Effect of Different Seasons on the Performance of Grey Giant Rabbits under Sub-Temperate Himalayan Conditions

R. S. Bhatt*, S. R. Sharma, Umesh Singh, Davendra Kumar and V. Bhasin

North Temperate Regional Station, Central Sheep and Wool Research Institute

Garsa via Bhuntar, Kullu (HP) -175 141, India

ABSTRACT : An experiment was conducted on 190 progeny (winter -74; summer -59; rainy -57) of 12 Grey Giant rabbits (10 female +2 males), to assess the effect of different seasons in a year, on their reproductive, growth and productive performances along with feed efficiency, under sub-temperate Himalayan conditions. The daily meteorological attributes recorded during winter (October to March), summer (April to June) and rainy (July to September) seasons, and analysed were minimum and maximum temperature, relative humidity and rainfall. Various biological parameters recorded were doe weights at mating and kindling, litter size at birth, litter weight at birth, kit mortality, litter size at weaning, litter weight at weaning, weekly body weight up to 98 d and weaner mortality. Individual weight gains, dressing percentages, meat weights, liver weights, raw-pelt weights, processed pelt weights and processed pelt areas at slaughter on d 84 and 98, respectively were also recorded. The feed and fodder compositions and their nutritive values during different seasons were also analysed. Average ambient temperature during winter, summer and rainy seasons were 13.2±2.8, 22.4±3.7 and 24.8±2.3°C, respectively. The average relative humidity and total rainfall for winter, summer and rainy seasons were 68.9±1.5% and 48±26.6mm, 66.3±4.8% and 125.6±56.8 mm, and 77.3±1.3% and 116.3±90.4 mm, respectively. The weight of doe at mating and kindling, litter size at birth, litter weight at birth and litter size at weaning were comparatively higher whereas litter weight at weaning was significantly ($p<0.05$) higher during winter as compared to summer and rainy seasons. The kit mortality was significantly ($p<0.05$) higher during winter while the weaner mortality was significantly ($p<0.05$) higher during rainy season. At 84 d, the live weight per doe, slaughter weight, dressing percentage and liver weight were significantly ($p<0.05$) higher during winter than summer and rainy. Similarly, the gain in weight and meat weight at 84 and 98 d were significantly ($p<0.05$) higher during winter. The weight of raw pelt and processed pelt were recorded significantly ($p<0.05$) higher during winter while no difference in the area of processed pelts during different seasons could be observed. No difference in the biological performance could be observed between sexes in any of the seasons. Roughage analysis revealed comparatively higher crude protein percent and lower crude fibre percent during summer and rainy seasons than in winter. The roughage dry matter intake was comparatively higher during summer and rainy seasons *vis-a-vis* constant amount of concentrate supplied during all the three seasons. The digestibilities of dry matter was significantly ($p<0.05$) lower, whereas that of crude fiber, acid detergent fibre and cellulose were negative during winter. Interestingly, the feed:gain was exceedingly well during winter than in other seasons and it is concluded that it was the best season for production of rabbits under sub-temperate Himalayan conditions. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 6 : 812-820)***

Key Words : Carcass Traits, Feed Efficiency, Growth, Rabbit, Reproduction, Seasons, Sub-Temperate Climate

INTRODUCTION

In tropical countries, the high temperature or heat stress, handicaps the success of rabbit farming (Cervera et al., 1997), as it leads to a significant reduction in the daily weight gain, daily feed intake and feed efficiency (Chiericato et al., 1993). Similarly, the milk yield of rabbit maximized at 15°C ambient temperature was reduced by 7.7 g for each 1°C rise in the temperature (Papp and Rafai, 1988). The negative effect of hot climate on rabbit growth and reproduction could be very useful for evaluating breeding conditions in relation to heat stress (Finzi et al., 1992b). Above 25-28°C of ambient temperature, rabbits decreased their feed consumption and required more digestible energy (Lebas, 1983). At 30°C, the average feed consumption was reported to be decreased by 30% and affected growth as well (Matheron and Martial, 1981). The effect of experimental hot environment conditions in rabbits have been extensively discussed in the last two decades mainly on growth performances and feed intake (Chiericato et al., 1992). But, the information based on experimental conditions, which are often quite different from each other, provide incomplete picture (Chiericato et al., 1992) and can not be implemented universally at least under farmer's conditions in developing countries.

In India, the postnatal growth of different rabbit breeds under semi-arid conditions revealed a significant better growth performance of September-December born young ones compared to those born in January-April (Gupta et al., 1992). However, information on the effect of different seasons on the biological performance of broiler rabbits under sub- temperate Himalayan conditions, in India, are lacking and the present experiment was, therefore, undertaken using Grey Giant rabbits.

* Corresponding Author: R. S. Bhatt. Tel: +91-1902-72-222; Fax: +91-1902-72-222.

Received September 28, 2001; Accepted January 8, 2002

MATERIAL AND METHODS

An experiment was undertaken with 190 progeny (winter -74; summer -59; rainy -57) of 12 (Ten females and two males) Grey Giant rabbits, to assess the effect of three major seasons on their growth performance, production parameters, reproductive performance and nutrient utilization. The parent adult animals of similar age were bred at least once during each season. Three major seasons categorized at this place were - winter (October to March), summer (April to June) and rainy (July to September) and the daily meteorological data (minimum and maximum temperature (°C), rainfall (mm) and relative humidity (%) were recorded during the experimental period. During each season, the experiment with the progeny was continued for a period of 84-98 d (till slaughter). The weight of females at breeding and kindling, litter size at birth (LSB), litter weight at birth (LWB), kit mortality, litter size at weaning (LSW), litter weight at weaning (LWW), weekly body weight from weaning to slaughter and mortality in weaners were recorded.

