and development that is possible, nutrition along with other environmental factors govern the actual rate of growth and extent to which development was attained (Irshad *et al.*, 2012, Goska *et al.*, 2017). Growth involves increase in body size and mass, genetic and environmental factors regulate the set of metabolic events that regulated growth (Marai *et al*., 2002; Nwagu and Iyeghe-Erakpotobor, 2012). The body weight of an animal at birth affects its performance later in life especially as birth weight was an initial reference point that affects subsequent development of animals (Yakubu *et al*., 2014). Efficiency of digestible energy (DE) utilization for growth was significantly high for weaners than grower and pubertal rabbits (Nwagu and Iyeghe-Erakpotobor, 2013).

Performance of rabbits in the tropics have been on the decline due to several unfavourable environmental factors (Mirjana *et al*., 2016). Environmental temperatures above 28ºC was

reported to cause heat induced physiological stress (Okab *et al*., 2008). The most obvious limitation to rabbit production in regions with hot climate was their susceptibility to heat stress (Ondruska *et al.,* 2011). The average minimum temperature in many parts of Nigeria is generally above 20^{o}C, while the average maximum temperature could go as high as 45^{o}C in some parts (Iyeghe-Erakpotobor *et al*., 2012, Anoh *et al*., 2017b). Rabbits in the tropics were raised at ambient temperatures ranging between 27-44^{o}C which is outside their comfort zone of 21-23^{o}C (Nwagu and Iyeghe-Erakpotobor 2013). Under these environmental temperatures, heat stress is a great challenge to successful animal production and improvement. Lower performance of rabbits in most tropical regions is attributable to the effect of high ambient temperature especially in the hot season (Iyeghe-Erakpotobor and Esievo, 2010). Extremes of ambient temperature was an important stressor confronting animals in tropical regions of the world resulting in large economic losses due to high mortality and decreased production (Anoh *et al.,* 2017b). This study was conducted to evaluate the effect of season on rabbit postpartum reproductive performance and kits growth reared in a sub humid environment.

MATERIALS AND METHODS

The study was conducted at the Rabbirty, Rabbit Research Unit, National Animal Production Research Institute (NAPRI), Shika, Zaria. Shika is located in the Northern Guinea Savannah, on latitude 11^{0} 12'N of the equator and longitude 7^{0}33'E with an altitude of about 640m above sea level (Ovimaps, 2014). The area receives an annual rainfall of 1100 mm, which is spread from April to October. The mean minimum and maximum temperatures range between 12 and 28°C in the dry cold (harmattan) season while, in the dry hot season, a temperature range of 20 - 36°C is recorded. Relative humidity during the rainy season is about 75 and 21% during the dry season (Iyeghe-Erakpotobor *et al.,* 2006).

A total of sixty-five (65) does consisting of twenty-two (22) New Zealand White (NZW), eighteen (18) Californian (CC) and twenty-five (25) Chinchilla (CH) purebred were used in the study. Thirty-two (32) sires consisting of 11 NZW, 10 CC and 11 CH were used interchangeably to minimize inbreeding. Mating of does was done in two seasons: Hot-dry (February-May) and cool-wet (June-September). A time interval of two days from the previous mating was allowed during service of does to allow the bucks to rest. Does were taken to the buck's cage for mating and diagnosis of pregnancy was done through abdominal palpation, ten or fourteen days later. Does diagnosed to be open were immediately returned to the appropriate buck for re-mating. A nest box measuring 41cm x 13cm x 21 cm or a nesting pot of diameter 31cm x 10cm were provided for each doe from the 27th day of pregnancy till the kits were weaned at 28 days.

The rabbits were kept in individual metal cages, measuring 40 x 60 cm in dimension. The cages were housed in a well-ventilated house with large windows. Each hutch was equipped with flat bottom earthen pots to prevent feed wastage. The rabbits were treated with an anti-stress (Vitalyte; Phoenix pharmaceuticals U.S.A), antibiotics (Tetracin; Vetinida Pharmaceutical Limited India), coccidiostat (Amprolium; Lonye Technology Limited Guangzhou, China) and Ivomec manufactured by Savorite Pharmaceutical Limited Baroda (Guj), India against external and internal parasites during the one- week adjustment period before commencement of the study. The rabbits were offered 100g of concentrate (20% CP, 2500Kcal ME/kg) feed in the morning at 8 am daily and given clean water *ad libitum.* The rabbits were also offered dried lablab forage in the afternoon to supplement their crude fibre intake. During lactation, they were offered 350g concentrate feed and lablab hay.

