



Preparation of bioclimatograph for haemonchosis and trichostrongylosis in goats of subtropical high humid zone of Sikkim

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ABSTRACT

Based on a systematic epidemiological study, bioclimatographs were prepared for *Haemonchus* and *Trichostrongylus* spp. infecting goats of subtropical high humid zone of Sikkim, India. Three meteorological parameters i.e., maximum and minimum temperature, average relative humidity and total rainfall were recorded for each month from April 2012 to March 2013 and correlated with faecal egg count, faecal larval count and pasture larval count of grazing area under investigation. Bioclimatographs were prepared against different meteorological parameters and the predicted values were correlated with actual field study. The findings in goats revealed higher rate of infection of *Haemonchus* and *Trichostrongylus* spp. from July to October and September to early March and higher intensity from June to October and November to February, respectively. The higher incidence of infection of larval stages on pasture was observed from June to October for *Haemonchus* spp. The prediction or forecasting of *Haemonchus* spp. and *Trichostrongylus* spp. infection in goats of this agroclimatic region as per bioclimatographs revealed a prediction for development and survival of eggs and larvae of *Haemonchus* spp. infection from July to October and for *Trichostrongylus* spp. from September to February. Bioclimatographs revealed that maximum temperature (Tmax.) v/s total rainfall (TRF) and Tmax. v/s relative humidity (RH) gave better prediction for *Haemonchus* spp, while for *Trichostrongylus* spp. it was minimum temperature (Tmin.) v/s RH.

Key words: Bioclimatograph, Goats, *Haemonchus* spp., *Trichostrongylus* spp., Sikkim

Gastrointestinal parasitism is one of the most pervasive challenges to the health and welfare of ruminants (Swarnkar and Singh 2015). Bioclimatographs, descriptions of the climatic envelope in which disease occurs, have been developed to predict outbreaks of soil transmitted helminthes in domesticated animals (Swarnkar and Singh 2011, Bonnell *et al.* 2016). Changing climatic conditions and shifting patterns of seasonality have been shown to have significant impact on transmission (Bonnell *et al.* 2016). Differences in environmental factors such as climate, nutrition, stocking density and management, host factors such as genetic resistance, age and physiological status of the animal and production techniques may influence prevalence of helminthic infections, load and pathogenesis (Singla 1995, Kapoor 2013). Host-parasite systems with a parasite life stage outside the host is considered particularly susceptible in the face of climate change, as the survival of the parasite is often linked to the suitability of the climate for persistence (Pullan and Brooker 2012). The interaction between climatic conditions of a particular region, grazing

strategies of that region, pattern of anthelmintic treatment and refugia can have a bearing on fluctuations in resistant and susceptible alleles according to seasons (Kumar *et al.* 2013). The subtropical and high humid climatic conditions of Sikkim are very congenial for propagation and multiplication of gastrointestinal parasites (Pal *et al.* 2014, Pal *et al.* 2015). Thus, the present study was designed to prepare the bioclimatograph for haemonchosis and trichostrongylosis of goats based on epidemiological findings since such type of study has not been done in this agroclimatic zone earlier.

MATERIALS AND METHODS

Meteorological data and preparation of bioclimatograph: The meteorological data such as mean maximum and minimum temperature, average relative humidity and total rainfall were collected from the Meteorological station, Tadong, Gangtok during 2012–2013 and correlated with the actual data for the preparation of disease forecasting model based on predicted and observed prevalence rates and intensity of infection of *Haemonchus* and *Trichostrongylus* spp. To see the effects of temperature, rainfall and relative humidity, bioclimatograph were prepared in which total rainfall (TRF) was plotted against the maximum temperature (Tmax) for *Haemonchus*

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contortus and average RH was plotted against Tmin for *Trichostrongylus* spp. for each month and the resultant points were joined by a closed curve. On these graphs, lines indicating the limits of climatic conditions most suitable for development, survival and dissemination of pre-infective stages of gastrointestinal nematode (GIN) were superimposed. Based on published information (Swarnkar and Singh 2011) the limits of suitable climatic conditions were taken as total monthly RF to the tune of 50 mm or more with average monthly Tmax ranging from 18 to 37°C for *Haemonchus* spp. and same rainfall with temperature ranging from 5 to 18°C for *Trichostrongylus* spp. The RH considered for optimum development of parasites was taken >50%. The predicted prevalence was then compared with observed incidence of *Haemonchus* and *Trichostrongylus* spp. of goats.

