

Mini Review: Current tick control strategies in Pakistan are possible environmental risks

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Abstract

Ticks infestation is the major problem of cattle and buffalo of Pakistan. Tick acts as vectors of many viral, protozoal and bacterial diseases and Crimean-Congo Haemorrhagic Fever (CCHF) is one of the most lethal in that list. During the last sixteen years, many sporadic outbreaks of CCHF in Pakistan has been reported with 24 percent case fatalities. In Punjab and Sind provinces mass tick control campaigns have been started to control the tick's population and spread of zoonotic diseases through tick's. In these tick control campaigns deltamethrin and ivermectin are used extensively. We highlighted that how extensive use of deltamethrin and ivermectin can adversely affect the environment and possible alternative methods for tick control. Extensive use of deltamethrin can damage the kidneys of insect eating birds and disturb the life cycle of many aquatic organisms if deltamethrin solution is mixed with water of streams. Widespread ivermectin use in domestic animals poses some serious threats to dung beetles and other coprophagic insects as almost 60-80 percent of total dose comes in feces without any metabolism in the body of animal. Decrease in dung beetles can result in decreased dung degradation.

Keywords: Tick control, Congo fever, Deltamethrin, Insecticides, Environment

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المخاطر البيئية للسيطرة على القراد في باكستان

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الخلاصة

أن الإصابة بالقراد هي من المشاكل الرئيسية التي تصيب الجاموس والابقار في باكستان، يعتبر القراد الناقل الرئيس للعديد من الامراض الفايروسية والاولالي والجراثومية ويعتبر الحمى النزفية (Crimean-Congo haemorrhagic fever) (CCHF) هو من اخطر هذه الامراض. خلال السنوات الستة عشر الماضية تم الابلاغ عن العديد من تقشي الإصابة بمرض الحمى النزفية كونغو بشكل متقطع في باكستان. مع نسبة وفيات وصلت الى ٢٤%. ولقد بدأت في البنجاب وولاية السند حملات واسعة للسيطرة على القراد والامراض الانتقالية التي بسببها. وقد تم استخدام في هذه الحملات مركبات الدلتاميثرين والايفرمكتين على نطاق واسع. لقد ابرزنا ان الاستخدام الواسع لمركبات الدلتاميثرين والايفرمكتين لها تأثيرات سلبية على البيئة والطرق البيلة المستخدمة للسيطرة على القراد. ان الاستخدام الواسع للدلتاميثرين يؤدي الكلية للطيور الاكلة للحشرات مما يؤدي الى تغيير في دورة حياة العديد من الطيور المائية اذا تم خلط هذه المركبات مع المياه من الجداول والانهار. ان الاستخدام الواسع للايفرمكتين في الحيوانات يؤدي العديد من الحشرات ومنها خنافس الروث والحشرات اكلة الروث كون ان ٦٠-٨٠% من هذا الدواء يطرح الى الخارج بدون تمثيل اي تمثيل غذائي داخل جسم الحيوان. ان نقصان اعداد خنافس الروث يؤدي الى نقصان في تحلل الخروج.

Introduction

Ticks economically are very important ectoparasites of the cattle and other domesticated animals in tropical as well as in subtropical regions. Ticks acts as vectors of many protozoans such as *Theileria*, *Babesia*, *Rickettsiae* such as *Ehrlichia*, *Anaplasma*, bacteria such as *Listeria*, *Pasteurella*, *Staphylococcus*, *Brucella*, *Spirochaetes*, and viruses such as Congo Haemorrhagic Fever Virus (1,2).

Crimean-Congo Haemorrhagic Fever (CCHF) has become a serious health issue in Pakistan and many sporadic outbreaks of CCHF had been reported since 1998 (3). In 2014, from 30th March to 20th July, a total of 42 cases of Crimean-Congo Haemorrhagic Fever were reported throughout the Pakistan and 22 cases were confirmed through lab tests, among these 42 cases 24% case-fatality rate was reported (4).

To prevent outbreaks of CCHF Congo control campaigns has been started from 2012. In these campaigns Acaricides are used widely to control the population of tick so chances of direct contact between human and ticks can be decreased. Studies have suggested that the occurrence of CCHF outbreaks in Pakistan is increased significantly near Eid-UL-Adha because of an increase in chances of contact with animals having tick infestation and direct contact with the blood of animals. Due to these facts use of Acaricides is enhanced many times near Eid-UL-Adha throughout the Pakistan (4).

