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# REPRODUCTIVE PERFORMANCE OF DIFFERENT BREEDS OF BROILER RABBITS UNDER SUB-TEMPERATE CLIMATIC CONDITIONS

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Abstract: This study was conducted to assess the effect of breed, season, age and weight of doe at mating on reproductive performance of 4 broiler rabbit breeds, Grey Giant, White Giant, Soviet Chinchilla, and New Zealand White, reared under standard management practices in sub-temperate climatic conditions of India. They were first mated at 6 to 7 mo of age, whereupon an extensive breeding system (re-mating after weaning) was followed. Weaning was done 42 d after kindling. The data from the records on reproduction consisting of 503 matings and 377 kindlings were analysed. The parameters considered were fertility rate, litter size at birth (LSB), litter weight at birth (LWB), litter size at weaning (LSW), litter weight at weaning (LWW), doe weight at mating (DWM), gestation length and sex ratio. Among 4 breeds, the LSB, LWB and LSW were higher in Grey Giant followed by White Giant, Soviet Chinchilla and New Zealand White. The LSB and LSW in Grey Giant breed differed significantly ($P<0.05$) from Soviet Chinchilla and New Zealand White. Season had significant ($P<0.05$) effect on LSW with higher values during spring (5.68±0.24), followed by summer (5.29±0.30), winter (5.13±0.25) and autumn (4.17±0.49). The body weight of doe at service significantly influenced fertility. The fertility increased as body weight increased. The age of the doe at mating had a significant effect on LSW, with higher values for does more than 2 yr and less than 1 yr old compared to 1- to 2-yr old does. The parity did not affect any of the parameters studied. It is concluded that the factors studied affect the reproductive performance of rabbit does. Grey Giant breed showed the highest litter size at birth and weaning, and the highest litter size and weight at weaning was in spring.

Key Words: fertility, broiler rabbit, season, breed and reproductive performance.

## INTRODUCTION

In many countries of the world, rabbit breeding plays an increasing role in meat and fur production. In recent years, there has been a rising awareness in India on the virtues of broiler rabbit production as an alternative means of alleviating food shortages. Apart from its high prolificacy, the rabbit has several advantages over many other farm species, including its high meat quality due to higher protein and much lower fat/cholesterol contents (Fielding, 1991). As production directly depends on reproduction, reproductive performance of rabbits becomes an important aspect in determining profitability of commercial rabbit breeding. Factors such as breed, season, age, and weight of females influence the reproductive performance of animals (Lazzaroni *et al.*, 2012). While applied and basic research conducted in developed countries has yielded numerous reports in the scientific literature, reports on reproductive performance of broiler rabbits raised in India are very limited (Ghosh *et al.*, 2008; Sivakumar *et al.*, 2013). Therefore, in the present study we determined the effects of these variables on reproductive performance of broiler rabbits under sub-temperate climatic conditions of India in order to find the best strategies for improving their reproductive efficiency.

## MATERIAL AND METHODS

Four breeds of broiler rabbits, Grey Giant (GG), New Zealand White (NZW), Soviet Chinchilla (SC), and White Giant (WG) were reared until culling or death under standard management practices at sub-temperate climatic conditions

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in the rabbit unit of the North Temperate Regional Station of Central Sheep and Wool Research Institute, Garsa, Kullu (HP), India. The station is located at a longitude of 32° N, latitude of 78° E and height of 1192.8 m above mean sea level.

All does were kept individually in standard size iron cages and were provided similar housing and management throughout the study period. Each doe was offered concentrate 140 g/d (280 g/d during lactation) in pellet form and seasonal roughage and water *ad libibitum.* The concentrate diet was composed of maize 30%, groundnut expeller 20%, sunflower cake 5%, soy flakes 5%, wheat bran 15%, rice bran 15%, fishmeal 3.5%, molasses 5%, mineral mixture 1% and common salt 0.5%. Additionally, the feed (100 kg) was supplemented with 10 g of vitamins A, $D_3$, K, and E together with selenium mixture, 5 g each of lysine and methionine, 50 g of magnesium oxide, and 250 g of Di-calcium phosphate. Seasonal roughage consisted of *Festuca arundinacea*, *Lolium perenne*, *Trifolium repens*, *Paspalum* spp., and *Setaria* spp., in wilted form, in the afternoon.

