



## Factors affecting instantaneous relative growth rate of Pantja kids under range conditions

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Received: 24 July 2019; Accepted: 29 July 2019

**Keywords:** Heritability, Instantaneous relative growth rate, Pantja goats, Sire

India possess 34 recognized breeds of goats, which constitute 20–25% of the total goat population and remaining are non-descript with mixed features (Khadda *et al.* 2019). Pantja is a newly registered goat breed of Tarai region of Uttarakhand, mainly reared for meat purpose. Instantaneous relative growth rate is the true measure of growth rate. The true relative growth rate eliminates the discrepancy between the physiological and physical unit of time and can be used directly for comparing growth of animals with widely different weights or even different species. The instantaneous relative growth Rate 'K' is the difference between the natural logarithms of weights,  $w_2$  and  $w_1$  divided by time interval  $t_2-t_1$  suggested by (Brody, 1945). Genetic studies on IRGR in Indian goats are scanty and lacking for Pantja goats. Therefore, a study was undertaken to identify various factor influencing instantaneous relative growth rates and to estimate genetic and phenotypic parameters of this traits in Pantja goats.

In the year 2015–16 data on Pantja goats maintained by registered farmers (56) in native tract under All India Co-ordinated Research Project on Goats (Pantja field Unit), Department of livestock Production and Management, College of Veterinary and Animal Sciences, G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) were used for study. Four clusters from (Bhimtal and Bara) Nainital and (Tilpuri and Kunda) Udham Singh Nagar districts of Tarai region of Uttarakhand were established to undertake genetic improvement work on Pantja goats. Elite Pantja bucks were distributed among selected farmers of these clusters. All the goats under genetic improvement programme were registered with rubber tagging identification marks. Body weights and measurements from birth to 12 months of age at an interval of 3 months were recorded. The records of 805 kids born from 514 does and 26 sires were used for present study. The data were classified according to sire, clusters, sex of kid, season of kidding, type of kidding, flock size, educational level of owner, parity of doe, and type of house. Generally goats were housed during night only and kept on grazing in the morning and evening. Goats were

primarily kept on natural vegetation consisting of shrubs and trees under semi intensive system of management. The goats were vaccinated against enterotoxaemia, *peste des petits* ruminants and foot and mouth disease regularly. Deworming was done twice in a year.

Instantaneous relative growth rate at 0–3 months (IRGR<sub>1</sub>), 3–6 months (IRGR<sub>2</sub>), 6–9 months (IRGR<sub>3</sub>) and 9–12 months (IRGR<sub>4</sub>) were calculated as per Brody (1945).

The effect of various genetic and non-genetic factors on instantaneous relative growth rate were further analyzed using mixed model least-squares and maximum likelihood computer program (LSMLMW PC-1 version) for fitting constant to overcome the difficulty of disproportionate sub class frequencies and non-orthogonality of data designed by Harvey (1990). Paternal half – sib correlation method was used to estimate heritability. The genetic and phenotypic correlations among different traits were estimated from the analysis of variance/covariance using half-sib data as suggested by Becker (1975).

The overall least-squares mean for Instantaneous relative growth rate at 0–3, 3–6, 6–9 and 9–12 months of age were found to be  $1.75 \pm 0.02$ ,  $0.35 \pm 0.01$ ,  $0.24 \pm 0.01$  and  $0.17 \pm 0.01$  per cent/ day, respectively (Table 1). Similar results have also been reported by Sharma *et al.* (2010) in Sirohi goats.

The effect of sire was found to be highly significant ( $P < 0.01$ ) on IRGR<sub>1</sub> (0–3 months), IRGR<sub>2</sub> (3–6 months) and IRGR<sub>4</sub> (9–12 months). The significant effect of sire on instantaneous relative growth rate indicating the existence of additive genetic variability among these traits which can be used effectively for further improvement.

The cluster had significant ( $P < 0.01$ ) effect on IRGR<sub>2</sub>, IRGR<sub>3</sub> and IRGR<sub>4</sub>. Different agro-climatic conditions, goat management practices followed by goat herds, socio-economic variability between the goat rearers of the different clusters could be some of the reasons for significant variations in relative growth rate amongst the different clusters.