Collection off aecal samples, coproculture and harvesting of larvae and pasture larval count: To compare the graph with the prevalence of these parasites in local goats, 1934 faecal samples of both sexes and different ages were collected in sterilized plastic bags directly per rectum or freshly voided faeces from different villages situated at elevations 1100m to 1600m amsl of Sikkim between April 2012 to March 2013. Every sample positive for *Haemonchus* spp. and *Trichostrongylus* spp. eggs was calculated for eggs per gram of faeces (EPG) using modified McMaster technique (MAFF 1984), and subsequently these samples were cultured at a temperature of about 27°C for 7 to 12 days for confirmative identification. The infective larvae (L₃) were separated by means of Baeremann's apparatus and harvested larvae were identified as per their morphological characters (Soulsby 1982). Similarly, grass samples were collected by "W" shaped sampling method in every month from common grazing areas of the selected villages. Pasture larval burdens (PLB) were assessed as per Swarnkar *et al.* (2008). These were compared with the bioclimatograph prepared as above to see if the same has any relationship between the availability of *Haemonchus* spp. and *Trichostrongylus* spp. infection in their hosts and larvae on pasture.

RESULTS AND DISCUSSION

The monthly prevalence of *Haemonchus* spp. and *Trichostrongylus* spp. in goats and meteorological data during the study period is shown in Fig 1. The overall mean species of egg counts of *H. contortus* and *T. colubriformis* in local goats is shown in Figs 3 and 4. Coprological examination revealed that *Haemonchus* spp. larvae were the predominant gastrointestinal nematode found throughout the year with maximum prevalence of 71.84% in autumn season. The infection rate was significantly high from June to October and it reached peak level during autumn. The significantly higher prevalence of *Haemonchus contortus* in goats might be due to the fact that this nematode has a relatively short generation interval and ability to take the advantage of favourable environmental conditions (Pal *et al.* 2014). The mean monthly maximum temperature of

18°C or above and total monthly rainfall of 50 mm are conducive for translation and transmission of *H. contortus* (Pal *et al.* 2014). The prepatent period for *H. contortus* in small ruminants is on an average of 15 days (Soulsby 1982). Therefore, the contamination of pasture by kids/ewes produces a peak in larval availability from mid-summer and when ingested by host animals results in heavy infection capable of producing disease in late July, August and September. The larval development of *H. contortus* occurs optimally at relatively high temperatures, high humidity, microclimate of faeces and herbage, and high rainfall (Pal *et al.* 2014). With the onset of winter, the infection rate gradually decreased up to 40.11%. The low rate of haemonchosis during winter (December to February) may be attributed to unfavorable climatic conditions like low temperature that retards the development of free-living stages and even at 9°C no development takes place (Soulsby 1982). Prevalence of *Trichostrongylus* spp. larvae was the highest in winter (7.63%). The real time observations for overall monthly generic composition of pooled faecal cultures of goats revealed that the population larvae of

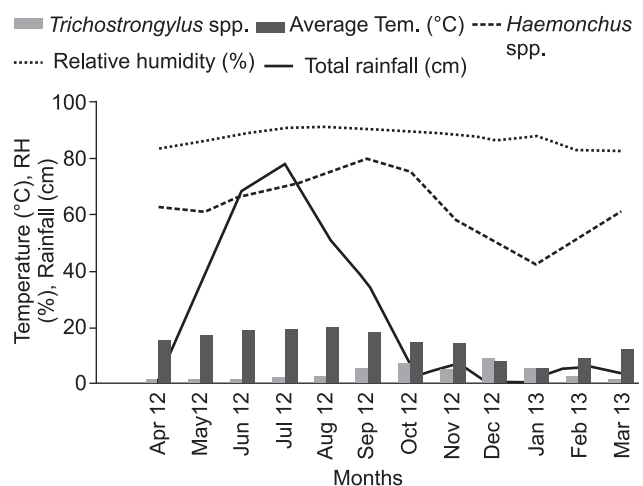


Fig. 1. Monthly prevalence of *Haemonchus* and *Trichostrongylus* spp. infection in goats and meteorological data during the year April 2012 to March 2013.

