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Epidemiology of gastrointestinal nematodes in small ruminants in aeolian plains of Haryana

Priyanka, Sukhdeep Vohra and Satyavir Singh

Abstract
The present article discusses the epidemiology of gastrointestinal parasitic infections in sheep and goats in aeolian plains of Haryana. Primarily the eggs of strongyle, *Strongyloides* sp. and *Trichuris* spp. were observed during faecal examination. The coproculture further elaborate the infection of *Haemonchus contortus*, *Trichostrongylus*, *Oesophagostomum* and *Strongyloides* sp. The study revealed higher prevalence of gastrointestinal parasites in goats than sheep. The difference in infection was significantly higher ($p<0.01$). Although, the animals were positive throughout the year but highest intensity of infection was observed during monsoon season. Higher prevalence was also observed in adult and male animals as compared to female and young animals. The detail about the morphology of adult worm, infective stage and their disease is discussed in the present paper.

Keywords: Aeolian plains, epidemiology, gastrointestinal nematodes, small ruminants

Introduction
Small ruminant sector is an integral part of Indian farming especially in arid, semi-arid and mountainous areas (Kumar and Roy, 2013) [24]. On an average, 15% of households in rural areas rear sheep/goat across the country and around 70% of these animals are reared by small and marginal farmers as well as landless labourers, playing a vital role in their nutrition, supplementary income and livelihood security (CSWRI, VISION-2050)[9]. The country possesses about 148.88 million goats and 74.26 million sheep, which account for 27.74% and 13.83% of total livestock population of India, respectively (20th livestock census, 2019) [1]. Though large ruminant dairy sector is more profitable but small ruminants have certain advantages over the counterparts. The small ruminants have wide adaptability to harsh environments, low production inputs and capital investment, high fertility and fecundity, low feed and management needs, less space and feeding requirements as well as high feed conversion efficiency (Devendra *et al.*, 2005) [12].

It has been seen that the gastrointestinal (GI) helminthic infections are one of the key constraint for the profitable sheep and goat husbandry especially in tropical and subtropical countries including India. These animals are vulnerable to a number of GI helminths which not only undermine their health but also play an important role in lowering the overall production (Sanyal, 1996) [38]. It is well documented that these helminths predispose the animals to various disease of biological origin by lowering the immunity of the infected host. Commonly occurring gastrointestinal parasitic diseases in goats and sheep are haemonchosis, strongyloidosis, oesophagostomosis, bunostomosis and trichostrongylosis. Among these GI nematodes, *Haemonchus contortus* is of prime important. These parasites cause both acute infections having a rapid onset along with high mortality levels and chronic infections, which are commonly subclinical, may lead to insidious and important economic losses (Singla, 1995) [45]. The problem of GI helminths is severe in tropical countries due to highly favourable environmental conditions for its transmission (Singh *et al.*, 2013) [44].

The degree of parasitism or worm burden greatly depends on the management and hygienic conditions of the area. In general, severe GI nematode pathogenesis has been attributed to the migration of the infective larvae after ingestion rather than the adult worms in the gut (Dube *et al.*, 2002) [14]. In addition, some trichostrongyle nematodes cause anaemia due to their ability to remove red blood cells as well as proteins, which can lead to ill-thrift in animals (Risso *et al.*, 2015) [37]. Gastrointestinal parasitism directly or indirectly affects the economic losses in number of ways such as lowered fertility, reduced work capacity, reduction in food intake, lower weight gain and milk production, treatment cost and mortality in heavily parasitized animals (Choubisa and Jaroli, 2013) [8].

The study of seasonal variations in the prevalence of GI helminths gains significance as the survival of the third stage infective larvae depends on the favourable microclimatic conditions prevailing in the pasture (Raman *et al*., 1996) [34]. In spite of significant production losses, the problem is neglected due to its chronic and insidious nature (Sanyal, 1998) [39]. Therefore, information on prevalence of GI helminths is mandatory for evolving effective strategies for their management and control (Jithendran and Bhat, 1999) [19]. The environment and host factors play an integral role in the onset of GI nematodes infections. The environmental factors include agro-ecological conditions, animal husbandry practices like housing system, deworming intervals and pasture management (Ratanapob *et al*., 2012) [12]. The host factors include species, sex, age, body condition and breed/genotype of the animal (Badaso and Addis, 2015) [35]. These largely determine the type, incidence and severity of various parasitic diseases (Badran *et al*., 2012) [4]. The climate in a particular locality is also one of the important factors that determines the type and severity of parasitic infections in grazing animals. However, the control strategies designed for one farming system may not necessarily be appropriate for all farming systems, due to differences in local ecological factors and management practices (Nginyi *et al.*, 2001) [28]. Therefore, it is of prime importance to identify the local GI parasites and to demonstrate the associated factors that influence their epidemiology.