Season of kidding had non-significant effect on IRGR<sub>1</sub> and IRGR<sub>2</sub> whereas; this effect was found to be significant ( $P < 0.01$ ) on IRGR<sub>3</sub> and IRGR<sub>4</sub> ( $P < 0.05$ ). Non-significant effect has also been reported by Sharma (1994) for 0–3 months of age in Sirohi goats. However, significant ( $P < 0.01$ )

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Table 1. Least-squares means and their standard error (per cent/ day) for instantaneous relative growth rate (IRGR) across different factors in Pantja goats

Factor	IRGR <sub>1</sub> (0–3 M)	IRGR <sub>2</sub> (3–6 M)	IRGR <sub>3</sub> (6–9 M)	IRGR <sub>4</sub> (9–12 M)
Overall mean ( $\mu$ )	1.75±0.02 (805)	0.35±0.01 (715)	0.24±0.01 (597)	0.17±0.01 (485)
Sire (26)	**	**	*	**
Cluster (4)	NS	**	**	**
Bhimtal	1.77±0.01 (317)	0.39±0.01 <sup>a</sup> (283)	0.24±0.01 <sup>ba</sup> (241)	0.18±0.01 <sup>b</sup> (202)
Tilpuri	1.72±0.01 (339)	0.37±0.01 <sup>a</sup> (298)	0.26±0.01 <sup>a</sup> (239)	0.15±0.01 <sup>c</sup> (187)
Bara	1.75±0.02 (121)	0.35±0.01 <sup>a</sup> (108)	0.24±0.01 <sup>ba</sup> (93)	0.20±0.01 <sup>a</sup> (76)
Kunda	1.76±0.04 (28)	0.29±0.02 <sup>b</sup> (26)	0.22±0.01 <sup>b</sup> (24)	0.16±0.01 <sup>c</sup> (20)
Season of kidding (4)	NS	NS	**	*
Summer (Mar.–Jun.)	1.77±0.03 (182)	0.34±0.01 (164)	0.25±0.01 <sup>a</sup> (149)	0.18±0.01 <sup>a</sup> (118)
Rainy (July–Sep.)	1.74±0.03 (138)	0.35±0.02 (115)	0.24±0.01 <sup>a</sup> (97)	0.17±0.01 <sup>a</sup> (77)
Autumn (Oct.–Nov.)	1.74±0.03 (232)	0.35±0.01 (209)	0.24±0.01 <sup>a</sup> (170)	0.16±0.01 <sup>ba</sup> (138)
Winter (Dec.–Feb.)	1.75±0.02 (253)	0.35±0.01 (227)	0.22±0.01 <sup>b</sup> (181)	0.15±0.01 <sup>b</sup> (152)
Type of birth (2)	**	**	**	*
Single	1.57±0.02 <sup>b</sup> (311)	0.33±0.01 <sup>b</sup> (283)	0.23±0.01 <sup>a</sup> (243)	0.16±0.01 <sup>b</sup> (198)
Twin	1.93±0.02 <sup>a</sup> (494)	0.37±0.01 <sup>a</sup> (432)	0.25±0.01 <sup>b</sup> (354)	0.17±0.01 <sup>a</sup> (287)
Sex of kid (2)	**	**	**	*
Male	1.80±0.02 <sup>a</sup> (458)	0.36±0.01 <sup>b</sup> (413)	0.25±0.01 <sup>a</sup> (340)	0.17±0.01 <sup>a</sup> (257)
Female	1.70±0.02 <sup>b</sup> (347)	0.34±0.01 <sup>a</sup> (302)	0.23±0.01 <sup>b</sup> (257)	0.16±0.01 <sup>b</sup> (228)
Type of house (3)	*	*	NS	NS
Kaccha	1.83±0.03 <sup>a</sup> (440)	0.30±0.03 <sup>b</sup> (389)	0.23±0.02 (323)	0.17±0.02 (259)
Pucka	1.87±0.07 <sup>a</sup> (230)	0.35±0.03 <sup>ba</sup> (207)	0.24±0.02 (174)	0.15±0.02 (147)
Slatted	1.55±0.12 <sup>b</sup> (135)	0.40±0.04 <sup>a</sup> (119)	0.25±0.03 (100)	0.19±0.03 (79)
Flock size (4)	NS	NS	NS	NS
Small (0–5)	1.68±0.05 (118)	0.35±0.02 (106)	0.24±0.01 (89)	0.17±0.02 (73)
Medium (6–10)	1.79±0.08 (70)	0.32±0.03 (63)	0.24±0.02 (53)	0.13±0.02 (44)
Semi-large (11–20)	1.81±0.07 (320)	0.36±0.05 (285)	0.27±0.04 (236)	0.20±0.04 (189)
Large (>20)	1.74±0.11 <sup>b</sup> (297)	0.35±0.04 (261)	0.21±0.03 (219)	0.17±0.03 (179)
Education level (3)	*	NS	NS	NS
Illiterate	1.64±0.11 (236)	0.38±0.07 (209)	0.22±0.05 (177)	0.14±0.06 (145)
Up to matriculate	1.67±0.07 (314)	0.33±0.03 (280)	0.24±0.02 (233)	0.20±0.02 (185)
Above matriculate	1.94±0.12 (255)	0.34±0.07 (226)	0.26±0.06 (187)	0.16±0.06 (155)
Parity of dam (6)	NS	*	NS	NS
First	1.74±0.04 (115)	0.37±0.02 <sup>a</sup> (103)	0.24±0.01 (89)	0.19±0.01 (70)
Second	1.79±0.02 (200)	0.34±0.01 <sup>ba</sup> (181)	0.24±0.01 (147)	0.17±0.01 (119)
Third	1.75±0.02 (239)	0.36±0.01 <sup>a</sup> (207)	0.24±0.01 (178)	0.16±0.01 (145)
Fourth	1.74±0.03 (145)	0.35±0.01 <sup>a</sup> (127)	0.24±0.01 (103)	0.16±0.01 (84)
Fifth	1.76±0.03 (85)	0.34±0.02 <sup>ba</sup> (76)	0.25±0.01 (62)	0.15±0.01 (52)
Sixth	1.73±0.07 (21)	0.31±0.02 <sup>b</sup> (21)	0.23±0.01 (18)	0.17±0.02 (15)
Reg. on DWK	0.016±0.004**	0.001±0.002	–0.001±0.001	0.001±0.001