Records on gestation length (interval from mating date to delivery date), litter size, litter birth weight and mean kitten birth weight were

kept. Individual body weight of the 258 kits at 2, 4, 6 and 8 weeks were also recorded. Data collected were log transformed and subjected to Analysis of Variance (ANOVA) Test using the General Linear Model (GLM) Procedure while Duncan multiple Range Test Procedure was used to separate significant differences among means (SAS, 2001).

The statistical model used for the analysis of traits of does postpartum reproductive performance and kits body weight change at all the ages is shown below;

$Y_{ijk} = \mu + C_j + e_{ijk}$

Y_{ijk} = the observation on the l^{th} kit born in the j^{th} season belonging to the k^{th} dambreed

μ = the overall mean

C_j = fixed effect of the j^{th} season (j = 1, 2)

e_{ijk} = random error associated with each record with expectation 0 and variance

RESULTS AND DISCUSSION

The Least Square Analysis of Variance of influence of season on some reproductive parameters of rabbits is shown in Table 1. There was a non-significant influence of season on gestation length, litter size, litter birth weight. mean kit birth weight. number weaned and percent mortality at weaning. However, season had significant effect on number of kits that survived ($p<0.05$), and total percent kit mortality ($p<0.05$). The kit mortality was significantly ($p<0.05$) higher in the hot dry season (ranging from 54.78-56.48%) than in the cool-wet season (ranging from 48.31 to 48.42%). Rabbit does were sensitive to heat stress, which had been associated with seasonal changes in their fertility. The effect of the season had also been shown on weight gain (Tůma *et al*., 2010). Rabbits raised under heat stress condition can only express their potentials of rapid growth rate and fertility when conditions are favorable. Favorable conditions must include adequate photoperiod, thermo-neutral conditions, food availability in quantity and quality as well as a low stress environment (Marai, 2001). Unfavourable environmental conditions may lead to a decrease in growth and reproductive capacity, varying from subfertility to infertility (Anoh *et al*., 2017a). By elevating circulatory corticosteroids and decreasing thyroid activity, heat stress impairs performance, especially in adult animals because the ability to dissipate heat decreases with age (Mahmoud et al., 2014; Ademu *et al*., 2018). The drastic decline in feed intake occurs in heat stressed animals as a physiological response to minimize intrinsic heat production and to maintain the thermal homeostasis, thus reducing the efficiency of feed utilization, live weight gain, and survival rates (Faria Filho *et al*., 2007; Ademu *et al*., 2018).

More kits born in the cool-wet season survived ($p<0.05$) compared with the hot-dry season. This effect was also seen in total kit mortality which was higher in the hot-dry than cool-wet season (Table 2). The season of the year had been shown to significantly affect number of services per number of pregnancies, litter size, litter weight at birth, litter weight at 21 days, litter size at weaning as well as live weight at 77 days (Tůma *et al*., 2010). Anoh *et al*. (2017a) reported that the temperature humidity index (THI) within the same Rabbit Research Unit in the mornings averaged 26.44 and 28.74 in the afternoon. The THI values increased from the month of February, peaked in May and declined in June. The THI values of 29.4 (March), 30 (April), 31.5 (May) and 28.49 (June) indicate that the rabbit house was thermally very severely stressful to the rabbits (Anoh *et al*., 2017a) in these months. Iyeghe-Erakpotobor et al. (2013) also reported that the THI in the morning was below 27.8 and comfortable but up to 31.2 in the afternoon hence severely stressful for the rabbits. This clearly shows that rabbits reared in this environment are always prone to heat stress.