Epidemiology is the study of the distribution and determinants of health-related states or events (including disease), and the application of this study to the control of diseases and other health problems (WHO). Epidemiological pattern of the parasitic diseases in different areas of the state would provide a basis for evolving strategic and tactical control of these diseases. After parasitic infections some animals show severe signs of disease or die whereas rest of the animals of the flock demonstrates chronic, sub-acute or subclinical manifestation of infection. The severity of parasitic infections depends upon the host, parasite and environment, each of which in turn, includes many factors. In the host category, the different factors are age, sex, species resistance, nutritional status and ability to develop immunity to parasitic infection. The parasite category contains various factors like life cycle pattern, survival of larvae/eggs on pasture as well as interaction between the host and its environment. Finally, the environmental category like climatic and seasonal variations in rainfall, temperature, humidity, amount and type of vegetation and micrometeorological conditions i.e. presence of overgrazed areas or damp low-lying terrain factors have important effect on the parasitism in animals. All these components also have a profound effect on the transmission of most of the parasitic infections (Shankaraiah, 1996) [40].

India has been divided into various geomorphic units based on landforms and other characteristics. The major units include alluvial plains, alluvial plains with stable sand dunes, aeolian plains, flood plains and hills. Among these aeolian plains are characterised by sand dunes and interdunal plains comprising of either sandy or loamy sand soils. In Haryana, about 5.8% area comes under the aeolian plains (Resource Atlas of Haryana, 2004) [36] and include part of Charkhi Dadri, Bhiwani and Mahendergarh districts.

Looking the importance of various parasitic infections in small ruminants and the role of different factors in disease transmission, the present paper explains the epidemiology of commonly occurring parasitic diseases in aeolian plains of Haryana.

The faecal samples of small ruminants have maximum infection of strongyle eggs (Fig. 1). These infections represent a group of parasites which produce bilayered thin walled eggs having 16 to 32 embryonic cell stages in them when laid in faeces (Fig. 2).