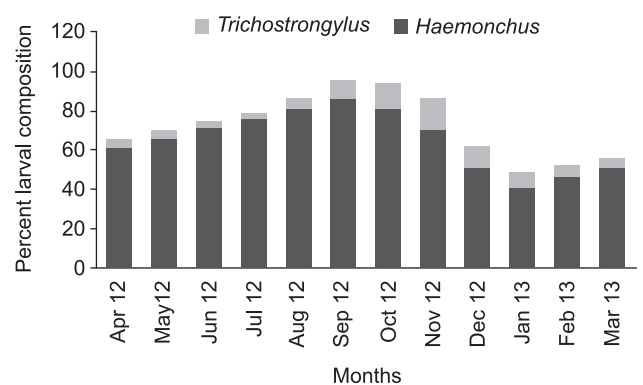


Fig. 2. Coproculture examination of goats in subtropical and high humid area of Sikkim.

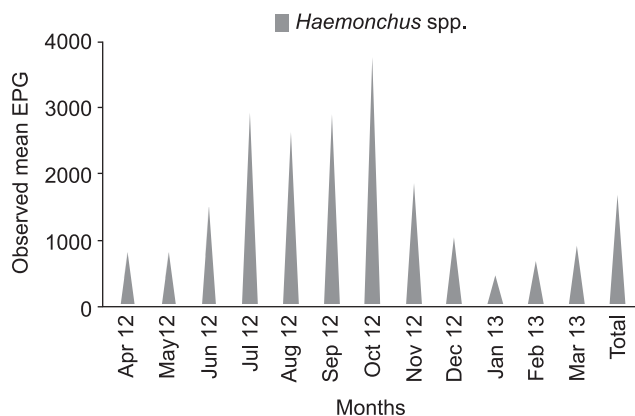


Fig. 3. Overall month-wise observed mean EPG of *Haemonchus* spp. in goats.

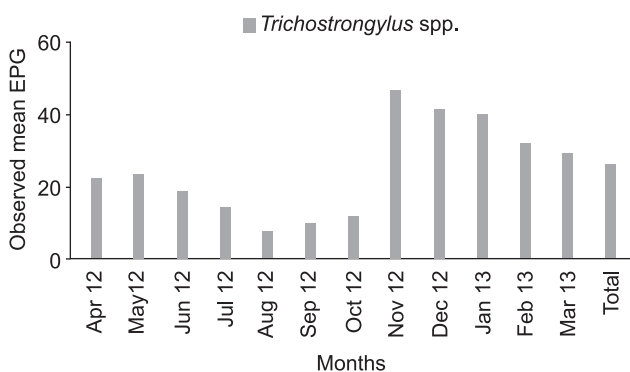


Fig. 4. Overall month-wise observed mean EPG of *Trichostrongylus* spp. in goats.

Haemonchus spp. was the highest (85.05%) in September and lowest (40.11%) in January, while *Trichostrongylus* spp. was the highest in December (15.57%) and their lowest percent was recorded at exogenous stages on pasture from May to July (Fig. 2).

