



Univariate Risk Analysis to Hemonchosis Outbreak in Goats

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Abstract

Haemonchosis is an evergreen threat to small ruminant production in tropics. Number of abiotic and biotic factors influences the seasonal incidence of haemonchosis in small ruminants. There was an outbreak in rainy season of October, 2016 to January, 2017 on young adult goats. From various meteorological agencies 12 relevant risk factors were chosen randomly and their influence was analyzed. Among the risk factors, relative humidity influences positively and maximum day temperature influences in negative way. The mean maximum day temperature in outbreak months was 29.5 °C whereas in rest of the months it was 34.6 °C. Similarly there was an increase in mean relative humidity (84%) when compared to rest of the months (71%). Increase in mean relative humidity for about 13% and a decrease in mean maximum day temperature for about 5.1 °C were the reasons for this outbreak. 92.9% of cases were correctly classified between outbreak and non – outbreak groups based on standardized canonical discriminant analysis. We conclude that increase in mean relative humidity (13%) and decrease in mean day time maximum temperature (5.1°C) determines hemonchosis outbreak when compare various other metrological parameters.

Keywords: Epidemic, Haemonchosis, Maximum Day Temperature, Relative Humidity

Introduction

Parasitic gastro-enteritis due to nematode infection has been reported as a major constraint to profitable small ruminant production in tropics especially in India (Rathod *et al.*, 2019). Haemonchosis is one among them in small ruminants which commonly cause high mortality (Mini *et al.*, 2015; Sheoran *et al.*, 2019). Haemonchosis by *Haemonchus contortus* causes haemorrhagic anemia (Mohammed *et al.*, 2013) as acute disease (Ombasa *et al.*, 2012). Environment is one among the important epidemiological factor that determines the disease (Agarwal and Banerjee, 2007). *Haemonchus* outbreak in small ruminant is influenced by number of abiotic and biotic factors. Due to its high biotic potential it is remarkably adaptable over a wide range of environmental conditions (Waller and Chandrawathani, 2005; Besier *et al.*, 2016). Haemonchosis occurs mostly in monsoon and post monsoon seasons with seasonal prevalence (Bulbul *et al.*, 2015). The length of time required for development to the L3 stage of *H. contortus* varies with temperature. They develop most successfully in warm wet (10-36°C) climates and do not tolerate cold temperatures well (Zajac, 2006). Most of the experimental studies proved that no haemonchus eggs were developed at low relative humidity (70-85%) and maximum at 100% (Hsu and Levine, 1977; Besier *et al.*, 2016). Such studies were not carried out in India and in particular natural epidemic. Hence knowing the exact environmental factor which influences the outbreak is essential. The study was aimed to identify the suitable risk factor which determines haemonchosis epidemic among a particular season in goats.

Materials and Methods

The study was conducted in ailing goats at the Teaching Veterinary Clinical Complex and Ambulatory Clinics of Veterinary College and Research Institute, Orathanadu, Southern India. The study area Orathanadu and nearby villages are situated on 2 m above the sea level, (10° 37' 12" N and 79° 16' 12" E) tributary of Cauvery river (New Delta Zone) and considered as part of rice bowl in Tamil Nadu. The predominant soil type is lateritic. The area is showered with heavy rainfall on Northeast monsoon from October to December months and less rainfall on Southwest monsoon in June to August months. Breeding season of goats starts immediately after Northeast monsoon and during cooler months (January, February and March) of every year. The season ends with kidding during Southwest Monsoon (June, July and August). The epidemic occurred in October, November, December and January months of 2016 and 2017 and when the kids are 4-5 months of age. Day-to-day information's on maximum and minimum temperature, humidity, rainfall, and pan-evaporation were collected from the meteorological records of Department of Statistics and Department of Disaster Management from District Collectorate and from Soil and water Management Research Institute, Tamil Nadu Agricultural University, Thanjavur. The monthly averages for each weather factor were calculated. With the two government sponsored schemes goats were distributed before the study period to landless farmers, widows and mentally retarded fellows to uplift their livelihood. Most of the livestock holds in our study were beneficiaries of government schemes. All the goats in our study were maintained under extensive grazing system. Very rarely these animals were supplemented with crop residues and house hold wastes. The animals use to share their grazing fields with other ruminants. The quality of the goats life is highly associated with owner's socio-economic status and all the animals in this study were neither vaccinated nor dewormed. None of the animal was provided with supplementary feed or mineral block before the study period. The sick and ailing animals brought to treatment were identified by their institutional case number.