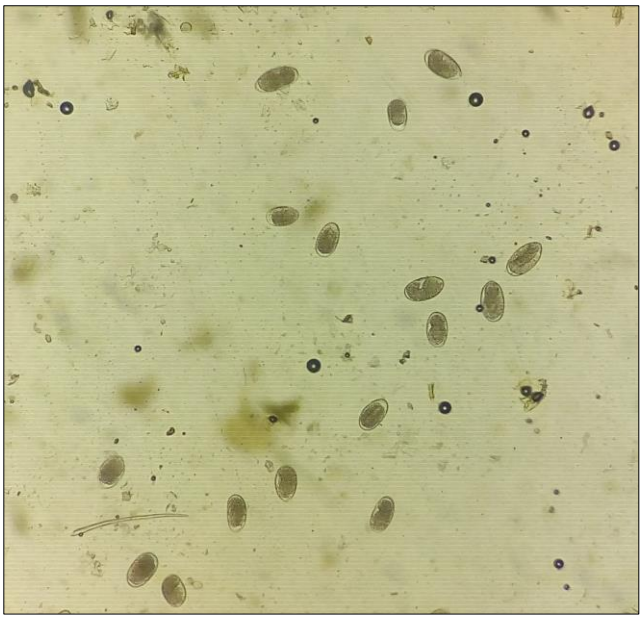

Fig 1: Strongyle eggs at low power

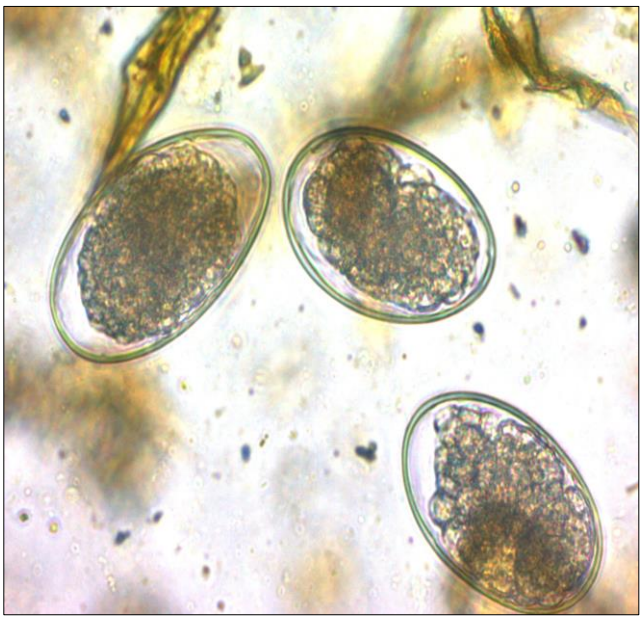

Fig 2: Strongyle eggs at high power

The life cycle involves first, second and third-stage larvae (L1, L2 and L3, respectively) which are free-living in the environment. The fourth larval (L4) and adult stages (dioecious) are parasitic in the gastrointestinal tract of the host. Disease is caused by the L4 and/or adult stages and depends on factors including: species of nematode infecting the host; intensity of the infection; species, age and immunological/health status of the host; host response against the parasite; environment and management aspects (Kassai, 1999 and Taylor *et al*., 2007) [20, 49]. The life cycle of strongyles is depicted in Fig.3.

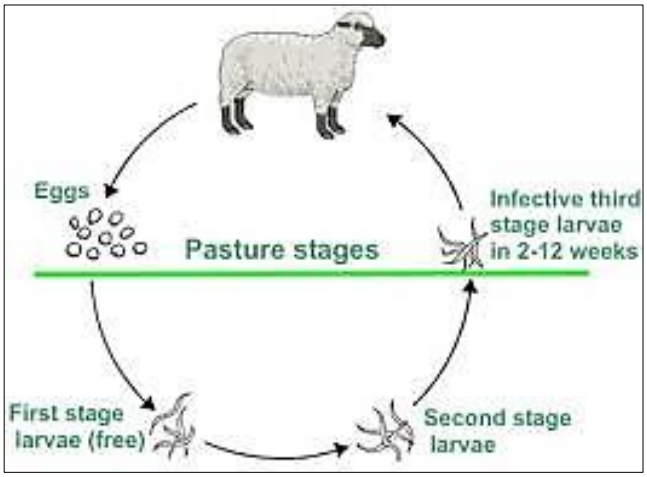

Fig 3: Life cycle of strongyles

The parasites are important as they cause numerous small haemorrhageic lesions on the abomasal mucosa. The abomasal contents become dark brown in colour due to presence of blood.

High incidence of strongyle was reported by Priyanka (2019) [30] in both sheep and goats in aeolian plains of Charkhi Dadri, Bhiwani and Mahindergarh district of Haryana. Further, she also reported a significantly (p<0.01) higher prevalence of strongyles in goats as compared to sheep. The higher prevalence in goats as compared to sheep was also reported in Bidar (Karnataka) by Thangathurai and Rao (2002) [50], in Southern Rajasthan by Choubisa and Jaroli (2013) [8] and in Pudukkottai (Tamil Nadu) by Rajarajan *et al*. (2017) [33]. Similar reports of higher prevalence of strongyles in goats than sheep was also documented from abroad like in Northeast Nigeria by Nwosu *et al*. (2007) [29], in Rawalpindi and Islamabad, Pakisthan by Gadahi *et al*. (2009) [16], in Northwest Ethiopia by Dagnachew *et al*. (2011) [11] and in Papua New Guinea by Koinari *et al*. (2012) [23]. A significantly (p<0.01) higher prevalence of strongyle was observed in adults as compare to young animals (Priyanka, 2019) [30]. Similar were the finding of Rahman *et al*. (2017) [32] in Tangail, Bangladesh and Dabasa *et al*. (2017) [10] in Bale zone, south eastern Ethiopia.

Seasonal prevalence of strongyle infection revealed highest infestation during monsoon and lowest during winter as per Priyanka (2019) [30]. However, both goats and sheep showed strongyle infection throughout the year. Similarly, Gupta *et al*. (1987) [18] reported similar finding in eastern region of Haryana. The reports in other states of India like Maharastra by Sutar and Khan (2011) [46] and Madhya Pradesh by Gaherwal *et al*. (2016) [17] also had similar findings.