Note: No. of observations are given in parentheses. Estimates with different superscripts differ significantly. F statistic of corresponding effects as \*\*Highly significant ( $P < 0.01$ ); \*Significant ( $P < 0.05$ ); NS, Non-significant.

effect of season of kidding on instantaneous relative growth rate has also been reported by Sharma *et al.* (2010) during 0–3, 3–6, 6–9 and 9–12 months of age in Sirohi goats.

The effect of type of birth was found to be highly significant ( $P < 0.01$ ) on IRGR<sub>1</sub> (0–3 months), IRGR<sub>2</sub> (3–6 months) and IRGR<sub>3</sub> (6–9 months) whereas, this effect was found to be significant ( $P < 0.05$ ) on IRGR<sub>4</sub> (9–12 months). Kids born as single were heavier than those born as twins and grew well up to 9 months of age, which might have been due to physiological limitations of uterine environment available to multiple fetuses, partitioning of maternal resources in pre-natal life and poor suckling, in addition kids born in multiple birth have to compete with each other

in sharing the milk of does during suckling (Dudhe *et al.* 2015).

The sex of kid had significant ( $P < 0.01$ ) effect on IRGR<sub>1</sub>, IRGR<sub>2</sub>, IRGR<sub>3</sub> and ( $P < 0.05$ ) IRGR<sub>4</sub>. The male kids grew faster than the female kids in all stages from birth to the yearling stage and this might be due to the fact that male gonads get activated earlier than the female gonads. The secretion of male hormone, androgen has an anabolic effect, which results into faster growth in males as compared to the female kids (Hafez 1962). The growth rate in male kids was fast up to 9 months and thereafter it slowed down considerably. Female kids grew steadily beyond 9 months of age.