The does (n=246) were first mated at 6-7 mo of age and thereafter extensive breeding system (re-mating after weaning) was followed. Mating was done as per the breeding plan to avoid inbreeding. According to the breeding plan, bucks of the same breed as the doe (one buck for 3 does) were assigned at random for breeding the does with the restriction to avoid parent-offspring, full- and half-sibling mating. Does were taken to the breeding cages of assigned bucks to be bred and returned to their own cages after copulation. Culling of breeding females was done on the basis of their reproductive performance including male refusal, not conceiving following 3 consecutive matings, and reduced litter size. Nulliparous does were continuously added to the breeding stock as per production demand. Primiparous and multiparous does were selected for breeding on the basis of their body weight at 84 d (slaughter age), litter size at birth (LSB) and litter size at weaning (LSW), while nulliparous does were selected on their body weight at 84 d, and LSB and LSW of the litter from which they derived.

Newborn kits were milk fed manually twice a day in the morning and evening, and 20 d after birth they were offered mashed concentrate diet along with doe's milk till weaning. The young ones were weaned at 42 d of age. The weanling rabbits were sexed and kept individually in all wire mash cages of standard size under similar housing and management conditions. Each weanling rabbit was given concentrate (50 g/d from 42 to 84 d and 80 g/d from 85 to 165 d) in pellet form and roughage and water *ad libitum.*

Monthly meteorological data, including minimum and maximum temperature, relative humidity, and rainfall, were collected from the station records and four seasons were categorised, i.e. winter (December to February), spring (March to May), summer (June to August) and autumn (September to November).

Data from the reproduction records on 222 does, consisting of 503 matings and 377 kindlings during the 5-yr period, were analysed to study the effect of breed (GG, NZW, WG, SC), season of kindling (spring, summer, autumn, winter), age of doe at mating (6 mo-1 yr, 1-2 yr, >2 yr), body weight of doe at mating (<2.5, 2.5-3.5, >3.5 kg) and parity (I, II, >III) on the reproductive performance of broiler rabbits. The reproductive performance parameters considered were fertility rate (proportion of females mated that kindled), prolificacy (LSB and LSW), litter weight at birth and litter weight at weaning, doe weight at mating, gestation length and sex ratio (per cent proportion of males to total kits born).

The data were analysed by analysis of variance (ANOVA) using the general linear model (GLM) procedure of SPSS 13.0 for Windows with different fixed effects: breed, season, age, weight, parity, and their interactions. Fertility rates were compared using chi square test as per Snedecor and Cochran, 1994. Results are presented as means, standard error means, and percentage.

## RESULTS AND DISCUSSION

The average temperatures were 10.34±3.27, 19.34±3.64, 25.57±2.36 and 19.57±3.97°C during winter, spring, summer, and autumn seasons, respectively. The average relative humidity (%) and total rainfall (mm) were 70.1±1.1 and 43.7±19.2, 61.0±2.4 and 41.2±11.0, 72.7±3.1 and 111.2±15.1, and 74.3±1.3 and 60.0±32.9, in the respective seasons. The overall value of fertility and mean values as influenced by breed, season of kindling, age and weight of doe at mating are presented in Table 1. The values for litter size at birth and weaning, doe's weight at mating, gestation length, and sex ratio as influenced by breed, season of kindling, age of doe at mating and parity are shown in Table 2.

Table 1: Effect of breed, season, doe's age and weight on fertility of broiler rabbits.

| Factors | No. of does | Mating No. | Fertility rate (%) |
|---|---|---|---|
| Overall | 246 | 503 | 74.95 |
| Breed | | | |
| GG | 56 | 108 | 75.9 |
| NZW | 37 | 80 | 71.3 |
| SC | 101 | 203 | 76.4 |
| WG | 52 | 112 | 74.1 |
| Season | | | |
| Spring | 141 | 184 | 77.9 |
| Summer | 116 | 130 | 76.9 |
| Autumn | 34 | 35 | 74.3 |
| Winter | 135 | 157 | 74.8 |
| Age | | | |
| 6 mo-1 yr | 127 | 142 | 73.2 |
| 1-2 yr | 177 | 271 | 75.6 |
| >2 yr | 59 | 90 | 75.6 |
| Weight | | | |
| <2.5 kg | 81 | 106 | 66.0[a] |
| 2.5-3.5 kg | 139 | 192 | 76.6[b] |
| >3.5 kg | 133 | 205 | 78.0[b] |

[a,b] Means in the same column and effect not sharing different superscripts differ ($P \leq 0.05$).
GG: Grey Giant, NZW: New Zealand White, SC: Soviet Chinchilla, WG: White Giant.