Among the gastrointestinal nematodes in small ruminants, *Haemonchus contortus* is one of the most fecund strongylid nematodes. The individual female is capable of producing thousands of eggs per day, which can lead to rapid larval pasture contamination and associated outbreaks of haemonchosis (Levine, 1968) [25]. The adult worm live in the abomasums of host and female have characteristic wire like appearance because of white coloured ovary twisted around red coloured intestine. The tail of sheath of third stage larvae is characteristically kinked (Fig. 4). In sheep and goats, the pre-patent period of *Haemonchus* varies from 18 to 21 days. Adult worms are short-lived, surviving in their hosts for only a few months. The main pathogenic effects are caused by the fourth stage larvae and adults worm. Both stages feed on blood, causing severe anaemia which usually becomes apparent after two weeks of infection (Baker *et al*., 1959) [5]. Acute disease is usually dependent on the intensity of infection, and is associated with signs of haemorrhagic anaemia, dark-coloured faeces, oedema, weakness, reduced production of wool and muscle mass, or sometimes sudden death. In cases of chronic disease, decreased food intake, weight loss and anaemia are most commonly observed (Kassai, 1999 and Taylor *et al*., 2007) [20, 49]. Unlike many other gastrointestinal parasites *H. contortus* is not a primary cause of diarrhoea, and its effects on a flock are often not readily detected by routine observation (Zajac, 2006) [54].

Priyanka (2019) [30] in aeolian plains of Haryana reported that the percent contribution of *Haemonchus* spp. ranged between 82 to 99% in goats and 83 to 99% in sheep with the maximum during the month of January and minimum during the month of September. Other workers *viz*. Al-Shaibani *et al*. (2008) [2] in Hyderabad, Pakistan, Tariq *et al*. (2010) [48] in goats of Kashmir valley, Lone *et al*. (2012) [26] in small ruminants at Ganderbal district, Kashmir, Khajuria (2013) [22] in middle agro-climatic zone of Jammu province, Varadharajan and Vijayalakshmi (2015) [51] in small ruminants of Tamil Nadu, Zvinorovae *et al*. (2016) [55] in Zimbabwe, Gaherwal *et al*. (2016) [17] in Barwani district, Madhya Pradesh, Molla and Bandyopadhyay (2016) [27] in 'Teesta river' valley, West Bangal, Sheikh *et al*. (2016) [41] in Gurez valley, Kashmir, Rajaranjan *et al*. (2017) [33] in Pudukkottai district, Tamil Nadu and Vohra *et al*. (2018) [52] in Goat and Sheep Breeding Farm, LUVAS, Hisar also reported the predominance of *Haemonchus*. The study revealed *H. contortus* as the predominant parasitic infection in goats and sheep.

Fig 4: Tail of *Haemonchus contortus* larvae showing kinked tail

The nematode second in prevalence after *Haemonchus contortus* in tropical and subtropical parts of world is *Trichostrongylus*. The difference species of this genus represent an important group of parasites of grazing small ruminants. These parasites occur in the small intestine and mainly exert their pathogenic effects in lambs and weaners, but have also been reported to cause significant depression of wool growth in older sheep (Donald *et al*., 1978) [13]. Adults parasite are small ranging from 2.5 mm to 8.0 mm in size occurring in abomasum, omasum and rarely in the small intestine of host. The larvae of worm is smaller in size, tail of sheath is very short and conical and tail bearing one or two

tuberosities or were indistinctly rounded (Fig. 5). The migration of young adult worms is associated with extensive damage to the duodenal mucosa and with signs of generalised enteritis, including haemorrhage, oedema and plasma protein loss into the intestinal lumen and subsequent hypoalbuminaemia and hypoproteinaemia (Barker, 1975, Barker and Titchen, 1982) [6, 7]. The duodenal villi are distorted and flattened. Infections with *Trichostrongylus* are often difficult to distinguish from malnutrition in the case of low-intensity infections (Taylor *et al*., 2007) [49] but, if worms are present in high numbers, cause protracted watery diarrhoea, which stains the fleece of the hindquarters (black scours) (Levine, 1968) [25]. Prevalence of *Trichostrongylus* was reported throughout year and maximum during monsoon season in month of September and minimum during winter season (Priyanka, 2019) [30]. Gupta *et al*. (1987) [18] also demonstrated infective larvae of *Haemonchus* spp. and *Trichostrongylus* spp. throughout the year in goats and sheep of eastern Haryana. Singh *et al*. (1997) ss[42] reported *Trichostrongylus* spp. during pre-monsoon at an organised farm of sheep in the semi-arid zone of Rajasthan (India). Kaur and Kaur (2008) [21] reported the prevalence of *Trichostrongylus* spp among sheep and goats of Patiala and its adjoining areas.