Newborn kits were milk fed twice a day during morning and evening and 15 d after birth, they were offered mashed concentrate diet along with doe's milk. The concentrate diet was composed of maize-30%, ground nut expeller-20%, sunflower cake-5%, soyaflakes-5%, wheat bran-15%, rice bran-15%, fish meal-3.5%, molasses-5%, mineral mixture-1% and common salt-0.5%. Additionally, the feed (100 kg) was supplemented with 10 g of vitamin A-D_3, K and E with selenium mixture; 5 g each of lysine and methionine; 50 g of magnesium oxide and 250 g of Di-calcium phosphate. At 35 d of age, all kits were sexed, tagged and weaned. Each weanling rabbit was kept individually in all wire mash cages of standard size inside the house having asbestos roof and wall made up of chicken wire mash, thereby providing similar housing and management conditions. Each animal was given concentrate in the form of pellet about 50 $g \cdot d^{-1} \cdot head^{-1}$, with a standard scoop in the morning and was supplied water *ad libitum*. Additionally, they were given seasonal grasses, *ad libitum* (*Festuca arundinacea, Lolium perenae, Trifolium repens, Paspalum* spp., *Puereria thunbergiana, Panicum* spp. *and Setaria* spp.), in the wilted form or their hay during winter, in the afternoon. The experiment was carried out for a period of 84-98 d and weekly body weight of individual animal(s) was recorded.

At 63 d of age a metabolic trial, of 5 d duration, was conducted with 4 animals from each group, to measure the digestibility of nutrients during each season. The total intake of concentrate and roughage during the metabolic trial was recorded. Feces voided and urine excreted were collected and representative samples were taken for proximate analysis (AOAC, 1990) and fiber fractions (Goering and Van Soest, 1984).

At 84 d of the age, rabbits were randomly divided into two subgroups during each season. One of the groups was slaughtered at the 84 d by standard method (Cheeke et al., 1982) following neck dislocation. While, the other group was reared for two more weeks and slaughtered at 98 d. All the animals were fasted for about 12 h before slaughter and their weights were recorded just before slaughter to calculate the dressing percentage on the basis of the weight of the hot carcass, liver and kidneys; whereas lungs and heart were discarded. During all three seasons, slaughter of animals was done by the same person to avoid the variation in meat and skin data. Parameters like weight gain at 84 and 98 d, hot carcass weight, liver weight and fresh pelt weight were recorded. Immediately after slaughter, the skins were secured on stretcher while warm and with flesh side out. The pelt(s) after drying were subjected to the salt-acid process (Cheeke et al., 1982) and their weight (g) and area (sq. cm.) after processing were also recorded. The data generated were subjected to statistical analysis using analysis of variance (ANOVA) (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

Meteorological attributes

The month-wise average minimum and maximum temperature (°C), rainfall (mm) and relative humidity (%) during different seasons is given in figure 1. The average monthly temperature (minimum to maximum) during winter, summer and rainy seasons for the period under experimentation ranged from 1.7 to 29.1, 10.1 to 33.1 and 17.8 to 30.7°C, respectively. Average temperature during the winter, summer and rainy seasons were 13.2±2.8, 22.4±3.7 and 24.8±2.3°C, respectively. The average relative humidity and total rainfall for winter, summer and rainy seasons were 68.9±1.5 percent and 48±26.6 mm, 66.3±4.8 percent and 125.6±56.8 mm, and 77.3±1.3 percent and 116.3±90.4 mm, respectively. The rainfall was recorded more during the end of June (due to pre monsoon rains) which increased the average rainfall during summer as compared to rainy seasons. The relative humidity during winter and summer seasons was almost equal and was within the acceptable limits for the optimum production (Lebas et al., 1986; Sandford, 1986). While it was increased considerably during the rainy season along with rise in average ambient temperature (24.8°C) making it an uncomfortable period to the animals. Moreover, the difference between the average minimum and maximum temperature during rainy seasons was also decreased as compared to winter and summer. The productive performance reported to impair in some way at 25°C and even a small fluctuation between maximum and minimum temperatures disturbed the growth performance of rabbits

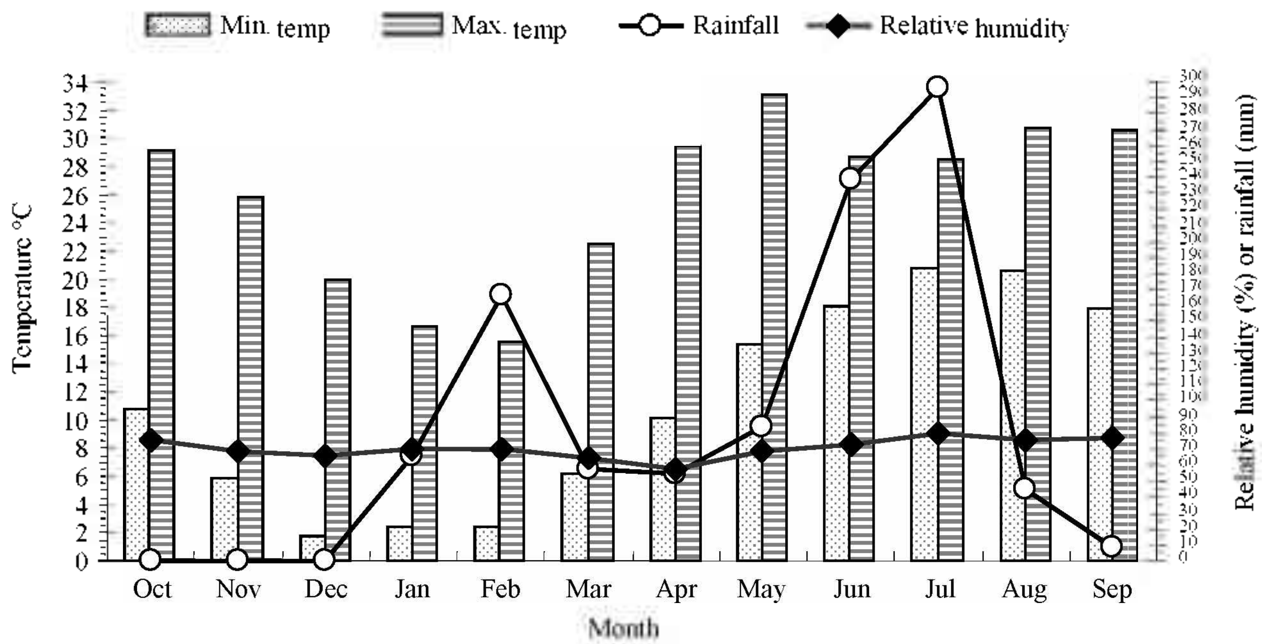

Figure 1. Meteorological attributes during different seasons

(Chiericato et al., 1992).