The sick and ailing goats presented to the outpatient unit with clinical signs suggestive of anaemia and parasitic gastroenteritis was selected for this study. The conjunctival mucous membrane was compared with FAMACHA chart. Fecal samples were directly collected from rectum and processed for nematode fecal egg counts through modified McMaster method described by Zajac (2006) and Nwosu *et al.* (2007) and at a sensitivity of 100 eggs per gram (EPG) of feces. Coprocultured L3 larvae were confirmed by characters described by Zarlenga *et al.* (2016). Further all the samples were analyzed for *Fasciola* spp. by sedimentation technique. All the clinical cases were treated by Albendazole and Ivermectin combinations (Bandy kind Plus*) @ 20 mg/kg body weight as single dose through oral route. Further owners were advised for protein supplementation daily (Pow. Khurak*) in diets @ 30-40 mg/goat as TD along with other B vitamin supplements.

Statistical Analysis

Collected data was analyzed in IBM SPSS 21 version software. The meteorological risk factors were subjected to discriminant function analysis with epidemic season. The statistical significance of discriminant function was analyzed through Wilks' Lambda and chisquare test.

Result and Discussion

Epidemic occurred between October to January months of 2016 and 2017, during the north-east monsoon and immediate post monsoon period. 32 clinical cases were taken for this study. The average age of affected animals was 7 months in our study. The most common clinical signs were severe anemia (Fig. 1), death; inter mandibular edema (Fig. 2), varying degrees of anorexia and unthriftiness. Incidence of haemonchosis infection during north east monsoon has already been reported in Delta district of Tamil Nadu by Balakrishnan *et al.* (2014).



Figure 1: Anemia in an affected goat



Figure 2: Jowl edema in a comatose animal

The North-east monsoon start at last week of October prevails over November and December months. Sivajothi and Reddy (2018) reported parasitic infection in goats was higher in winter season from Kadapa District of Andhra Pradesh and has similar pattern with our study. Month wise rainfall status, minimum and maximum day temperature, relative humidity, soil temperature and wind speed were given in Table 1. The multivariate analysis of standardized canonical discriminant function revealed that meteorological factors had high significant rate (1% level) with epidemic season (Table 2). Among various parameters relative humidity (Fig. 4) and maximum day temperature (Fig. 3) were significantly influencing the epidemic. Mean relative humidity influences positively and mean maximum day temperature influences in negative way. As 92.9% cases were correctly classified by our analysis. The mean maximum day temperature in outbreak months was 29.5°C whereas it was for the rest of the months 34.6 °C. Similarly, there was an increase in mean relative humidity (84%) during outbreak when compare to rest of the months (71%). The increase in mean relative humidity for about 13% and decrease in mean maximum day temperature for about 5.1 °C were the reasons for this outbreak. The temperature range which favors the development of *H. contortus* larvae along with wet and humid season is 10° C to 36° C and minimum length of time for larval development is 3 – 4 days (Zajac, 2006). *H. contortus* is adopted largely in relation to the availability of moisture (rainfall) and the typical temperature range in different types of environments (Besier *et al.* 2016). The optimum temperature and relative humidity during northeast monsoon rain favored the development, survival and translocation of L3 larval stages in our study. Similar observations were also made by several African workers which were reviewed by Besier *et al.* (2016).