Fig 5: Tail of *Trichostrongylus* spp. larvae having short and stumpy tail with tuberosity

The nematode, *Oesophagostomum* lie in large intestine of sheep and goat causing nodular worm disease. Adults of *Oesophagostomum* (nodular worm) are 12–21 mm long and the head is bent dorsally. Because the eggs are very similar to those of *Haemonchus*, they are often grouped together on routine faecal examination. The life cycle is direct. The larvae penetrate primarily into the wall of the lower 10 to 20 ft of the small intestine but also into the cecum and colon, where they remain for 5–10 days and then return to the lumen as fourth-stage larvae. The prepatent period in susceptible animals is approximately 6 wk. However, in subsequent reinfections, larvae become arrested for some time and many never return to the lumen (host encystment). Larvae of this are medium in size and tail of sheath very long (Fig. 6). Infection causes anorexia and persistent dark foetid diarrhoea. The affected animal loss weight and may die. In older, resistant animals, the nodules surrounding the larvae become caseated and calcified, thus decreasing the motility of the intestine. Stenosis or intussusception occasionally occurs. The faeces of infected animal may contain excess mucus as well as streaks of blood. The sheep become weak, lose weight despite a good appetite and show intermittent diarrhoea and constipation.

Priyanka (2019) [30] reported presence of *Oesophagostomum columbianum* during spring, summer and monsoon season. Singh *et al*. (1997) [42] also reported the presence of *Oesophagostomum* spp. during summer and monsoon in semi-arid zone of Rajasthan. Molla and Bandyopadhyay (2016) [27] who recorded prevalence of *Oesophagostomum* spp. infection as 21.48% in India. Vohra *et al*. (2018) [52] observed the prevalence of *Oesophagostomum* spp. in small ruminant at Goat and Sheep Breeding Farms, Lala Lajpat Rai University of Veterinary and Animal Sciences, Haryana.

Fig 6: Tail of *Oesophagostomum* spp. larvae having long filamentous tail

The intestinal threadworm, *Strongyloides papillosus* has only the female worms in the intestine of the host. They are 3.5–6 mm long and are embedded in the mucosa of the upper small intestine. Small, embryonated eggs are passed in the faeces which hatch rapidly and develop directly into infective larvae or free-living adults. The offspring of these free-living adults may develop into another generation of infective larvae or free-living adults. The host is infected by penetration of the skin or by ingestion; infective larvae can be transmitted in colostrum. The prepatent period is approximately 10 days. Pictorial demonstration of life cycle is given in Fig.7.

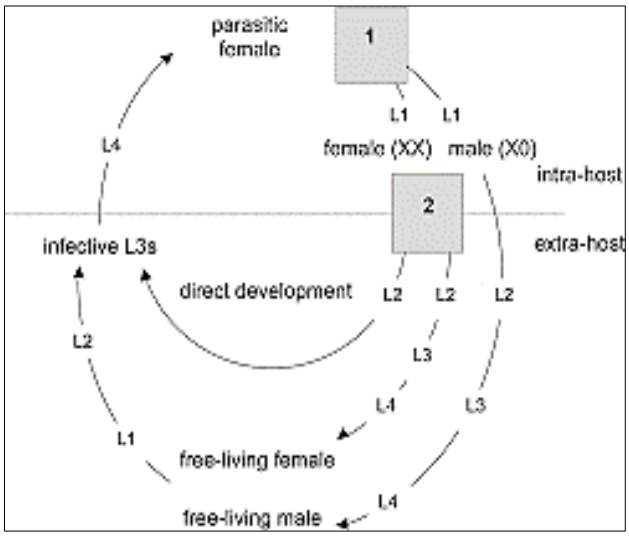

Fig 7: Life cycle of *Strongyloides*

Larvae is unsheathed and oesophagus is nearly half length of the body (Fig.8).

Heavy infections with adult worms cause a disease resembling trichostrongylosis. Infection is usually by skin penetration but can also occur via the milk. Damage to the skin between the claws, produced by skin-penetrating larvae, resembles the early stages of footrot and may aid penetration of *Dichelobacter nodosus* bacteria, the causal agent of footrot. Most infections are transitory and inconsequential.