Chemical composition of concentrate and roughage

The chemical composition of the concentrate and roughage(s) are presented in the table 1. The concentrate (pellets) contained 21.3% crude protein (CP) and 9.4% crude fiber (CF). The higher CP and lower CF than the recommended levels, advocated in the concentrate were to compensate for their respective low and high levels in the roughage(s) given. The chemical composition of roughage(s) (table 1) revealed lower CP and higher CF in winter season as compared to summer and rainy seasons. The difference could be due to the stage of roughage offered in the particular season; as during winter, rabbits were fed hay while in other two seasons fed lush green grass. In addition, the loss of tender portion of grasses during hay-making could also be responsible for the higher CF fed during the winter. The comparatively less ether extract (EE) in the roughage (hay) offered during winter (table 1), could be due to lower amount of pigments, precursors of vitamin A and other extractable materials in the hay. The amount of cellulose in the roughage(s) during different seasons was proportional to their corresponding CF levels. The maturation of forages leads to decreased CP, increased CF and decreased nutritive value due to lignification of stems (Cheeke, 1987). All the nutrients (concentrate+roughage) were within the permissible limits (NRC, 1977).

Table 1. Chemical composition of concentrate and roughage(s) in different seasons

Nutrients	Concentrate	Roughage		
		Winter	Summer	Rainy
Dry matter (DM)	92	95.6	92.6	94
Crude protein (CP)	21.3	9.7	11.8	11.8
Crude fiber (CF)	9.4	30.6	26.3	28.7
Ether extract (EE)	1.89	1.63	2.7	2.6
Nitrogen free extract (NFE)	57.4	49.1	47.5	46.2
Acid detergent fiber (ADF)	22	56.4	48.1	52.3
Acid detergent lignin (ADL)	6.6	11.2	10.3	9.5
Cellulose (ADF-ADL)	15.4	45.2	37.8	42.8
Total ash	10	8.9	12.1	10.7

Biological performance

The weights of the doe at mating and kindling were comparatively higher, though non-significant, in winter (figure 2), as compared to summer and rainy seasons. It was interesting to note that the body weight of doe decreased with an increase in the average ambient temperature from winter to rainy season indicating the effect of temperature on the body weight of the animals. Since, the relative humidity in rainy season was also higher along with higher average environmental temperature, the negative effect on the body weight was more accentuated in this season. Though, the relative humidity of about 75% inside the animal house at a temperature of about 10 to 13°C

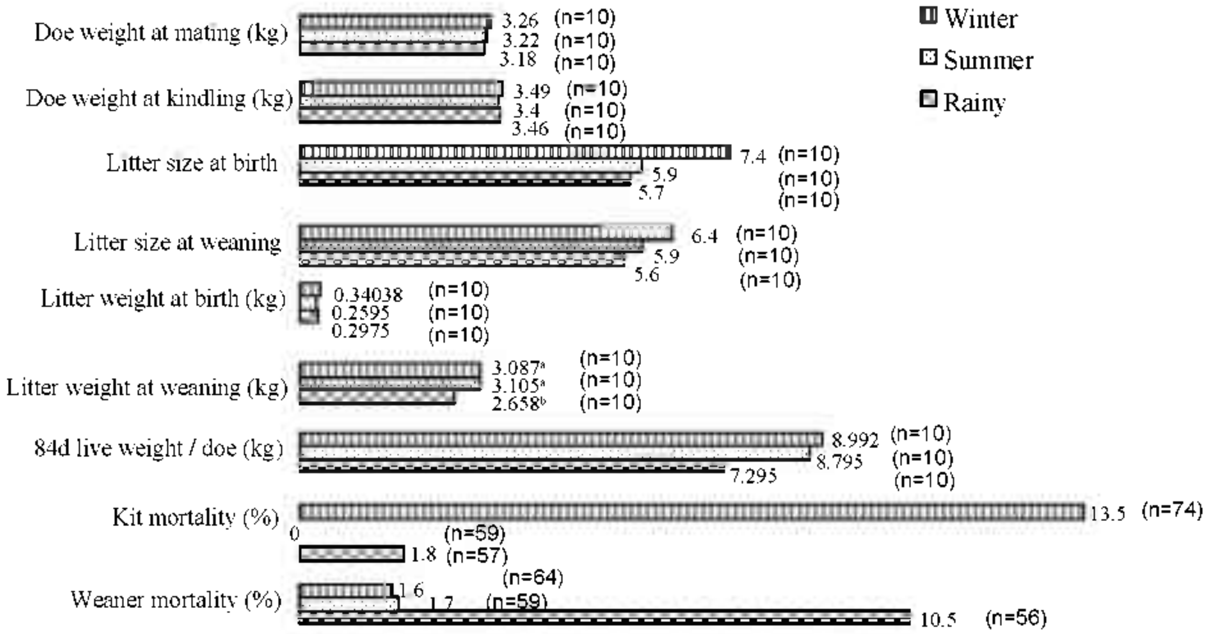

Figure 2. Biological performance of rabbits during different seasons

considered ideal for rabbits; a fluctuation in the temperature by more than 5°C than outside could affect the performance (Sandford, 1986). In this experiment, there was no variation in the inside and outside temperature of the animal house owing to its construction, the increase in temperature from winter (13.2°C) to rainy season (24.8°C) has negative effect on the body weight of the doe at mating. Maertens and De Groote (1990) also reported low body weight of doe at high ambient temperature than normal ambient temperature though the differences were non-significant. The decrease in body weight due to the heat stress has been acknowledged a limiting factor in tropical countries (Finzi et al., 1992a).