In a similar study Qamar *et al.* (2009) reported that a correlation between disease prevalence and humidity, rainfall and high temperature in Pakistan. Rain is important in larval release from the manure on to the herbage (Zajac, 2006). For the development and survival of eggs, 100% relative humidity at 20-35°C in faecal pellets is ideal. No eggs were developed at low humidity levels and high temperature and this was reviewed by Besier *et al.* (2016). Most *H. contortus* eggs die if allowed to desiccate, but once eggs were embryonated they hatch rapidly when exposed to moisture. Our study also proves in similar way. However, the average relative humidity lies between 74-86% throughout the epidemic periods. The reason may be diurnal variation in relative humidity. Our study reveals that relative humidity is high in forenoon rather than after noon particularly in outbreak months. In experimental studies maintenance of low humidity (70%) for more than 12 hours halts the egg development (Hsu and Levine 1977; Besier *et al.* 2016).

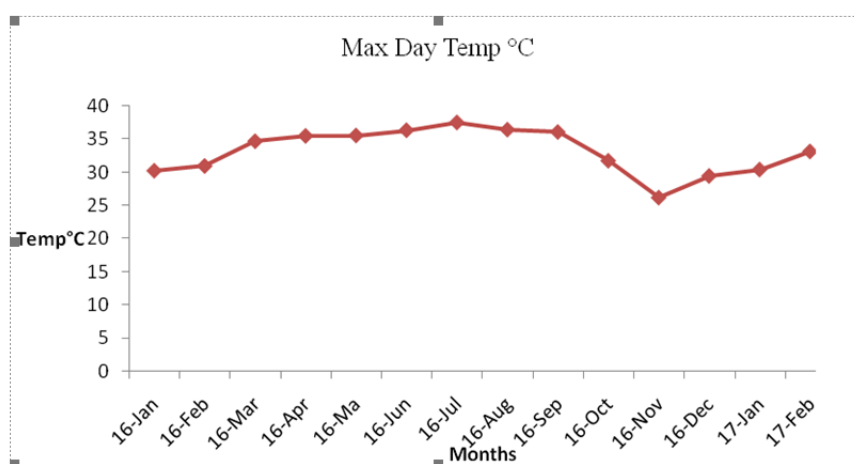
Table 1: Month wise mean meteorological data in the outbreak area

S. No.	Month	Rain fall (in mm)	Day Temperature		Relative Humidity %	Evaporation (in mm)	Wind velocity (mph)	Soil Temp at 5cm depth	Diurnal Soil Temp variation at 5cm depth	Soil Temp at 10cm depth	Diurnal Soil Temp variation at 10cm depth	Soil Temp at 20cm depth	Diurnal Soil Temp variation at 20cm depth
			Min. °C	Max. °C									
1	Jan 2016	0	25.85	28.4	77.9	3.36	3.38	32.52	11.6	31.61	10.58	31.41	5.54
2	Feb 2016	0	25.4	30.35	74.3	4.45	3.93	35.39	15.48	34.18	13.8	33.2	6.3
3	Mar 2016	1.9	29.35	32.05	70.3	4.93	3.33	39.28	17.8	37.66	15.63	36.8	7.95
4	Apr 2016	111.8	29.3	33.6	68.4	5.08	3.58	39.91	13.58	38.16	12.08	37.88	5.64
5	May 2016	56.7	27.5	33.35	67.8	4.38	3.75	38.63	11.55	38.18	7	37.14	5.38
6	Jun 2016	34	29.92	36.12	64.92	5.03	4.4	38.43	11.7	36.49	9.33	36.45	5.4
7	Jul 2016	19	30.65	37.84	61.61	7.42	4.92	40.36	13.72	39.79	10.26	39.65	5.5
8	Aug 2016	40.2	30.05	36.55	64.84	5.43	3.95	39	12.6	37.84	11.18	37.11	5.38
9	Sep 2016	25	29.45	36.15	66.85	5.03	3.48	38.83	11.35	37	9.25	29.89	4.03
10	Oct 2016	54	28.27	33.43	74.27	4.44	2.49	37.25	10.94	35.37	9.1	35.72	4.12
11	Nov 2016	192.1	25.62	29.42	86	3.78	2.58	31.4	8.8	30.76	6.73	30.8	3.15
12	Dec 2016	176.3	25.34	29.28	85.06	7.3	3.18	30.86	7.2	30.25	6.46	30.31	3.1
13	Jan 2017	0	25.58	31.24	76.61	5.43	2.83	33.85	12.1	32.46	10.13	32.1	4.35
14	Feb 2017	0	27.06	33.97	70.59	4.53	2.5	35.76	15.44	34.08	12.35	33.8	4.75