Among the 4 breeds examined, litter size at birth and weaning were higher ($P<0.05$) in GG followed by WG, SC and NZW. A similar trend was observed for litter weight at birth, but the differences were non-significant. However, litter weight at weaning as well as weight of does at mating were higher in White Giant ($P<0.05$), although the differences for litter weight at weaning were non-significant. Ponce de Leon *et al.* (2000) also observed a significant effect of breed on litter size at birth and weaning comparing Semi-giant, Chinchilla, New Zealand, and California broiler rabbit breeds. Similar to our results, Das and Yadav (2007) reported no significant difference between NZW and SC for prolificacy and litter weights at birth and weaning. In the present study, breed had no effect on fertility, whereas Ghosh *et al.* (2008) observed a significantly higher number of services per conception and inter-kindling interval in NZW than in SC does, while Ponce de Leon *et al.* (2000) reported that the New Zealand had the highest fertility compared to Semi-giant, Chinchilla, and California breeds.

Season of kindling significantly ($P<0.05$) affected both litter size and weight at weaning, as well as the doe's weight at mating and gestation length. All the other parameters here examined were not influenced by the season. In agreement with our results, Khalil and Mansour (1987) and El-Maghawry *et al.* (1988) also noted higher values for litter size at weaning in spring, while Kumar *et al.* (2005) reported a significant effect of season on gestation length in Angora rabbits. Similarly to our data, the absence of seasonal effects on fertility (Rodríguez and Fallas, 1999), litter size at birth and weaning (Bhatt *et al.*, 2002) and sex ratio (Khalil and Mansour, 1987) has also been reported. In contrast, Ponce de Leon *et al.* (2000) observed that the season had a significant effect on fertility, being higher in spring and lower in autumn. In the present study, litter size at birth and weaning as well as litter weight at birth were higher during spring followed by summer and winter, and lowest in autumn. In addition, Belhadi *et al.* (2002) also supports our findings that spring is the favourable season for rabbit reproduction. In the present study, summer was not found such an unfavourable season for reproduction as reported in temperate (García *et al.* 2000), sub-temperate (Kumar *et al.*, 2005) and tropical (Ponce de León *et al.* 2000) climates.

The influence of season on reproductive efficiency observed in this study may be attributed to changing photoperiod (Hudson and Distel, 1990) and/or temperature (Simplicio *et al.* 1988). The increasing day length, comfortable temperature and availability of quality fodder during spring season may contribute to the high reproductive efficiency of rabbits in this period of the year. The pasture during spring was lush, having higher nutritive value with more protein and carotene content as compared to other seasons (Bhatt *et al.*, 2002) and it has been observed that higher feed intake during lactation increased both litter size and weight at weaning (Pascual *et al.*, 2002).

Table 2: Effect of breed, season, doe's age and parity on reproductive parameters of broiler rabbits.

| Factors | No. | LSB | LWB (g) | LSW | LWW (kg) | DWM (kg) | Gestation length (d) | Sex ratio (%) |
|---|---|---|---|---|---|---|---|---|
| Overall | 377 | 5.57±0.14 | 307.16±9.57 | 5.24±0.14 | 3.86±0.16 | 3.39±0.03 | 31.57±0.08 | 49.27±1.78 |
| Breed | | | | | | | | |
| GG | 82 | 6.30±0.30$^{b}$ | 344.43±20.78 | 6.11±0.31$^{b}$ | 3.60±0.24 | 3.29±0.07$^{a}$ | 31.36±0.17 | 55.40±3.87 |
| NZW | 57 | 5.28±0.32$^{a}$ | 286.48±21.94 | 5.03±0.33$^{a}$ | 3.77±0.24 | 3.47±0.07$^{ab}$ | 31.68±0.18 | 50.22±4.09 |
| SC | 155 | 5.31±0.21$^{a}$ | 297.33±14.41 | 4.72±0.22$^{a}$ | 3.79±0.18 | 3.31±0.05$^{a}$ | 31.49±0.12 | 47.63±2.68 |
| WG | 83 | 5.48±0.30$^{ab}$ | 303.22±20.9 | 5.27±0.31$^{ab}$ | 4.24±0.23 | 3.51±0.07$^{b}$ | 31.76±0.17 | 44.88±3.89 |
| Season | | | | | | | | |
| Spring | 141 | 5.91±0.23 | 312.76±15.72 | 5.68±0.24$^{b}$ | 4.21±0.18$^{b}$ | 3.41±0.05$^{b}$ | 31.78±0.13$^{b}$ | 46.94±2.93 |
| Summer | 100 | 5.45±0.29 | 312.18±20.06 | 5.29±0.30$^{ab}$ | 4.19±0.21$^{b}$ | 3.49±0.06$^{b}$ | 31.51±0.17$^{ab}$ | 55.01±3.73 |
| Autumn | 26 | 4.96±0.47 | 270.72±32.65 | 4.17±0.49$^{a}$ | 3.26±0.34$^{a}$ | 3.47±0.10$^{b}$ | 31.53±0.27$^{ab}$ | 41.90±6.08 |
| Winter | 110 | 5.53±0.24 | 312.06±14.46 | 5.13±0.25$^{ab}$ | 3.47±0.21$^{a}$ | 3.22±0.06$^{a}$ | 31.39±0.14$^{a}$ | 50.90±3.07 |
| Age | | | | | | | | |
| 6 mo-1 yr | 104 | 5.80±0.25 | 321.78±17.06 | 5.49±0.26$^{b}$ | 3.86±0.24 | 3.19±0.07$^{a}$ | 31.59±0.14 | 47.88±3.18 |
| 1-2 yr | 205 | 5.33±0.19 | 285.84±13.27 | 4.84±0.20$^{a}$ | 3.48±0.15 | 3.32±0.05$^{a}$ | 31.46±0.11 | 47.62±2.47 |
| >2 yr | 68 | 5.79±0.32 | 331.93±21.85 | 5.73±0.33$^{b}$ | 4.42±0.21 | 3.57±0.06$^{b}$ | 31.77±0.15 | 53.93±4.07 |
| Parity | | | | | | | | |
| I | 210 | 5.61±0.14 | 310.38±9.20 | 5.29±0.14 | 3.81±0.10 | 3.20±0.04 | 31.61±0.08 | 49.38±1.74 |
| II | 131 | 5.52±0.17 | 297.85±11.70 | 5.34±0.17 | 3.89±0.12 | 3.48±0.05 | 31.57±0.10 | 47.30±2.21 |
| >III | 36 | 5.06±0.33 | 283.89±22.23 | 5.03±0.33 | 3.59±0.24 | 3.50±0.08 | 31.78±0.19 | 49.64±4.19 |