On the other hand, use of Acaricides on large level is affecting our ecosystem too. If acaricides are used systemically their residues comes in meat, milk and can cause liver and kidney problems. Mass Spray of acaricides in dairy farms is a source of environmental pollution.

Important species of ticks infesting cattle and buffaloes in Pakistan

Figure 1 shows the infestation rate of different genera of ticks on cattle and buffalo in Peshawar, Pakistan, according to a study done by (5).

In a study performed by (6) prevalence of ticks in sheep and goat was recorded as 43.37 and 41.53% in respectively in two different livestock farms located in the Potohar region, namely Barani Livestock Production Research Institute Kherimurat, District Attock and National Agricultural Research Centre, Islamabad, Pakistan. (7) investigated the prevalence ticks in dairy cattle and buffalo in district Faisalabad, district Jhang and district Khanewal of Punjab, Pakistan. Those researchers found that tick's infestation rate in cattle was 70% and in buffaloes was 34%.

Impact of ticks on animals

Tick infestation results in substantial losses to livestock farmers (8). Ticks and tick borne diseases result in loss of

around US\$ 499 million per annum in India (2). In 1974 in Australia, *Boophilus microplus* caused a loss of 62 million USD. It is estimated that Brazil suffers around 2 billion USD per year due to tick infestation (9). Ticks causes economic losses either by directly sucking blood from host animal or indirectly by acting as vector of pathogens. Ticks causes decrease in live weight of host animal. Tick bites also lessen the quality of hides of domestic animals. Ticks infestation result in irritation and unrest in livestock that can lead to drop in their production (10). As vector of pathogens ticks transmit many pathogens that can cause diseases in human and animals such as CCHF, Lyme disease, Theileriosis, Anaplasmosis, Babesiosis and East Coast fever. *B. microplus* act as vector for pathogens that cause Anaplasmosis and Babesiosis (11). These losses can be curtailed if the population of ticks in the farm is kept at the lowest possible level.

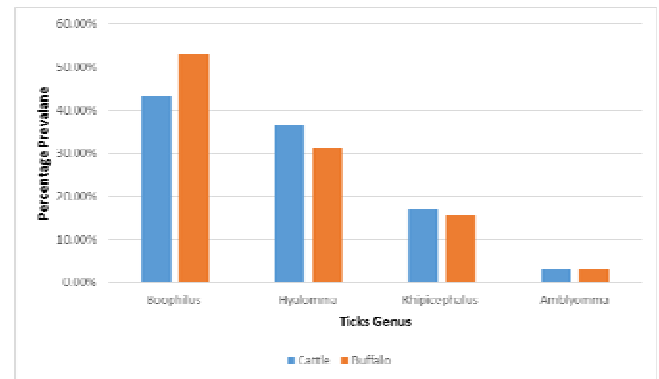


Figure 1: Prevalence of different genera of Ticks in cattle and buffalo.

Impact of ticks on human health

Tick-borne diseases in human came under the light after discovery of Lyme borreliosis. Pathogen of Lyme diseases is *B. burgdorferi* that is transmitted by ticks belonging to genus *Ixodes*. Lyme borreliosis is now becoming the most frequently reported arthropod-borne disease in Europe, North America and China (4,12,13). *Ixodes* ticks also transmit many viral infections in human all over the world such as European tick-borne encephalitis, Crimean-Congo haemorrhagic fever, Kyasanur forest disease and Russian spring summer encephalitis. CCHF is transmitted by different species of genus *Hyalomma*. Many outbreaks of CCHF have been reported in recent years in Asia and Africa (4,13). Kyasanur forest disease is caused by flavivirus and transmitted by *Haemaphysalis*. Many deaths are reported annually in India due to Kyasanur forest disease (2). Ticks of genus *Dermacentor* act as vector of *Rickettsia rickettsii*, causing agent of Rocky Mountain spotted fever. Rocky

Mountain spotted fever has been reported from many states of the United States (14).

Prevalence of ticks in different Asian countries

There are many reports that describe the prevalence of ticks in Asian Countries. In Turkey thirty-two tick species that infest mammals and birds have been reported. Ticks belonging to genera *Dermacentor*, *Rhipicephalus* and *Boophilus* are prevalent in Anatolia. Genus *Ixodes* ticks are present in Northern Turkey (15). A study conducted in Diyabakir province in Turkey by Neval Kaya demonstrated that 26.2% animals had ticks' infestation and commonly prevalent ticks were *R. bursa*, *R. turanicus*, *R. sanguineus*, *Hyalomma anatolicum excavatum*, *H. anatolicum anatolicum*, *Haemaphysalis parva*, and *H. punctate* (16).