Table 2: Standardized canonical discriminant function coefficients

S. No.	Function	Coefficient Values
1	Maximum Temp	2.116
2	Relative Humidity	2.547

92.9% of original grouped cases correctly classified between outbreak and non – outbreak groups

**Figure 3:** Mean maximum day temperature in relation to months

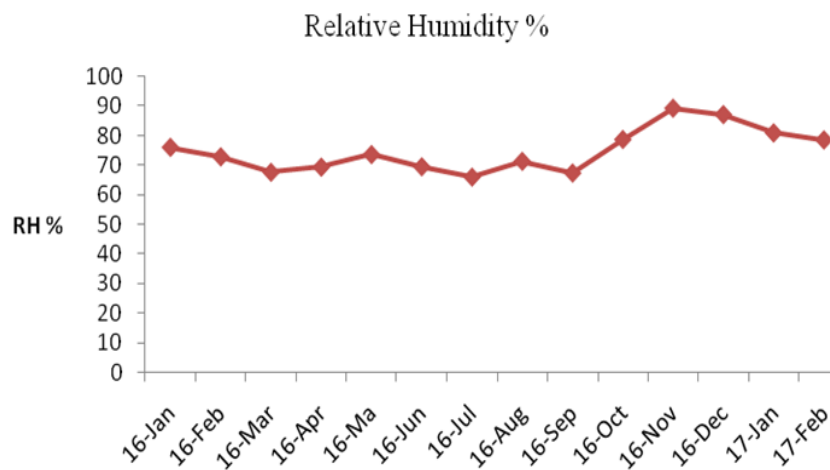


Figure 4: Relationship of relative humidity in relation to months

Episodic increase in relative humidity which doesn't prevail for more than 12 hours might be another reason for outbreak. Fecal egg count and coproculture were confirmed as *Hemonchus contortus* in all the affected goats, however mixed infection with *Trichostrongylus colubriformis* was observed in 4 goats and *Coccidia* spp. in 2 goats. None of the animal in our study had *Fasciola* infection. Fecal egg count was about 20,000/gram. Fecal egg count is a simple technique, cost effective and good diagnostic indicator (Besier *et al.*, 2016). Good relationship has already been established between fecal egg count and total strongyl worm burden in goats (Cringoli *et al.*, 2008; Rinaldi *et al.*, 2009). Blood loss typically occurs after the fourth stage larvae and anemia being detected after 10-12 days of infection. Each haemonchus worm sucks 0.05 ml blood per day so that sheep/ goat with a total of 500 nos. of *Haemonchus contortus* may suck about 250 ml of blood/day, resulting anaemia, loss of body weight and wool growth (Dutta *et al.*, 2017). This makes these animals more prone to anaemia and hypoproteinemic and even death.

Conclusion

We conclude that increase in mean relative humidity (13%) and decrease in mean day time maximum temperature (5.1 °C) determines hemonchosis outbreak during monsoon and post monsoon season when compare various other metrological parameters.

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Conflict of Interests

There is no conflict of interest.

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