The LSB was largest (7.4±0.5 per doe) in winter followed by summer (5.9±0.6 per doe) and rainy season (5.7±0.5 per doe); but were non-significant from each other (figure 2). However, the LSB decreased gradually with increase in average ambient temperatures from winter to rainy season. The non-significant effect of season of kindling on the LSB, similar to our observation, had been reported (Ayyat et al., 1995). The LWB was highest during winter compared to rainy followed by summer seasons (figure 2), though non-significant from each other, indicating no effect of the season on the LWB, which corroborated with earlier findings (Ayyat et al., 1995). A kit mortality of 13.5% was recorded during winter (figure 2) and was significantly more ($p<0.05$) than other two seasons indicating the negative effect of winter on the survivability of kits. All deaths of kit recorded during winter were due to starvation, pneumonia and overfeeding. It was observed that during winter kits born were relatively weak due to higher LSB and needed extra care from chilling and on account of feeding; in addition to mothering ability (Bhasin and Singh, 1995). Similar significant effect of cold seasons on the pre weaning mortality had been documented (Ferraz et al., 1991).

The LSW had a similar pattern to LSB during different seasons and was influenced considerably by kit mortality during winter (figure 2). The LWW was significantly ($p<0.05$) more during winter and summer than rainy season (figure 2). Individually, the 35 d weights (weaning weight) during all three seasons were differing significantly ($p<0.05$) from each other (figure 3). These findings revealed the significant influence of different seasons on the growth of young ones from their birth to weaning (35 d); as their LWB were non- significant from each other. The weaner mortality (between 35 d-84 d) was significantly ($p<0.05$) more in rainy season (10.5%) as compared to winter and summer (figure 2). The earliest death during winter and summer was recorded after 70th d, while during rainy season deaths occurred between 35th and 49th d of age. All the death(s) during winter, summer and rainy seasons were due to enteritis, pneumonia and enteritis, respectively. The significant death of weaners during rainy season was possibly due to environmental stress and significantly low body weight of young ones after weaning. Other important factors, like large litter size, insufficient milk production (Valderma Dedeaz and Varela-Alverez, 1975; Torres et al., 1986; Vicente and Garcia-Ximenez, 1992), affecting post weaning survival and growing capacity were not significant.

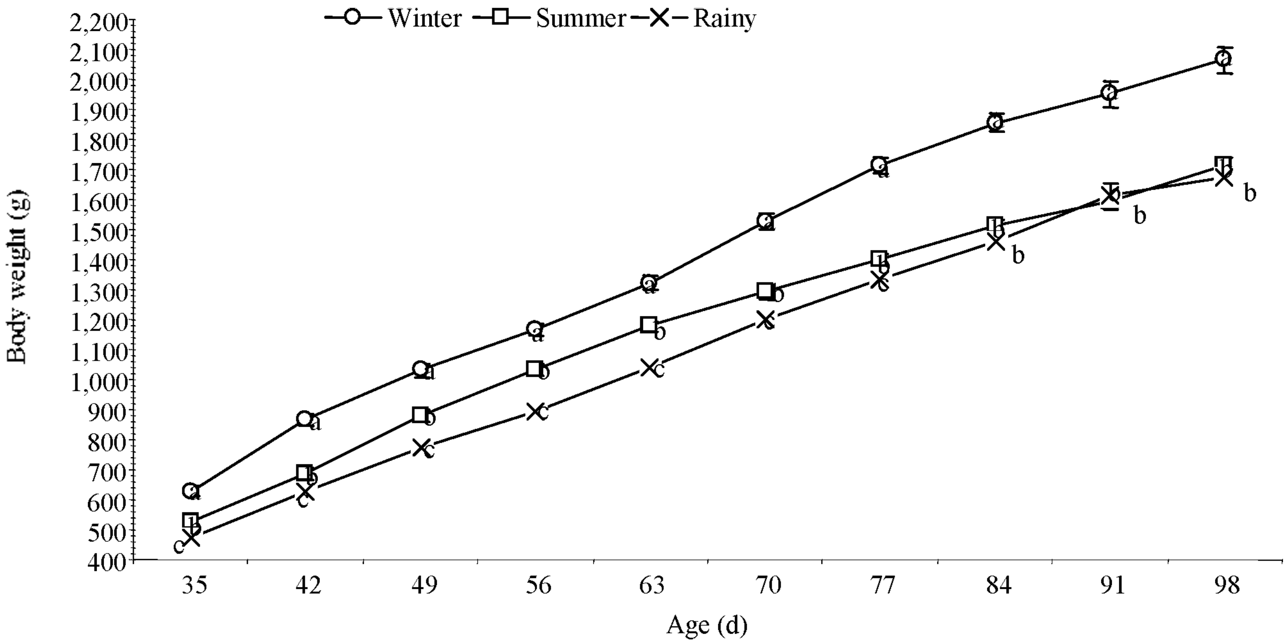

Figure 3. Overall growth performance of rabbits during different seasons (Mean±S.E.). The letters at the tops of the spots indicate statistical significance; means with different letters are significantly different ($p<0.05$).

during rainy season, in this experiment.

The analysis of weekly body weights of weaners (figure 3) indicated significantly ($p<0.05$) higher body weight(s) during winter season as compared to other two seasons and corroborated with findings of Remois et al., (1996). Between group comparison exhibited that the body weights at 35, 42, 49, 56, 63, 70 and 77 d in weaners, during all three seasons, were significantly ($p<0.05$) different from each other with lowest weights recorded during rainy season. From 84 to 98 d, the body weights in winter season were significantly ($p<0.05$) more as compared to other two seasons while no significant difference between the body weight of animals during summer and rainy seasons could be observed for this period. The poor growth during rainy season up to 77 d was possibly due to adverse environmental interactions, as the LWB, genetic make up and management was similar. Animals born in the rainy season performed comparatively better after 77 d of their age due to fall in the average ambient temperature with the onset of winter.

