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EFFECT OF PHOTOPERIOD ON THE GROWTH PERFORMANCE OF SAHIWAL CATTLE HEIFERS

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The aim of this study was to check the effect of photoperiod (lightning duration) on dry matter intake (DMI), water intake, average daily gain (ADG) and body condition score of Sahiwal heifers. For this purpose, a total of nine yearling Sahiwal heifers having similar age, body weight and height were selected and divided into three groups (A, B and C) in such a way that each group had three heifers. Group A was allotted short day photoperiod (8 h Light: 16 h Dark), Group B was maintained on natural photoperiod and Group C was kept on long day photoperiod (16 h Light: 8 h Dark). The duration of experimental trial was from December to February (90 days) and during these months the duration of natural photoperiod varies from 8 to 12 hours. Results of this study showed that the photoperiod manipulation had a significant ($p<0.05$) effect on DMI, water intake and weight gain. The DMI in heifers of Group A, Group B and Group C were4.86, 4.76 and 5.33 kg day^{-1}, respectively. Water intake in heifers of Group A, Group B and Group C was 2.68, 2.49 and 3.06 Lday^{-1}, respectively. Average daily weight gain in Group A, Group B and Group C was 372.5, 338.1 and 435.4 g day^{-1}, respectively. Body measurements were not statistically different ($p >0.10$) however, body measurements were numerically greater in heifers exposed to long-day photoperiod than those on short-day photoperiod. Based on results, it is concluded that supplemental lighting had a significant effect on the growth performance of Sahiwal cattle heifers.

Keywords: photoperiod, heifers, dry matter intake, growth performance.

INTRODUCTION

It is worldwide acknowledged that the livestock farming is playing an important role in food security and poverty alleviation for rural poor (Herrero *et al*., 2011). Livestock plays an important role in national economy of Pakistan by contributing 60.5% in agriculture sector and 11.2% in the national GDP (Rs. 14, 40 billion). The subsistence farming is the predominant livestock production system in Pakistan. Normally, smally scale livestock farming is inherited from generation to generation throughout Pakistan. Hence, small scale dairy farming could not be eliminated from the farmer's life of the developing countries because it is necessary for their sustainable livelihood. The livestock sector is moving from traditional and conservative farming to commercial and progressive farming rapidly both in management and genetic aspects in Pakistan (Annonymous, 2018-19). The management of light period in livestock production could be one of the beneficial factors for dry matter intake (DMI), weight gain and early puberty in heifers (Roy *et al*., 2016). The duration of exposure to photoperiod directly affects the growth as well as the mammary tissue development in heifers (Lacasse and Petitclerc, 2021). Light has emerged as one of the primary components of microclimate of farm animal environment (Penev *et al.*, 2014). The photoperiod is divided into two classes. First is the Short-day photoperiod (SDPP) 6-8 hours of light and 16-18 hours of darkness. Second is the Long-day photoperiod (LDPP) 16-18 hours of light and 6-8 hours of darkness in 24-hour duration (Wankhade *et al.*, 2019). Photoperiod has a noteworthy impact on the growth of replacement heifers and dry cows. Extended length of photoperiod had a beneficial effect on the earlier onset of puberty in heifers (Sejrsen *et al.*, 2000 and Dahl and Petitclerc, 2003).Photoperiod helps in the secretion of growth hormone which stimulates the early weight gain and improves the production performance of an animal (Jin *et al.*, 2012).Earlier studies on the experimental heifers (270 days age) kept under 16 hours of light showed earlier onset of puberty, increased body height and greater development of mammary glands (Rius *et al.*, 2005; Rius and Dahl, 2006). The above mentioned discussion revealed that photoperiod affects the calf growth and its subsequent performance. Most of the research pertains to the exotic animals and not much has been done on indigenous animals in Pakistan. Keeping in view this deficiency and future managemental needs, the present study was planned to investigate the effect of light period on feed intake, body dimensions and weight gain in Sahiwal cattle heifers.

MATERIALS AND METHODS

The research trial was conducted at the Livestock Research Station, University of Agriculture Faisalabad. Pakistan. Nine yearling Sahiwal heifers almost of the same age (15-17 month) were selected and randomly divided into three groups (A, B and C) of uniform age, number of animals; body weight and body height in a completely randomized design. Group A was allotted short day photoperiod (8 h L: 16 h D), Group B was maintained on natural photoperiod and Group C was kept on long day photoperiod (16 h L: 8 h D). The duration of experimental trial was from December to February (90 days) and during these months the duration of natural photoperiod varies from 8 to 12 hours. First 15 days were given as an adjustment period to acclimatize animal in experimental conditions and to avoid sudden shocks and endocrinological stress over time. A uniform quantity of feed in the form of total mix ration (3% of body weight) and water was offered (thrice) to each individual animal of each group. Feeding stall was divided in three compartments by covering with black cloth, flexes and plastic to stop the additional light coming from surrounding and light escaping from the covering. A clean housing environment was maintained to avoid dampness in addition to wheat straw bedding. Animals were free from stress and normal behavior of animals were ensured as described in recent studies (Aziz ur Rahman *et al.,* 2017; Aziz ur Rahman *et al.,* 2019; Chen *et al.,* 2020)