The comparison of predicted value of haemonchosis and trichostrongylosis with the real time observations in goats (Fig. 3) revealed that higher prevalence of *Haemonchus* spp. was recorded from June to October and higher intensity from July to October, while for *Trichostrongylus* spp. higher

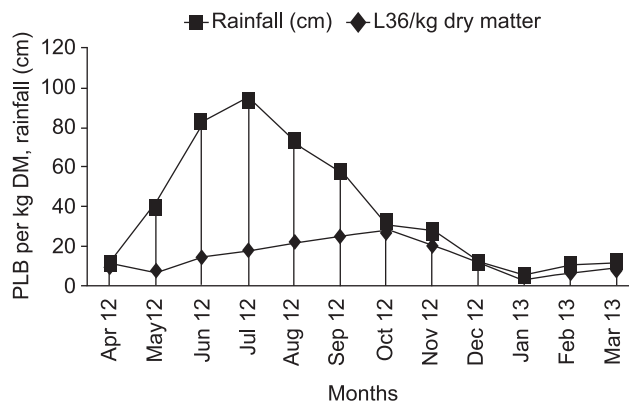


Fig. 5. Pasture larval counts (L₃/kg dry matter) in subtropical high humid region of Sikkim.

intensity was recorded from November to February (Fig. 4). Pasture larval burden examination showed that *Haemonchus* spp. larvae was predominant throughout the year while *Trichostrongylus* spp. larvae were found mostly in the winter from December to February (Fig. 5).

The bioclimatographs for prediction of *H. contortus* and *T. colubriformis* for the year 2012 to 2013 are presented in Fig. 6a-6d, Fig. 6e- 6h and Table 1. The favorable months predicted in the present study by bioclimatographs were April to October, February to November, May to November, and February to June when plotted against T_{max} v/s TRF, RH v/s T_{max}, TRF v/s T_{min} and RH v/s T_{min}, respectively, for the parasite *H. contortus*. In case of *T. colubriformis*, the favourable months predicted by bioclimatographs were December to January, February and October to February when plotted against RH v/s T_{max}, TRF v/s T_{min} and RH v/s T_{min}, respectively. The observed months for higher incidence of *H. contortus* and *T. colubriformis* were April to October and September to January, respectively. Bioclimatograph have been prepared by several workers to predict the prevalence of gastrointestinal nematodes (Borthakur and Das 2005, Swarnkar and Singh 2011, Kumar *et al.* 2013, Laha *et al.* 2013, Swarnkar and Singh 2015). Swarnkar and Singh (2011) observed June to mid-September and late June to mid-August in semi-arid and arid zones of India,

Table 1. Comparative prediction of bioclimatographs of *Haemonchus contortus* and *Trichostrongylus colubriformis* in goats

Parameters of bioclimatograph	<i>H. contortus</i>		<i>T. colubriformis</i>	
	Favourable months predicted by bioclimatograph	Observed months for higher prevalence of <i>H. contortus</i>	Favourable months predicted by bioclimatograph	Observed months for higher prevalence of <i>T. colubriformis</i>
Tmax v/s TRF	March to November	April to October	November	October to January
RH v/s Tmax	April to March	July, August, September and October	January	November to January
Tmin v/s TRF	May, June, July, August, September, October, November	March to October	November, December, January	October, November, December
RH v/s Tmin	April to November	March to October	October to March	September to February