Sex-wise analysis for growth revealed non-significant differences for weight gain from 35 to 98 d, during each season (figure 4). Comparison of body weights among females (progenies) for different seasons revealed significant ($p<0.05$) difference up to 70 d, with lowest weight recorded in the rainy season. From 70 to 98 d, the body weights for females were significantly ($p<0.05$) higher in winter as compared to other two seasons. The body weights in males during different seasons were similar to female from 35 to 70 d, while significantly ($p<0.05$) more in winter after 70 d. Reduced growth in caged rabbits at temperature over 25°C (Withorff et al., 1988) due to impaired body heat dissipation through skin (Harkness, 1988) could be one of the reasons for low growth during rainy season in this experiment. An effect of the month of birth on post weaning gain of rabbits had been attributed to the nutritional and climatic conditions (Afifi, 1971) other than the breed, year and parity (Mcnitt and Lukefahr, 1990).

The overall gain in weight and meat weight at 84 and 98 d were significantly ($p<0.05$) more in winter as compared to other two seasons (figure 5). In sex-wise analysis, differences were non-significant between female and male during different seasons for these parameters (figure 6). Sex-wise, females and males had significant ($p<0.05$) gain in weight and meat weights at 84 and 98 d during winter than summer followed by rainy season. The dressing percentages were significantly ($p<0.05$) different, at 84 d, during three seasons with highest in winter and lowest in rainy seasons (figure 5). While at 98 d the highest ($p<0.05$) dressing percentage was recorded during summer and lowest during rainy season. Sex-wise, at 84 d, the dressing percentages of male and females were not differing significantly from each other (figure 6). Individually, for females and males, the dressing percentages were significantly ($p<0.05$) higher in winter than summer followed by rainy seasons (figure 6), due to their respective slaughter weights, as a direct proportion existed between slaughter weights and dressing percentages (Kulkarni et al., 1995). Liver weights, at 84 d, were significantly ($p<0.05$) more during winter and summer than rainy season, whereas, at 98 d, the liver weight was significantly ($p<0.05$) more in winter than summer and rainy seasons (figure 5). Liver

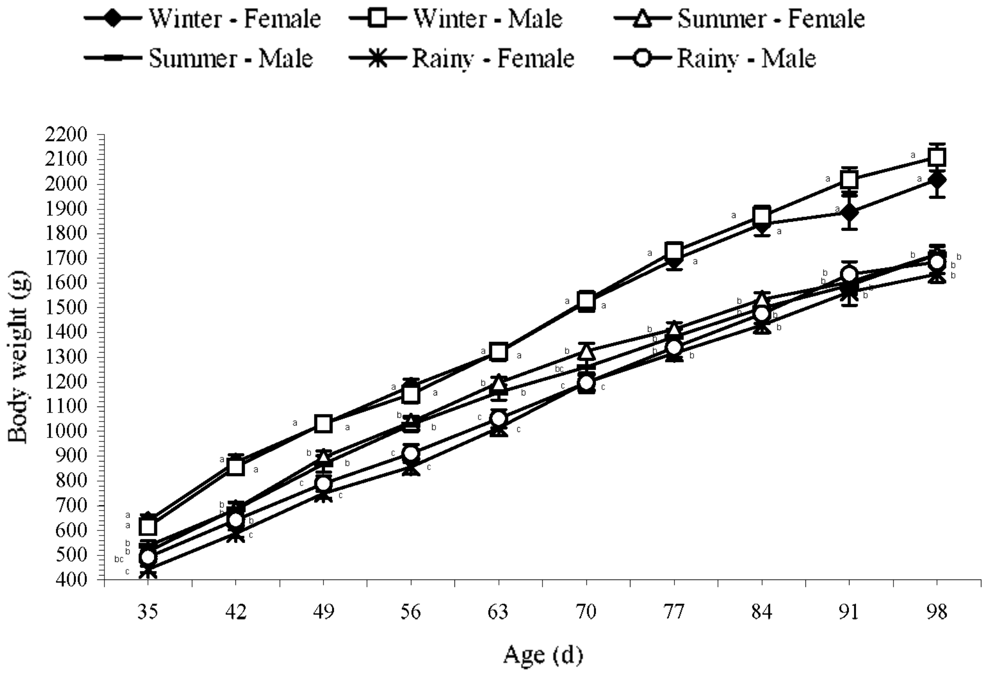

Figure 4. Sex-wise growth performance of rabbits during different seasons (Mean±S.E.). The letters at the tops of the spots indicate statistical significance; means with different letters are significantly different ($p<0.05$).

weights were directly proportional to their respective meat weights at 84 d, but no such trend existed for liver weights at 98 d slaughter. Sex-wise, the liver weight at 84 d was significantly ($p<0.05$) more in female than male during winter (figure 6). The lowest liver weights were recorded in the female and male during rainy season. On the other hand, at 98 d there was no difference in the liver weights of both the sexes during any of the season.

The pelt weights immediately after slaughter (raw), at 84 and 98 d, during winter, were highest and significant ($p<0.05$) than summer and rainy seasons (figure 5). Sex-wise, raw pelts weighed significantly ($p<0.05$) more in males and females during winter than summer followed by rainy season (figure 6). Direct dependence of the pelt size on the body weight of rabbit (Taylor and Johnston, 1984) and lower skin weights in heat stressed rabbits as compared to those kept in thermoneutral zone (Chiericato et al., 1996); elucidate the higher and lower pelt weights, during different seasons, in the present experiment. The overall and sex-wise analysis of processed pelt weights (figures 5 and 6) followed trend similar to weights of raw pelts during different seasons. However, at 98 d slaughter, the processed pelt weight in rainy season was comparatively better than summer possibly due to the onset of winter when the animals born in rainy season reached the slaughter age. It was noted that during processing of pelt, about 64-69% of their raw weight was lost during all three seasons indicating that subcutaneous tissues and fascia did not contribute much to the increased or decreased (raw or processed) weights of the pelt. An important factor-pelt area, which otherwise could have influenced the pelt weights, was non-significant during different seasons in this experiment, thereby, confirming that the variation in pelt weights were due to the skin thickness.