[a,b] Means in the same column and effect not sharing different superscripts differ significantly ($P \leq 0.05$).

GG: Grey Giant, NZW: New Zealand White, SC: Soviet Chinchilla, WG: White Giant. LSB: Litter size at birth, LWB: Litter weight at birth, LSW: Litter size at weaning, LWW: Litter weight at weaning, DWM: Doe weight at mating.

Fertility, prolificacy, litter weight at birth, gestation length, and sex ratio were higher in rabbit does over 2 yr of age, followed by females of less than 1 yr of age and 1-2 yr old. However, significant ($P \leq 0.05$) differences were observed only for litter size at weaning. The lower litter size at weaning of 1-2 yr old rabbit does might be due to the inclusion of a greater number of primiparous does in this group, as body energy deficit of primiparous does and the negative interactions between lactation and fertility are well known (Theau-Clement and Roustan, 1992; Fortun-Lamothe *et al.*, 1999; Xiccato *et al.*, 2004), which explains the high fertility rate in nulliparous does, a lower fertility in primiparous does and intermediate values in multiparous does (Rebollar *et al.*, 1992). Contrary to these findings, Aumann *et al.* (1984) reported a highly significant effect of age on litter size at birth and Telbert *et al.* (1968) as cited by Larson and Foote (1972) reported the decrease in reproductive efficiency of older females with advancing age. The doe's body weight had significant ($P<0.05$) effect on fertility rate, showing an increasing trend as body weight of the doe increases.

The parity did not have a significant effect on any of the reproductive parameters measured in the present study. However, litter size and weight at birth as well as litter size at weaning increased with advancing parity. Similar findings were reported by Xiccato *et al.* (2004) on litter size at weaning and gestation length, by Das and Yadav (2007) on litter weight at birth as well as litter size and weight at weaning, and by Tuma *et al.* (2010) on litter weight at birth. In contrast, Xiccato *et al.* (2004) found a significant effect of parity on litter size and weight at birth as well as litter weight at weaning, and Das and Yadav (2007) on litter size at birth, which were higher in the 3$^{rd}$ parity than in the 1$^{st}$ and the 2$^{nd}$ parity.

The interactions of these factors had no effect on all the reproductive parameters studied. The inconsistencies in the influence of these factors on reproductive performance among studies as discussed above can be attributed to different breeding systems, particularly reproductive rhythms, housing, feeding, climate and the breed/genotype used. In view of the importance of these factors in affecting reproductive performance of broiler rabbits, their consideration at the time of breeding can enhance reproductive performance and consequently production.

In conclusion, the results of the present study indicate that the Grey Giant breed of broiler rabbit appears to be the most suitable breed under sub-temperate climatic conditions of India as far as reproductive performance is concerned. Spring was the most favourable season for efficient reproduction of broiler rabbits under sub-temperate climatic conditions of India.

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