Table 1: Least square analysis of variance of influence of season on some reproductive and growth response of rabbits

Source	DF	GESTL	L. Size	LBWT (g)	MBWT (g)
Season	1	2.8NS	0.79NS	411.81NS	132.20NS
Error	252	4.76	251	4463.97	120.14
Source	**DF**	**NoWeaned**	**NoSurv**	**MWD%**	**Pmortot%**
Season	1	0.16NS	4.29*	753.96NS	2172.66*
Error	90	3.06	2.66	1538.67	1469.86

NS = Not significant. P>0.05, DF = Degree of freedom, GESTL = Gestation length, L. Size = Litter size, LBWT = Litter birth weight, MBWT = Mean Kit birth weight, number weaned (NoWeaned), number survived (NoSurv), percent mortality at weaning (MWD%) and total percent mortality (Pmortot%)

Table 2: Least square mean (LSM± SE) for influence of season on reproductive performance of rabbit does

	Season		
Parameter	**Hot-dry**	**Cool-wet**	**LS**
Gestation length (days)	31.32±0.2	31.0±3	NS
Litter size	5.04±0.1	5.17±0.2	NS
Litter birth weight (g)	216.49±8.0	219.54±8.8	NS
Mean Kit birth weight (g)	44.26±0.8	45.99±1.0	NS
Number of kits weaned	2.05±0.2	2.15±0.4	NS
Number of kits that survived	1.76 ± 0.2^{a}	2.11 ± 0.3^{b}	*
Percent kit mortality at weaning (%)	54.78±5.0	48.31±8.0	NS
Total percent kit mortality (%)	56.48 ± 5.0^{a}	48.42 ± 8.0^{b}	*

[ab]Means followed by the same superscript on the same row are not statistically different from each other at NS = non-significant p>0.05, * = p<0.05.

The Least Square Analysis of Variance of influence of season on growth performance of rabbit kits is shown in Table 3. Season had significant (p<0.001) effect on kit body weight at 2, 4, 6 and 8 weeks postpartum. Kits born in the cool wet season had significantly (p<0.05) higher weights at 2, 4, 6 and 8 weeks of age than those born in the hot dry season (Table 4). This could be attributed to the possible effect of high temperatures (21-36°C) and low relative humidity experienced during the hot period resulting in low feed intake and higher rate of metabolism with its consequent effect on growth performance of the kits. Yakubu *et al.* (2014) reported that calves cropped at the early dry season (October, November and December), weighed higher than calves from the late dry (January, February and March), early wet (April, May and June) and late wet (July, August and September) seasons. When ambient

temperature rises above 25ºC, feed intake and in consequence, daily weight gain of rabbits were reduced, resulting from considerable rise in maintenance energy requirements of rabbits under high ambient temperatures, causing additional protein losses from blood plasma due to increased sweat gland activity, reduction in production efficiency through both direct and indirect effects on metabolism and physiological function of animals (Iyeghe-Erakpotobor and Esievo, 2010). Iyeghe-Erakpotobor *et al*. (2013) observed that rectal temperature of rabbits was higher ($p<0.001$) in the hot than cool season while respiratory ($p=0.018$) and pulse rates ($p=0.05$) were higher in the cool than hot season.

Table 3: Least square analysis of variance of influence of season on some reproductive and growth response of rabbits

Source	DF	WT_2	WT_4	WT_6	WT_8
Season	1	52272.05^{xxx}	293613.12^{xxx}	961527.55^{xxx}	1714194.07^{xxx}
Error	252	3293.83	11965.32	29212.04	55117.47

WT_2 = Kit body weight at 2 weeks, WT_4 = Kit body weight at 4 weeks, WT_6 = Kit body weight at 6 weeks, WT_8 = Kit body weight at 8 weeks.

Table 4: Least square mean (LSM± SE) for influence of season on body weight of rabbit kits at 2, 4, 6 and 8 weeks of age

Kit body weight (g)	Season		LS
	Hot-dry	Cool-wet	
2 weeks	$108.44±4.3^{b}$	$142.8±7.6^{a}$	xxx
4 weeks	$157.01±8.1^{b}$	$238.53±14.4^{a}$	xxx
6 weeks	$206.37±12.7^{b}$	$352.79±22.5^{a}$	xxx
8 weeks	$263.19±17.5^{b}$	$460.03±30.9^{a}$	xxx

^{ab}Means followed by the same superscript on the same row are not statistically different from each other at xxx = $p<0.001$.