Table 1. Treatment plan to study the effect of photoperiod on the growth performance in Sahiwal heifers

Groups	A	B	C
No. of Animals	3	3	3
Initial body weight (Kg)	145.3	140.4	150.9
Initial body height (Inches)	41.7	41	42.1
Photoperiod	SDPP (10am-6pm)	Natural	LDPP (11 am-3am)

*Basal ration of berseem+ mustered+ mott grass 70% and wheat straw 30% on DM basis; SDPP = short-day photoperiod; 8 h of light. LDPP = long-day photoperiod; 16 h of light.

Photoperiod management and light implantation: Short day photoperiod group availed 8 hours of light by sun or by fluorescent bulb in case of foggy or cloudy day. Long day photoperiod (16 hours light) was maintained by adjusting fluorescent bulbs (Philips 100-watt and 800-watt). This increased photoperiod was adjusted at specific light intensity of 500 lux throughout the barn. For this mounting height of bulbs was maintained at about 3.5 feet above the manager so, that maximum light should fall on the eye area. Light intensity (lux) was measured by using digital lux meter. In case of no light period, a separate bulb was adjusted just to enlighten the barn.

***Data recording*:** Data related to water intake and DMI were recorded on daily basis. *Ad-libitum* assess to the fresh water was provided and the intake of water was measured by subtracting the refusal from the quantity offered as described in recent studies (Hussain *et al.,* 2018; Rehman *et al.,* 2019; Hussain *et al.,* 2020).

W1 (Water offered) – W2 (refusal) = WI (Water intake)

The DMI was calculated by using the following formula:

F1 (Dry matter offered) – F2 (Dry mater refusal) = FI (DMI)

Feeding and watering of heifers in all treatments did ad-libitum thrice daily at 7 am, at 3 pm and 10 pm.

Animal performance related to weight gain was measured by weighing on weekly basis throughout the research duration. Electrical weighing balance was used to measure animal's weight (Niu *et al.,* 2017; He *et al.,* 2018; Sharif *et al.,* 2018; Li *et al.,* 2019). The animals were weighed at weekly intervals at 6.00 am before offering any feed. Weight gain or loss was calculated by subtracting the initial weight from the final weight as described in recent studies (Bajwa *et al.,* 2020; Muhmmad *et al.,* 2020).

$$\text{Weight Gain} = \text{Final weight} - \text{Initial weight}$$

Data for body condition scoring was done for the frequency and size of calves. Maintenance of good skin condition and other welfare protocols were followed. The health status of calves was observed visually for any kind of disease injuries or pain stress induced by management practices as described in recent studies (Muhammad *et al.,* 2016). Heifer feed was analyzed as described in literature (Su*et al.,* 2013; Li *et al.,* 2014; Wang *et al.,* 2016) for its chemical composition. Experimental animals were reared on total mix ration. Concentrate was formulated by using corn (58%), soybean meal (27%), wheat bran (12%), calcium carbonate (2%), di-calcium phosphate (1%), and sodium chloride (1%). Dry matter content, crude protein, neutral detergent fiber, and acid detergent fiber contents of total mix ration were 91.10%, 12.05%, 62.81%, and 23.10%, respectively.

Data on each prescribed parameter were subjected to statistical analysis using analysis of variance (ANOVA) technique of Minitab Statistical Software (2018) and means were compared for the significance using the Tuckey's test.

RESULTS AND DISCUSSION

Photoperiod had a significant (p = 0.001) effect on the DMI (Table 2). Dry matter intake in heifers of group A, B and C was 4.86, 4.76 and 5.33 kg day^{-1}, respectively. The findings of current study were supported by those of Dahl *et al.* (2000) who found that DMI was higher in cows kept under LDPP than those kept under SDPP. Peters *et al.* (1980) also reported that heifers subjected to 16 L: 8D consumed more dry matter than animals exposed to a natural photoperiod during the winter months. Extending the period of light from a natural 9-12 h to 16 h (16 L: 8D) resulted in increased DMI in dairy cows due to more time for feed consumption (Peters *et al.,* 1981). There findings are further confirmed by Bilodeau *et al.* (1989) who reported that DMI of cows on long days fed ad libitum was higher than that of short day cows. Kendall *et al.*

(2003) findings are not in line with the present investigation who found that in Holstein steer calves, DMI was not affected by LDPP. No effect of photoperiod on DMI in the study of Kendall *et al.* (2003) could be justified with lower difference in day length (only 2 hour). Photoperiod length not only affects the DMI but it also effects the specific feed portion. For example, Almeida *et al.* (2017) reported that intake of concentrate was significantly higher($p<0.05$) in calves kept under 20 hours of light than those kept under 12 hours of light. Moreover, a study also reported that supplementary light have variable effect on DMI in animal with different physiological (Dahl, 2006). For instance, Auchtung *et al.* (2005) reported that DMI was greater in cows exposed to SDPP during the dry period than those on LDPP. Therefore, it could be assumed that DMI intake due to increased photoperiod is reversed in animals in dry period.