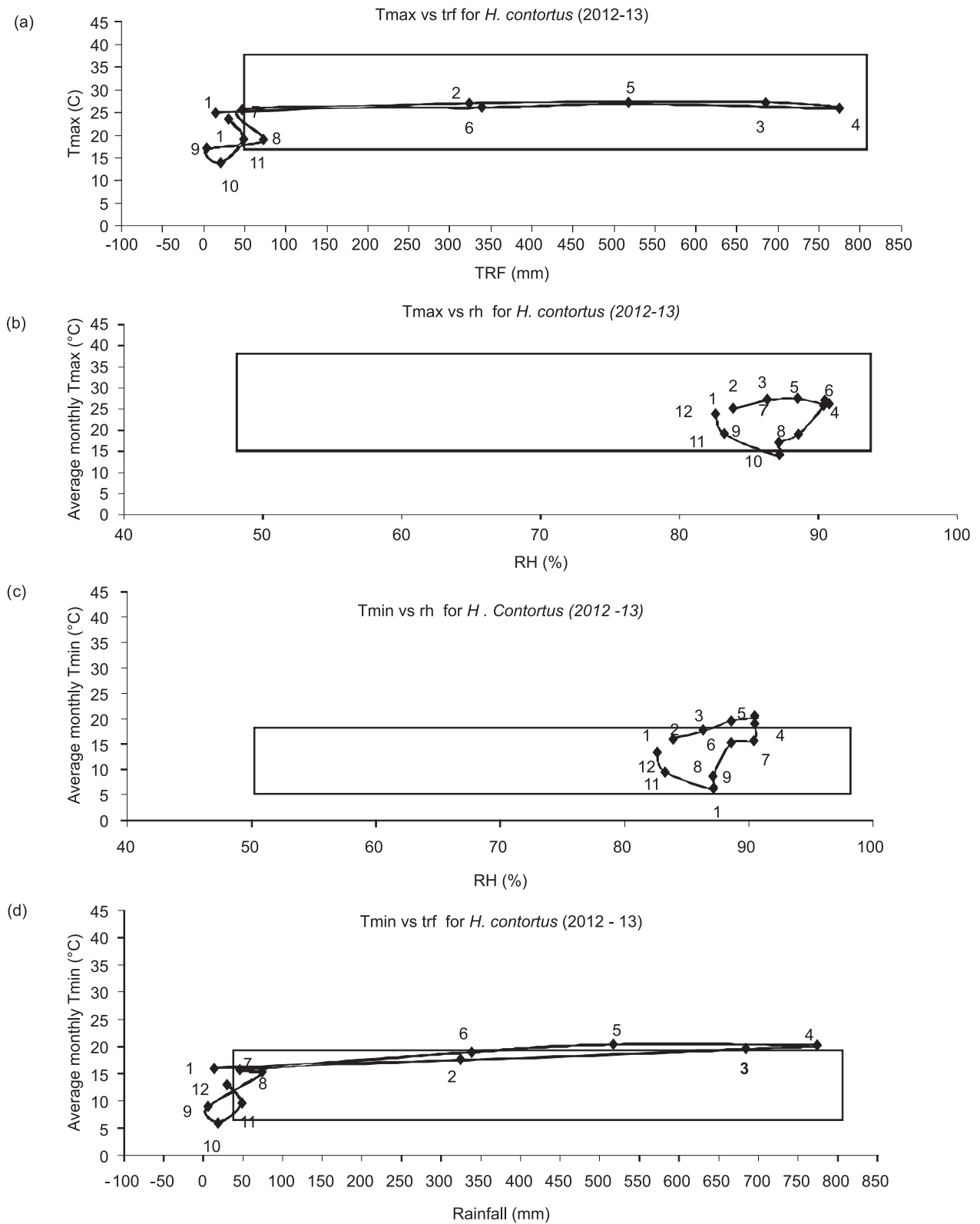


Fig. 6a–6d. Predicted prevalence of *Haemonchus* spp.

respectively are suitable for development, survival and dissemination of exogenous stages of *H. contortus*. Their observations on real time incidence was fully in agreement with prediction by bioclimatographs on long-term basis,

but minor variation on real time incidence with predicted months by bioclimatographs on annual basis was observed by them.