Nwagu and Iyeghe-Erakpotobor (2012) reported that metabolic weight gain decreased with the age of the rabbits from weaners to adults. Empty body gain, water, protein, fat and ash content of body gain, retained energy as protein, fat or growth, energy requirement for protein and fat synthesis and total DE requirement for growth were significantly high ($P<0.001$) for weaner rabbits indicating the fact that weaner rabbits utilize energy better for growth than other groups of rabbits. The lower weights of rabbit kits in the hot-dry season could have resulted from the consequences of high ambient temperatures. The changes that occur in the rabbit's biological functions under heat stress conditions were depressed feed intake, feed efficiency, utilization, and disturbance in metabolism of water, protein, energy, mineral balance, enzymatic reaction, hormonal secretions and blood metabolites (Marai *et al.*, 2002). Agbor *et al*. (2017) had observed that in rabbits, stress associated with exposure to high ambient temperature decreased growth performance, possibly because it destroyed cellular biological molecules. One of the constraints to the successful rearing of rabbits especially improved breeds in tropical countries is heat stress. Rabbits exposed to ambient temperature of 25ºC for 12 hours daily had lower weight gains than those kept at 15ºC

(Okab *et al*., 2008, Anoh *et al*., 2016). Rabbits kept in the study location were raised at temperatures above 15 -25ºC. It was concluded that adult breeding rabbits and their kits raised in this environment were exposed to heat stress which impaired their performance and growth, an effect which was more pronounced in the hot-dry than cool–wet seasons.

REFERENCES

Ademu, L. A., Iyeghe- Erakpatobor, G. T., Barje, P. P., Daudu, O. M. and Wafar, R. J. (2018). Response of Broiler Chickens under Dexamethasone Induced Stress Conditions. *Asian Journal of Research in Animal and Veterinary Sciences* 1(1): 1-9, 2018; Article no.AJRAVS.39782.

Agbor, F., Nwani, K. A., Azua, J., Addass, P. A and Iyeghe-Erakpotobor, G. T. (2017). Level and method of supplementation of vitamin c on performance and thermoregulatory responses of rabbits raised in a humid tropical environment. *Journal of Animal Production Research 29(2):192-207.*

Anoh, K. U., Barje, P. P., Erakpotobor, G. I. and Akpa, G. N. (2016). Thermoregulatory response of growing rabbits fed diets supplemented with bi-carbonate buffer, vitamin c and baobab fruit pulp meal. *Journal of Animal Production Research 28(2):50-54.*

Anoh, K. U., Barje, P. P., Iyeghe-Erakpotobor, G. T. and Akpa, G. N. (2017a). Growth performance of heat stressed rabbits fed diets supplemented with synthetic and organic antioxidants. *Nigerian Journal of Animal Production* 44(5): 177 - 180

Anoh, K. U., Barje, P. P., Iyeghe-Erakpotobor, G. I. and Akpa, G. N. (2017b). Influence of baobab (*Adansonia digitata)* fruit pulp meal on semen characteristics and morphology of rabbit buck during hot season in *Nigeria. Nigerian Journal of Animal Production* 44(3):84 – 88.

Faria Filho D. E., Campos, M. and Alfonso-Torres, K. A. (2007). Protein levels for heat-exposed broilers: performance, nutrients digestibility, and energy and protein metabolism. *International Journal of Poultry Science. 6*:187–194

Goska, D. Y., Kibon, A., Madziga, I. I., Alawa, C. B. I., Lamidi, O. S., Voh, A. A., Iyeghe - Erakpotobor, G. T. and Yakubu, B. and Dauda, J. (2017). Dressing percentage and carcass characteristics of Bunaji bulls fattened on varying inclusion levels of groundnut haulms and maize offal. *Nigerian Journal of Animal Production.* 44(2):213-222.

Iyeghe-Erakpotobor, G. T. and Esievo, L. O. (2010). Performance of growing rabbits fed varying levels of soybean cheese waste diet and lablab hay. *Nigerian Journal of Animal Production* 37(2): 173-183.

Iyeghe-Erakpotobor G. T., Aliyu, R. and Uguru, J. (2006). Evaluation of concentrate, grass and legume combinations on performance and nutrient digestibility of grower rabbits under tropical conditions. *African Journal of Biotechnology* Vol. 4 (20): 2004-2008. http://www.academicjournals.org/AJB

Iyeghe-Erakpotobor, G. T., Akinsola, O. M., Samuel, T. T. and Pewar, P. F. (2013). Growth and physiological responses of rabbit hyla stock in a sub-humid tropical environment*. Journal of Animal Production Research.* 25: 25-36.