Nutritive index

Plane of nutrition (table 2) indicated lowest and highest dry matter intake (DMI) during winter and rainy seasons, respectively. The increased DMI and roughage intake during summer and rainy seasons were due to the better palatability of roughages owing to their succulent nature; as palatability declined with maturity of grasses (Church, 1986). The higher protein and lower fiber contents of roughage during summer and rainy season were indicators of better roughage quality. The daily weight gain was highest and significant ($p<0.05$) during winter months followed by summer and rainy seasons. The feed:gain was best during winter than summer and rainy seasons, indicating the suitability of winter season for rabbit production. In spite of comparatively less daily dry matter intake and poor quality of roughage (hay), the better growth performance during winter could be attributed totally to favorable environment, less disease stress and better feed: gain ($p<0.05$). On the other hand, the better quality of roughages supplied during summer and rainy seasons could have compensated for the heat stress. The need of high energy density in growing rabbits during high temperature needed to alleviate the thermal stress (Cervera et al., 1997). The effect of seasons on the post weaning weight gain and performance, similar to our findings, have been attributed to

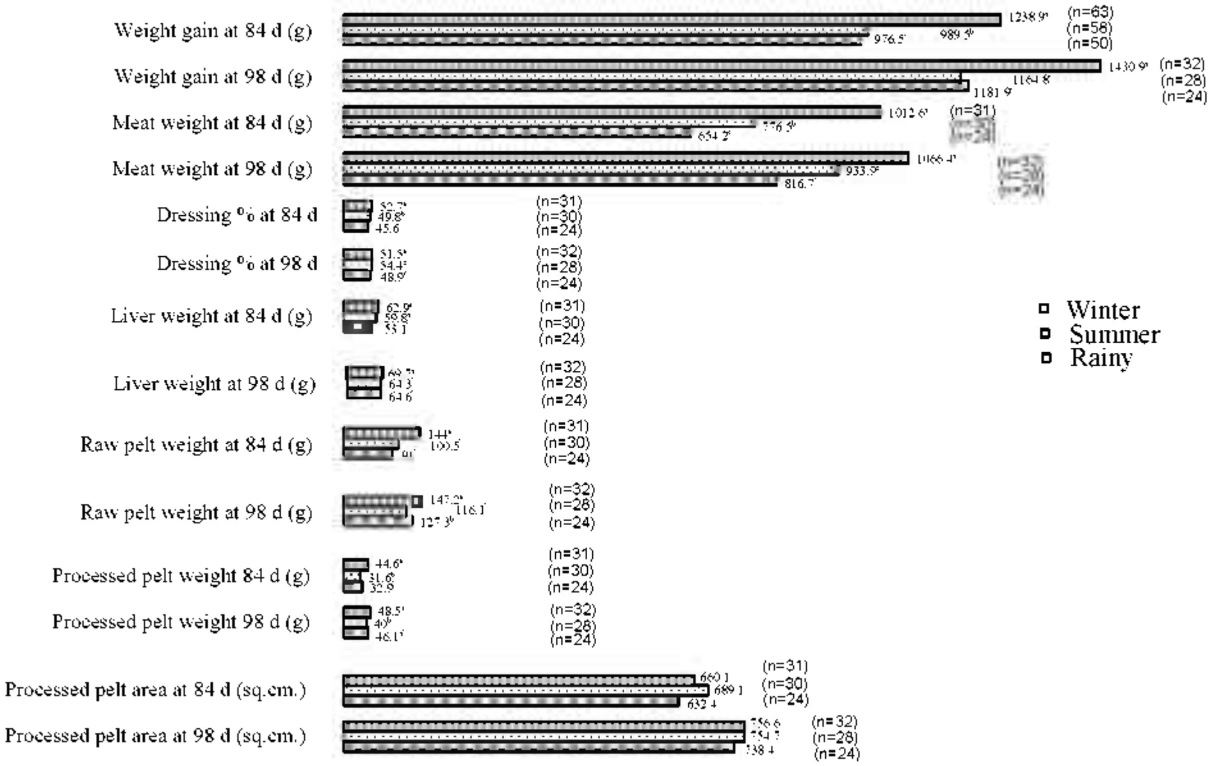

Figure 5. Production performance of rabbits during different seasons. Different superscripts for a particular parameter indicates statistical significance; means with different superscripts are significantly different ($p<0.05$).

the changes in nutritional and climatic conditions (Afifi and Emara, 1990).

Digestibilities of nutrients (table 2) revealed significantly ($p<0.05$) lower digestibility of dry matter (DM) during winter as compared to summer and rainy seasons. The digestibilities of crude fiber (CF), acid detergent fiber (ADF) and cellulose were negative during winter and could be due to matured grasses (hay) fed to the rabbits. Digestibilities of crude protein (CP), ether-extract (EE) and nitrogen free extract (NFE), during different seasons, were non-significant from each other. It is not unusual to have negative digestibility of fiber in rabbits (Singh et al., 1988) and could be related to proportionately higher CF and low CP in the roughage (Sanchez et al., 1985). Grasses fed during summer and rainy seasons were either premature or partially mature and therefore, had better digestibilities of CF, ADF and cellulose. An increased fibers, decreased proteins, digestibility and nutritive value (Cheeke, 1987) and decreased palatability (Church, 1986) of forages, on maturation, due to lignification of stem could possibly explain the findings in this experiment. Overall, digestibilities of different nutrients did not correlate well with the growth performance and to the feed: gain during different seasons. Though, the nutritive value of feeding regime was better during summer and rainy seasons than winter, the feed:gain was superior during winter possibly due to less thermal stress. A higher heat stress during rainy season, not only caused significant ($p<0.05$) mortality but also outweighed the effect of better nutrition on growth performance as well.