The development of free living stages of strongyle worms

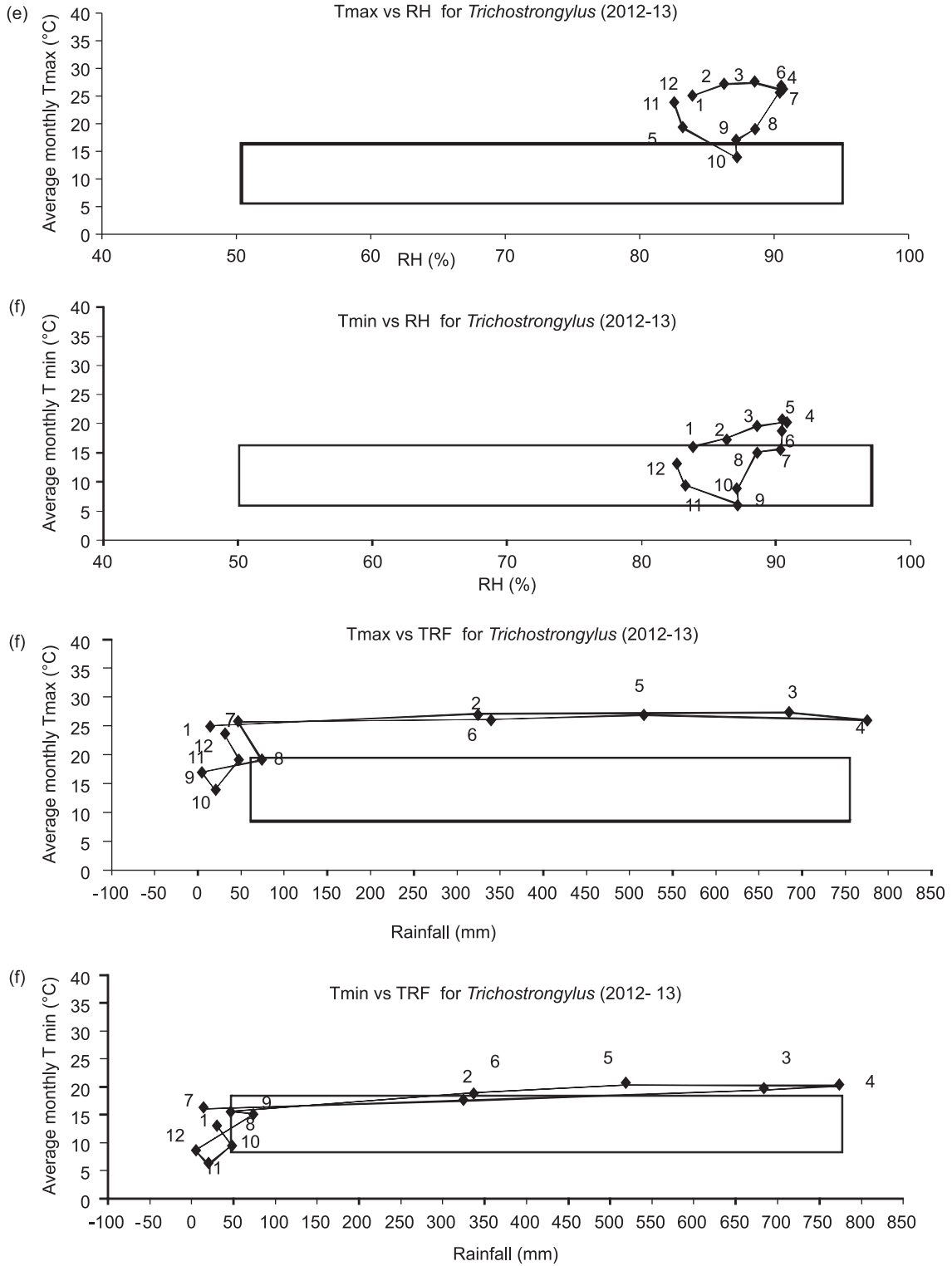


Fig. 6e–6h. Predicted prevalence of *Trichostrongylus* spp.

is influenced by temperature and moisture (Kumar *et al.* 2013). A total monthly rainfall of 50 mm or more along with an average monthly maximum temperature from 18–30°C are considered most favourable for development of *H. contortus* while for *Trichostrongylus* spp. optimum temperature varies from 5–18°C. Cold temperature is

generally a constraint in development of strongyle larvae even if moisture is available whereas interaction between moisture and temperature becomes important as weather conditions become warmer (Kumar *et al.* 2013). However, when the infective (L₃) stages are reached, the effect of temperature and moisture on survival of L₃ becomes less