Table 2. Estimates of heritability (on diagonal), genetic correlation (above diagonal) and phenotypic correlation (below diagonal) for instantaneous relative growth rate (IRGR) at subsequent ages in Pantja goats

Traits	0–3 M	3–6 M	6–9 M	9–12 M
0–3 M	0.22±0.08	0.05±0.25	–0.26±0.25	–0.11±0.24
3–6 M	–0.16±0.04	0.32±0.10	0.52±0.19	–0.18±0.22
6–9 M	–0.19±0.04	0.21±0.04	0.26±0.09	–0.28±0.23
9–12 M	–0.09±0.05	0.06±0.05	0.02±0.05	0.61±0.16

The significant effect of type of house was found on IRGR<sub>1</sub> and IRGR<sub>2</sub>. Kids reared under *pucca* houses had more instantaneous relative growth rate as compared to those reared in *kachcha* houses, it might have been due to the fact that the goats are more comfortable on *pucca* and clean floor which results in enhanced growth. The flock size and parity of dams had a non-significant effect on IRGR<sub>1</sub>, IRGR<sub>2</sub>, IRGR<sub>3</sub> and IRGR<sub>4</sub>. Similar results have also been reported by Sharma (1994) and Sharma *et al.* (2010) in Sirohi goats.

The effect of education level of goat keepers was found significant on instantaneous relative growth rate during 0–3 months of age. The finding signified that education level of goat keepers was an important consideration for scientific goat husbandry practices.

The regression of dam's weight at kidding and instantaneous relative growth rate was positive and dam's weight at kidding had a highly significant effect on instantaneous relative growth rate between 0–3 months whereas, this effect was found to be positive and dam's weight at kidding had a non-significant effect on instantaneous relative growth rate during 3–6 and 9–12 months of age. Positive regression coefficients indicated that heavier kids were produced by dams whose body weight at kidding was higher as heavier dams provided better nourishment and more space for the developing fetus and thus resulting in heavier weight at birth.

The heritability estimate for instantaneous relative growth rate was moderate to high during the period of 0–3, 3–6, 6–9 and 9–12 months of age (Table 2). This indicated that these traits could be improved through better breeding and selection practices.

Most of the genetic and phenotypic correlations of instantaneous relative growth rate were observed to be negative between different periods. Such trends were seen because the absolute growths during these periods were standardized to initial weights of the same periods. Therefore, in case any animal had poor growth during a preceding period, the instantaneous relative growth rates were higher in the subsequent period due to compensatory growth. The moderate to high genetic correlation between pre-IRGR and post-IRGR may allow selection of kids even at the time of weaning to improve performance based on a 6 month body weight, and it may permit initial culling even at weaning due to correlated response to selection. Further, the selection for increasing early body weights may bring genetic improvement in body weights at subsequent periods/ ages.

## SUMMARY

A study was conducted to estimate the Instantaneous relative growth rate of 805 Pantja kids born to 514 goats and 26 sires during the year 2015–16 under All India Co-ordinated Research Project on Goats (Pantja field unit), College of Veterinary and Animal Sciences, Pantnagar (Uttarakhand). The overall least-squares mean for IRGR at 0–3, 3–6, 6–9 and 9–12 months of age were found to be 1.75±0.02, 0.35±0.01, 0.24±0.01 and 0.17±0.01%/day, respectively. The heritability estimate for IRGR was moderate to high during the period of 0–3, 3–6, 6–9 and 9–12 months of age. It can be concluded that the pre-weaning IRGR was higher which indicated that the kids were given full care during this period. The post-weaning IRGR can be improved through better nutrition and management of kids after weaning. Hence, for higher economic gain selection should be made at earlier age, preferably at 3 to 6 month. Nutritional and managerial interventions are essential to promote growth and earn more profit from goat rearing.

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