CONCLUSIONS

From this experiment, it was concluded that different seasons under sub temperate Himalayan conditions did not have any significant effects on doe weight at mating and kindling, litter size at birth, litter weight at birth, litter size at weaning and processed pelt areas. The litter weight at weaning, growth performance from weaning to day of slaughter, kit and weaner mortality, meat weight, dressing percentage, liver weight, and raw and processed pelt weights were influenced significantly by different seasons. In addition, the superior feed : gain during winter proved to be a better season for broiler rabbit production under conventional management conditions.

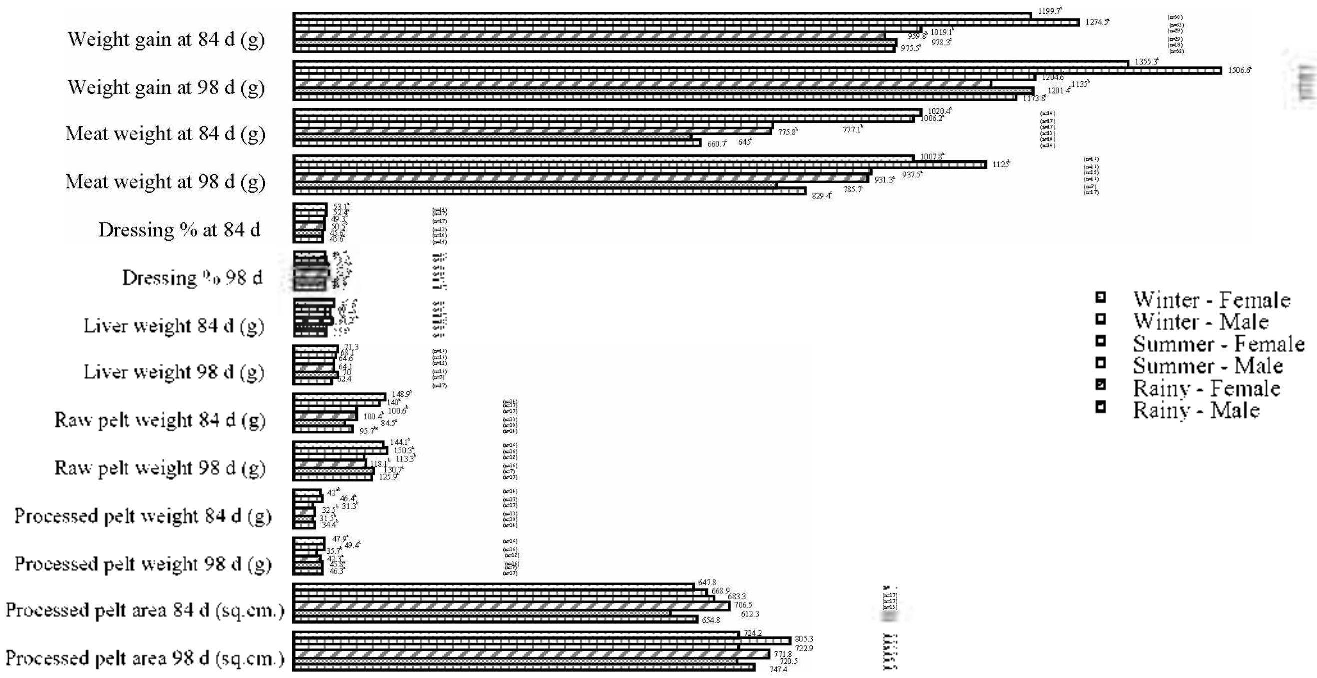

Figure 6. Sex-wise production performance of rabbits during different seasons. Different superscripts for a particular parameter indicates statistical significance: means with different superscripts are significantly different ($p<0.05$).

Table 2. Plane of nutrition, digestibility coefficients of nutrients and nutritive value of feeding regime in Grey Giant rabbits during different seasons

Parameters	Winter	Summer	Rainy
Plane of nutrition ($g \cdot d^{-1} \cdot head^{-1}$)			
Concentrate intake (Dry matter)	45	45	45
Roughage intake (Dry matter)	20	26.4	30.4
Total dry matter intake	65	71.4	75.4
Daily weight gain (g)-35 to 84 d	25.3±0.7[a]	20.2±0.4[b]	19.9±0.4[c]
Feed:Gain (Pooled)	2.6	3.5	3.8
Digestibility coefficients (%)			
Dry matter (DM)	36.5±5.6[a]	52.5±2.1[b]	55.6±3.9[b]
Crude protein (CP)	62.9±0.7	66.4±2.4	68.8±3
Crude fiber (CF)	-10.9±0.4	32.8±8.1	30.9±5.6
Ether extract (EE)	40.8±8.2	49.3±5.8	52.2±10.7
Nitrogen free extract (NFE)	48.2±7	63.1±1.7	62.4±1.6
Acid detergent fiber (ADF)	-4.9±6.9	33.9±4.3	25.5±2.2
Cellulose (ADF-ADL)	-16.8±13.4	36.2±4.9	28.6±0.1
Nutritive value of feeding regime (%)			
Digestible crude protein (DCP)	11.1	11.8	12.0
Total digestible nutrients (TDN)	39.4	53.7	53.2

Figures bearing different superscript in a row significantly ($p<0.05$) differ from each other.

REFERENCES

Afifi, E. A. 1971. A study of some economical and productive characters in some strains of rabbits and their crosses. PhD thesis. Faculty of Agriculture, Ain-Shams Univ., Egypt.

Afifi, E. A. and M. E. Emara. 1990. Breed group and environmental factors influencing post weaning daily gain in weight of pure-bred and cross bred rabbits. J. Appl. Rabbit Res. 13:114-118.

AOAC. 1990. Official Methods of Analysis (15th Ed.) Association of Official Analytical Chemists. Washington. DC.