The intake of water was also increased significantly in heifers kept under 16 h of light (Table 2). Water intake in heifers of Group A, Group B and Group C was 2.68, 2.49 and 3.06 $Lday^{-1}$, respectively. The intake of water can be influenced by many factors such as ambient temperature, DMI, sodium intake in feed, body weight and availability of clean, cool and enough water for drinking. In present study, water intake was higher in heifers managed under 16 h of light (C) as compared to other lighting groups (A and B). The results of present study are not in line with those of Osborne *et al.* (2007) who reported that calves under 18 hours of light showed no differences ($p > 0.05$) in water intake than calves on 10 hours of light from birth to 56 days of age. The amount of water a cow will consume depends on her live weight, quantity of DMI, ambient temperature and relative humidity of the environment, drinking water temperature, availability of water and water available from the feed (Waldner and Looper, 2007). Water intake exhibited positive correlation with DMI and in the current study long day period significantly increased water intake in animals, therefore, the higher water intake in animals on long day period could be due to higher DMI.

Table 2. Effect of supplementary light on feed and water intake.

Groups	A	B	C	SEM	*P*-value
Dry matter intake (kg day^{-1})	4.86^{b}	4.76^{b}	5.33^{a}	0.05	0.001
Green fodder intake (kg day^{-1})	24.1^{ab}	23.9^{b}	24.6^{a}	0.16	0.04
Water intake (L day^{-1})	2.68^{ab}	2.49^{b}	3.06^{a}	0.09	0.02

A = 8 h L: 16 h D, B = Natural photoperiod and C = 16 h L: 8 h D

Body measurements are mostly used to measure growth in animals (Otte *et al.*, 1992). Body measurements increased during the study but did not differ between treatments. Body measurements of the heifers during the study period are shown in (Table 3). Overall, body measurements were not statistically different ($p > 0.10$) however, body measurements were numerically greater in heifers exposed to LDPP than those on SDPP. The results of the present study were supported by those of Maasz (2006) who reported that under supplemental lighting, there were no differences observed in body measurements of young beef bulls fed under intensive conditions.

Table 3. Body measurements of Sahiwal heifers under different lighting groups.

Groups	*A*	*B*	*C*	*SEM*	*P-value*
Heart girth (inches)	48.87	48.70	51.52	1.11	0.21
Body length (inches)	49.15	48.82	50.72	0.69	0.19
Wither height (inches)	42.99	42.15	43.51	0.44	0.17

A = 8 h L: 16 h D, B = Natural photoperiod and C = 16 h L: 8 h

The LDPP had a significant effect on weight gain (Table 4). The average weight gain in heifers of group A, B and C was 23.5, 21.3 and 27.4 kg, respectively. The results of present study showed a positive correlation of DMI and weight gain. The findings of present study were supported by the findings of Wankhade *et al.* (2019) who reported that the photoperiod length is directly associated with the growth of calves and heifers; and also with the mammary tissue growth in case of heifers. The exposure of calves to LDPP during growth phase led to larger, leaner animals at maturity (Patbandha *et al.*, 2016). Tucker *et al.* (1984) also reported that heifers exposed to a LDPP had an improved growth rate and showed a lean format of growth compared to those on a SDPP. Similarly, Rius and Dahl (2006) also reported that heifers raised under LDPP were heavier and taller at parturition as compared to their herd mates raised under SDPP. Moreover, Osborne *et al.* (2007) also reported that exposure of calves to LDPP during the growth phase had higher average daily weight gain compared with calves under SDPP. Therefore, it could be concluded that management of light can be used to improve heifer growth and exploit the deposit potential of lean tissues, including development of mammary parenchyma. This will lead to subsequent increase in production (Dahl and Petitclerc, 2003).

Table 4. Effect of different light schedules on weight gain

Groups	A	B	C	SEM	P-value
Av.Initial weight (Kg)	145.3	140.4	150.9	6.31	0.33
Av.Final weight (Kg)	168.7	157.9	178.3	5.80	0.12
Av. Weight gain (Kg)	23.5^{b}	21.3^{b}	27.4^{a}	0.89	0.01
Av. Weekly weight gain (Kg)	2.61^{b}	2.36^{b}	3.04^{a}	0.09	0.01
ADG ($gday^{-1}$)	372.5^{b}	338.1^{b}	435.4^{a}	0.01	0.01

A = 8 h L: 16 h D, B = Natural photoperiod and C = 16 h L: 8 h D, Av = average; ADG = Average daily gain

***Conclusion*:** Based on the current study results, it is concluded that extended length of photoperiod in heifer had a significant effect on DMI, water intake and weight gain. Therefore, management of light can be used to improve heifer feed intake, water intake and growth.

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