important (O'Connor *et al.* 2008, Kumar *et al.* 2013). In the present study, slight variations in predicted months was observed by bioclimatographs, which is due to climatic variations of this agroclimatic zones of Sikkim. Within similar agroclimatic region, slight to moderate variation in prediction have been observed by Laha *et al.* (2013). Although EPG was observed throughout the year but more EPG as well as larval culture indicated *H. contortus* and *T. colubriformis* observed from April to October and November to March, respectively. But for making an accurate bioclimatograph, a detailed study of soil type, vegetation, drainage, irrigation, etc. is also needed to be taken into consideration apart from climatological factors and precipitation for a period of 3–5 years. Therefore, further study in this line is suggested for effective use of bioclimatograph as a tool for forecasting haemonchosis and trichostrongylosis in goats in Sikkim.

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REFERENCES

- Bonnell T R, Ghai R R, Goldberg T L, Sengupta R and Chapman C A. 2016. Spatial patterns of persistence for environmentally transmitted parasites: Effects of climate and local landscape. *Ecological Modelling* **338**: 78–89.
- Borthakur S K and Das M R. 2005. An approach to forecast haemonchosis in cattle in Guwahati using bioclimatograph: a preliminary study. *Journal of Veterinary Parasitology* **19**(2): 111–14.
- Kapoor D. 2013. Factors influencing gastrointestinal nematode infections in Gaddi sheep and goats kept in smallholder farming conditions. *Journal of Veterinary Parasitology* **27**(1): 29–32.
- Kumar D, Vatsya S and Kumar R R. 2013. Preparation of obioclimatograph for strongylosis in small ruminants of tarai region of Uttarakhand. *Journal of Veterinary Parasitology* **27**(2): 83–87.
- Laha R, Das M and Goswami A. 2013. Seasonal dynamics of gastrointestinal parasitic infections and prediction of *Haemonchus contortus* infections of goats in a subtropical hilly region of North-Eastern India. *Indian journal of Animal Research* **47**(4): 309–14.
- MAFF 1984. *Manual of Veterinary Investigation*. Vol.2 (Reference Book 390, HMSO, London), 161–187. Techniques. HMSO. O, Connor, Khan L P and Walkden-Brown S W. 2008. Intertaction between the effect of evaporation rate and amount of simulated rainfall on development of the free-living stages of *Haemonchus contortus*. *Veterinary Parasitology* **155**: 223–34.
- Pal P, Chatlod L R and Avasthe R K. 2014. Epidemiology of *Haemonchus contortus* infection in goats in Sikkim. *Indian Journal of Animal Sciences* **84** (8): 829–32.
- Pal P, Chatlod L R, Bandyopadhyay S, Rahman H and Avasthe R K. 2015. Epidemiology of *Nematodirus filicolis* infection in goats in temperate humid zone of Sikkim. *Indian Journal of Animal Sciences* **85**(8): 840–43.
- Pullan R L and Brooker S J. 2012. The global limits and population at risk of soil-transmitted helminth infections in 2010. *Parasite & Vectors*: **5**: 81.
- Singla L D. 1995. A note on sub-clinical gastrointestinal parasitism in sheep and goats in Ludhiana and Faridkot districts of Punjab. *Indian Veterinary Medical Journal* **19**: 61–62.
- Soulsby E J L. 1982. *Helminths, Arthropods and Protozoa of domesticated Animals*. 7th edn, 809 pp. ELBS and Baillire, Tindall, London.
- Swarnkar C P, Singh D, Krishna L and Khan F A. 2008. *Epidemiology and Management of Gastrointestinal Parasites of Sheep in Rajasthan*. 1st edn. CSWRI, Avikanagar, p. 135.
- Swarnkar C P and Singh D. 2011. Role of obioclimatographsin forecasting of strongyle infection in Rajasthan. *Indian Journal of Animal Sciences* **81**(3): 216–23.
- Swarnkar C P and Singh D. 2015. Epidemiology of ovine gastrointestinal parasites under different worm management strategies at an organized farm in arid Rajasthan. *Indian Journal of Small Ruminants* **21**(1): 53–63.