Ayyat, M. S., I. F. M. Marai and A. GH. El- Sayaid. 1995. Genetic and non-genetic factors affecting milk production and pre weaning litter traits of New Zealand does under Egyptian conditions. World Rabbit Science, 3:119-124.

Bhasin, V. and D. Singh. 1995. Pre-weaning mortality in rabbits. Int. J. Anim. Sci. 10:77-79.

Cervera, C., E. Blas and J. Fernandez-Carmona. 1997. Growth of rabbits under different environmental temperature using high fat diets. World Rabbit Science, 5:71-75.

Cheeke, P. R. 1987. Rabbit feeding and nutrition. Hartcourt Brace Jovanovich, Publishers Academic Press, Inc.

Cheeke, P. R., N. M. Patton and G. S. Templeton. 1982. Rabbit Production. The Interstate Printers and Publishers Inc. Danville Illinois.

Chiericato, G. M., L. Bailoni and C. Rizzi. 1992. The effect of environmental temperature on the performance of growing rabbits. J. Appl. Rabbit Res. 15:723-731.

Chiericato, G. M., C. Rizzi and V. Rostellato. 1993. Effect of genotype and environmental temperature on the performance of the young meat rabbits. World Rabbit science, 1:119-125.

Chiericato, G. M., C. Rizzi and V. Rostellato. 1996. Effect of genotype and environmental conditions on the productive and slaughtering performance of growing meat rabbits. 6th World Rabbit Congress, Toulouse, III:147-151.

Church, D. C. 1986. Livestock feeds and feeding. (2nd Ed.). Prentice-Hall, Englewood Cliffs, New Jersey, USA, 07632.

Ferraz, J. B. S., R. K. Johnson and J. P. Eler. 1991. Breed and environmental effects on reproductive traits of Californian and New Zealand White rabbits. J. Appl. Rabbit Res. 14:172-179.

Finzi, A., S. Nyvold and M. El. Agroudi. 1992a. Evaluation of heat stress in rabbits under field conditions. J. Appl. Rabbit Res. 15:739-744.

Finzi, A., S. Nyvold and M. El. Agroudi. 1992b. Efficiency of three different housing systems in reducing heat stress in rabbits. J. Appl. Rabbit Res. 15:745-750.

Goering, H. K. and P. J. Van Soest. 1984. Forage Fibre Analysis. Agricultural Handbook No. 379, ARS, USDA, Washington, DC.

Gupta, S. C., N. Gupta, Riyazudin and G. Singh. 1992. Growth performance of meat rabbits in semi arid tropical conditions in India. J. Appl. Rabbit Res. 15:766-774.

Harkness, J. E. 1988. Rabbit behaviour as related to environmental stress. J. Appl. Rabbit Res. 11:227-236.

Kulkarni, V. V., K. Gupta, R. Bhatt and N. K. Manuja. 1995. Growth, carcass traits and meat composition of broiler rabbits. Indian J. Anim. Sci. 65:599-601.

Lebas, F. 1983. Small scale rabbit rearing in developing countries. World Rev. 46:10-17.

Lebas, F., P. Coudert, R. Rouvier and H. C. Rochambeau de. 1986. The Rabbit Husbandry, health and production. F.A.O. of the United Nations, Via delle Terme di Caracalla 00100 Rome Italy.

Maertens, L. and G. De Groote. 1990. Comparison of feed intake and milk yield of does under normal and high ambient temperature. J. Appl. Rabbit Res. 13:3-4.

McNitt, J. I. and S. D. Lukefahr. 1990. Effect of breed, parity, day of lactation and number of kits on milk production of rabbits. J. Anim. Sci. 68:1505-1512.

Matheron, G. and J. P. Martial. 1981. Growth and feed consumption of rabbit does from weaning to 4 months of age in different ambient temperature and humidities. Zootechniques et Physiologiques. E.N.S.A. Rennes.

NRC. 1977. Nutrient Requirement of Rabbits. (2nd Ed.). National Acad. Sci. Washington, DC.

Papp, Z. and P. Rafai. 1988. Impact of heat stress on pregnant rabbits and on the development and viability of their fetuses. 4th World Rabbit Congress, Budapest, 470-478.

Remois, G., P. Lafargue-Hauret, A. Bourdillon and H. Rouillere. 1996. Effect of weaning weight on growth performance of rabbits. 6th World Rabbit Congress, Toulouse, 237-240.

Sanchez, W. K., P. R. Cheeke and N. M. Patton. 1985. Effect of dietary crude protein level on the reproductive performance and growth performance of New Zealand White rabbits. J. Anim. Sci. 60:1029-1039.

Sandford, J. C. 1986. The Domestic Rabbits. (4th Ed.). William Collins Sons and Co. Ltd. 8, Grafton street, London.

Singh, B., H. P. S. Makkar and L. Krishna. 1988. Utilization by growing rabbits of a low crude protein diet with or without urea and groundnut cake supplementation. J. Appl. Rabbit Res. 9:25-28.

Snedecor, G. W and W. G. Cochran. 1967. Statistical Methods. (6thEd.). Oxford and IBH Publishing Co. Calcutta.

Taylor, T. W. and N. P. Johnston. 1984. The effect of feed restriction on pelt size and degree of prime in rex rabbits. J. Appl. Rabbit Res.7:62-67.

Torres, C., M. Pla and I. Garcia. 1986. Relation de las predidas de gazapos deuante el engorde, XI Symposium de cunicultura, 125-129. Terace.

Valderma de Deaz, G. and H. Varela-Alverez. 1975. Genetic study on the improvement of some productive characters in rabbits. Agro Ciencia, 21:115-124.

Vicente, J. S. and F. Garcia-Ximenez. 1992. Growth limitations of suckling rabbits. Proposal of a method to evaluate the numerical performance of rabbit does until weaning. J. Appl. Rabbit Res. 15:848-855.

Withorff, E. K., C. E. Heird, J. M. Rakes and Z. B. Johnson.1988. Growth and reproduction of nutrient restricted rabbits in a heat stressed environment. J. Appl. Rabbit Res. 11:87-92.