In Iran (17) reported that 57% cattle, 62% goats and 55% sheep were infested by hard ticks. *Haemaphysalis*, *Dermacentor* and *Rhipicephalus* ticks were prevalent in the mountainous area and *Boophilus* and *Ixodes* ticks were found in the Caspian region. An epidemiological survey performed by (18) in Uzbekistan reported that three most prevalent ticks in Uzbekistan were *Hyalomma anatolicum* (34.9%), *Hyalomma detritum detritum* (31.8%), and *Boophilus kohlsi* (30.7%). In Iraq (19) reported presence of *Hyalomma anatolicum marginatum* and *H. anatolicum anatolicum* in cattle. Similarly, *Rhipicephalus bursa*, *R. turanicus*, *Hyalomma spp.* and *Haemaphysalis parva* were reported in sheep and goats.

Many human tick-borne diseases have reported from China such as Crimean-Congo hemorrhagic fever (called as Xinjiang hemorrhagic fever in China), Lyme disease, Forest encephalitis, Q-fever and tularemia all these indicated the prevalence of ticks in China (20,21).

Commonly prevalent genera of ticks in India are *Hyalomma*, *Rhipicephalus*, *Boophilus*, *Haemaphysalis* and *Argas*. According to different studies performed in Bangladesh it is reported that *Boophilus microplus* infested 28.3% cattle and 6.3% goats. *Rhipicephalus sanguineus* was more prevalent in canines as compared to other ticks. In India, Pakistan and Bangladesh tick load is increased during May-June due to favorable environmental conditions in April that lead to increased embryonic development and larval activity. During August-September heavy rainfall in results in reduction in ticks as rain washes away larva (2).

Current ticks control strategy in Pakistan

Acaricides are periodically used in dairy farming to control the ticks. Ticks control by the use of acaricides can be used against the ticks free living stages that are in the environment or can be against the stages of parasite on the host. In Pakistan acaricides are applied in many different ways. Sometimes acaricides are applied by spraying on

animals, by dipping of animals, by injections and by spot or pour-on are methods.

Wide range of acaricides is currently available in the market. Pyrethroids are easily degraded, safe as well as effective acaricides. Ecofleece™ is a formulation by Prix Pharmaceutica, which contains 10 EC cypermethrin in it. The dose recommended for good acaricidal effect is 1ml of the drug in 1 liter of water. Sometimes farmers use the insecticides of the crops that contains cypermethrin. The product Neguvon contains trichlorofon, a chemical belonging to organophosphate group. When used as a spray or dip, then concentration of this drug which is recommended is 0.15%.

Acaricidal drugs that can be applied to the animal's back are pour-on, they are costly, but much easier to use than others. These pour-on chemicals work by absorption in the blood so when tick feed on that blood these chemicals cause the death of ticks. Use of Ivermectin against ticks belonging to genus *Boophilus* @ 200 µg/kg provides very good results (8). Regardless of choice of method for the application of these acaricides, the sheds of animals must be periodically sprayed by the acaricides by preparing the solution at double strength than prepared for the spray or dip (8).

Adverse effects of pyrethroids

Use of acaricidal drugs has many drawbacks like their residues comes in meat, milk and also causes environmental pollution. Some insecticides have been made from chrysanthemumic acids in the form of semisynthetic derivatives called as 'Pyrethroids', and they are likely to be a little bit toxic to mammals and more efficient as compared to pyrethrins that are natural (22).

Allethrin is the most common synthetic pyrethroid. World Health Organization labelled Deltamethrin as a moderately hazards chemical. Interaction of pyrethroids with GABA receptors makes a complex known as ionophore complex. This ionophore complex lead to neurotoxicity (23).

Human toxicity

Pyrethroids are highly used in animal husbandry. Pyrethroids are mildly toxic to humans but still in 1982, 200 cases of acute occupational poisoning by pyrethroids were reported in China (24). Most of the cases were due to deltamethrin exposure and later on by cypermethrin, fenprothrin, cyfluthrin, fenvalerate exposure. After these incidents an epidemiological survey was conducted in China in which it was seen that there was 0.38% prevalence of mild acute poisoning by pyrethroids in 3,113 spray men (25).