Iyeghe-Erakpotobor, G. T., Tudunwada, I. K., Tijjani, A., Muhammad, I. R. and Bello, N. (2012). Influence of level of groundnut haulms and feeding system on performance of growing rabbits. *Nigerian Journal of Animal Production* 39(1): 64-73.

Irshad, A., Kandeepan, G., Kumar, S., Ashish, K. A., Vishnuraj, M. R. and Shukla, V. C. (2012). Factors influencing carcass

composition of livestock: A review: *Journal of Animal Production Advances*, 2012. 3(5): 177-186

Mahmoud, U. T., Abdel-Rahman, M. A. and Darwish, M. H. (2014). Effects of propolis, ascorbic acid and vitamin E on thyroid and corticosterone hormones in heat stressed broilers. *Journal of Advanced Veterinary Resource.* 4:18–27.

Marai, I. F. M., Habeeb, A. A. M. and Gad, A. E., (2002). Rabbits' productive, reproductive and physiological performance traits as affected by heat stress: a review Livestock Production Science 78: 71–90.

Marai, I. F. M., Habeeb, A. A. M. and Gad, A. E. (2007). Biological functions in young pregnant rabbit does as affected by heat stress and lighting regime under sub-tropical conditions of Egypt Tropical and Subtropical Agroecotimos, 7: 165 – 176.

Marai**,** I., Ayyat, M., Gabr, H. and Abdeh-Monem, U. (2001). Growth performance and reproductive traits at first parts of New Zealand white female rabbit as affected by heat stress and its alleviation, under Egyptian conditions. *Journal of Tropical Animal Health and Production*, 33: 1 – 12.

Mirjana, J. T., Davidovic, V. and Mirjana, B. R. (2016). The effects of some microelements supplementation- Selenium, Zinc and Copper into Dairy cows feeds on their health and reproductive performances *Biotechnology in animal husbandry* 32 (2): 101-110.

Nwagu, F. O., and Iyeghe-Erakpotobor, G. T. (2012). Protein and energy partitioning for growth by rabbits fed soybean cheese waste diet and lablab hay. *Nigerian Journal of Animal Production* 39(1): 54-63.

Nwagu, F. O. and Iyeghe-Erakpotobor, G. T. (2013). Energy partitioning for growth by rabbits fed groundnut and stylo santhes forages supplemented with concentrate. *Nigerian Journal of Animal Production. 40(1): 37-47*

Okab, A. B., El-Banna, S. G. and Koriem, A. A. (2008). Influence of environmental temperatures on some physiological and biochemical parameters of male New-Zealand rabbits. *Slovak Journal of Animal Science* (41), 12–19.

Ondruska, L., Rafay, J., Okab, A. B., Ayoub, M. A., Al-Haidary, A. A., Samara, E. M., Pakanyi, V., Chrastinova, L., Jurcik, R., Massanyi, P., Lukac, N. and Supuka, P. (2011). Influence of elevated ambient temperature upon some physiological measurement of New Zealand White Rabbits. Veterinary Medicine, 56: 180 – 186.

Ovimaps, (2014). Ovi location map: ovi earth imaginary, July 5th, 2014.

SAS 2001. Statistical Analysis Institute User's Guide. North Carolina, USA.

Tsavkar, D. T., Latu, M. Y., Olutunmogun, A. K., Barje, P. P. and Iyeghe-Erakpotobor, G. T. (2019). Energy partitioning of pregnant and lactating rabbit fed combination of concentrate and *stylosanthes hamata* hay. Nig. J. Anim. Prod. 2019, 46(1):94 – 100.

Tůma, J., Tůmova, E. and Valašek, V. (2010). The effect of season and parity order on fertility of rabbit does and kit growth. Czech *Journal of Animal Science*, 55, 2010 (8): 330–336.

Yakubu, H., Barje, P. and Iyeghe-Erakpotobor, G. (2014). Influence of Calf Parity Number, Season of Calving and Period of Calving on Birth and Weaning Weights of Friesian-Bunaji Calves. *World Journal of Life Science and Medical Research* 3(2): Pp.59-62