Priyanka, 2019 [30] reported the higher infection of *Strongyloides* in adults as compared to young animals. Similarly, Singh *et al*. (2017) [43] in western zone of Punjab, Yadav *et al*. (2006) [53] at Jammu and Emiru *et al*. (2013) [15] in Gechi district, Southwest Ethiopia recorded a higher prevalence of infection in adults than young ones. A high prevalence of *Strongyloides* was recorded during monsoon season in studies carried out by Priyanka (2019) [30] in Aeolian plains of Haryana. Al-Shaibani *et al*. (2008) [2] also reported maximum number of sheep positive for *Strongyloides* infection during the month of July to October at Hyderabad district of Pakistan.

Rajarajan *et al*. (2017) [33] studied prevalence of *Strongyloides* in sheep and goats in Pudukkottai district, Tamil Nadu. The higher prevalence of *Strongyloides* was observed in young animals when compared to adult ones. A significant difference was observed with respect to season where in higher prevalence was recorded during the wet season while less prevalence was recorded in dry season.

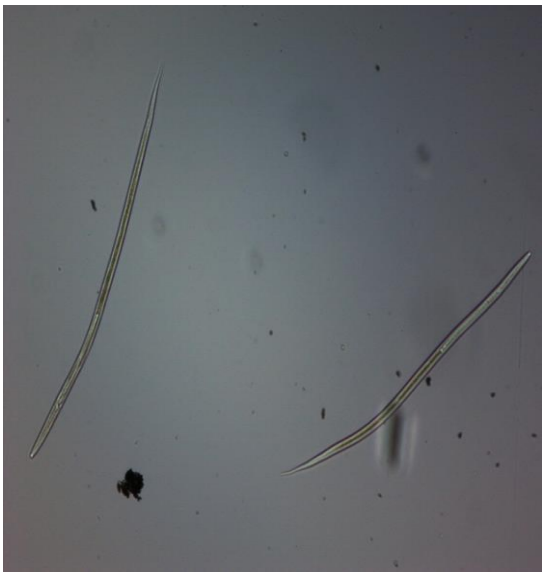

Fig 8: Larvae of *Strongyloides* sp. showing oesophagus nearly half length of the body

The adult *Trichuris ovis* worms are seen in the caecum of small ruminants. Parasite is also known as whip worm. The eggs of *Trichuris ovis* was observed in sheep and goats very frequently. Heavy infections with whipworms are not common but may be seen in very young lambs or during drought conditions when sheep are fed grain on the ground. Eggs are brown in colour, barrel shaped with transparent plug at either pole and contain usegmented embryo when laid (Fig. 9). The eggs are very resistant to adverse environmental conditions. Congestion and oedema of the caecal mucosa, accompanied by diarrhoea and unthriftiness are observed in infected animal.

Higher infection of *Trichuris* in young animals as compare to adult was recorded in aeolian plains of Haryana by Priyanka (2019) [30]. Age wise higher incidence of infection in young animals as compared to adult was observed by Talukdar (1996) [47] in goats of Assam and Pundlikrao (2009) [31] in goats of Nagpur, Maharashtra. The highest prevalence rate of parasites recorded in younger age group while the lowest prevalence rate was in older age group (Molla and Bandyopadhyay, 2016) [27]. Varadharajan and Vijayalakshmi (2015) [51] observed infection was higher in rainy season followed by winter and summer in sheep and goat of both organised and small farms of coastal areas *viz*. Cuddalore, Nagapattinam of Tamil Nadu.

Fig 9: *Trichuris* egg showing brown colour and transparent plug on poles

Conclusion

The paper reveals higher prevalence of gastrointestinal nematodes in sheep and goats in aeolian plains of Haryana. The infection of *Haemonchus contortus*, *Trichostrongylus*, *Oesophagostomum*, *Strongyloides* sp. and *Trichuris* spp. were observed on coprological examination. The parasitic infection of small ruminants in relation to location, age and sex of host, season and month of year and intensity of infection of parasites is discussed.

The present article discusses the epidemiology of gastrointestinal parasitic infections in. Primarily the eggs of strongyle, *Strongyloides* sp. and during faecal examination. The coproculture further elaborate the infection of the study revealed higher prevalence of gastrointestinal parasites in goats than sheep. The difference in infection was significantly higher ($p<0.01$). Although, the animals were positive throughout the year but highest intensity of infection was observed during monsoon season. Higher prevalence was also observed in adult and male animals as compared to female and young animals. The detail about the morphology of adult worm, infective stage and their disease is discussed in the present paper.

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