Additionally, indoor spray of pyrethroids can be the source of chronic exposure and adsorption of pyrethroids by numerous objects such as dust particles makes them

probable indoor toxicants (26). Pyrethroid poisoning symptoms initiate with epigastric pain, dizzy feeling, headache, anorexia, nausea, fatigue, muscular fasciculation increased secretion of the stroma and vomiting. In severe situations, some additional symptoms like convulsion attacks, cyanosis, difficult breathing and edema of the pulmonary system are frequently observed (27). Because of the disturbance to cell membrane bilayer when pyrethroids interfere the order of lipid packing of mast cells and basophils which cause the release of histamine (27,28).

Pyrethroids which are synthetic in nature are such acaricides that are lipophilic in nature and their chemical composition and biological activities seems to be related directly (29). Duration and severity of symptoms depend upon exposure and can range from a few minutes to more than 20 hours (30).

Toxicity in aquatic organisms

Pyrethroids can cause many disturbing effects on the life cycle of aquatic invertebrates. Just like mosquito and flies LC50 value for aquatic invertebrates is less than 1.0 parts per billion (30). Aquatic invertebrates, those are highly sensitive to pyrethroids includes nymphs of the mayfly, certain large crustaceans, surface living insects, benthic organisms and zooplankton (31).

It is also reported that even at non-lethal concentration, pyrethroids can result in a change of behavior of aquatic invertebrates. Deltamethrin, cypermethrin and permethrin all are very toxic for fish, lobster and shrimp (32). In fish, poisoning by fenvalerate causes the symptoms like disturbance in schooling behavior, surface swimming, restlessness, coughing, increased secretion of mucus from the gills and before death shaking of the head (31).

Toxicity in birds

Pyrethroids affect the birds indirectly, due to the risk of their supply of food. Most prone birds are small insect eating birds and waterfowl (32). Birds can tolerate the pyrethroids better as compared to the mammals because of fast metabolism, low absorption and rapid elimination (33,34).

Mammalian toxicity

Pyrethroids are very powerful neurotoxicating agents in invertebrates and vertebrates, but in mammal's acute toxicity is less. In mammal's toxicity is less due to their rapid and speedy biotransformation and excretion from the body, usually along with the urine in the shape of metabolites that are non-active (35).

Adverse effects of ivermectin:

Avermectin group contains many macrocyclic lactone chemicals such as ivermectin, doramectin, eprinomectin,

moxidectin and abamectin (36). Among all members of avermectin group ivermectin is most widely used in Asia. Although it provides an effective and inexpensive way for treating and controlling ectoparasites but it also affects the biodiversity in farmland systems (37). After administration, 62%-98% of the ivermectin of total dose come in the feces without any metabolism in the body (37,38).

Many studies supported the fact that ivermectin does not rapidly degrade in dung and remains for long periods at such concentrations that are harmful to coprophagous fauna (39-41). (42) reported the presence of 13 µg of ivermectin per kg of cattle dung after 180 days in Argentina. Presence of ivermectin in dung effect the life cycle of dung beetles, dipteran larvae and such birds who eat these invertebrates (39).

Withdrawal period of ivermectin from cattle range from 21-55 days depending on dosage and route of administration (43). Prolong withdrawal time from meat and other edible parts of the animals also hinders the use of ivermectin in food animals. But in Pakistan use of ivermectin in animals is enhanced near Eid-UL-Adha irrespective of its side effects on human health.

Alternative strategies for tick control

Animals that are newly purchased should not keep in the same shed with the already present animals. Newly purchased animals must be treated with acaricidal drugs if ticks are present on them. Rotational grazing can decrease the population of one-host ticks such as *Bophilus microplus* (44).

Sahiwal cattle (*Bos indicus*) are much more resistant to ixodid ticks than European (*Bos taurus*) breeds of cattle. There are some factors that contribute to tick resistant ability of Zebu cattle such as they have very thick and mobile skin that is covered with hair that are straight, short, and non-medulated (wooly hair on the skin of European cattle), blood circulation of skin is good and high, panniculus muscles are well developed, when ticks and flies sit on the skin than hair become erected and repels the ticks are repelled by sebum secretion in hair (45).

The host's resistance can decline due to many factors such as host stress, any disease, lactation and malnutrition (46). Tick resistance traits are heritable and bulls that are selected for their resistance ability by breeding with them this ability can be enhanced in their progeny as well (45). There are many natural enemies for ticks that can be considered as a weapon of biological control for ticks. Some other predators like rodents, ants, birds and spiders play certain role in the control of ticks. Ox peckers eat the ticks from animals and studies revealed the fact that burden of the ticks is low in those buffaloes and cattle that

are tied or stay in summers beneath the trees, because birds in the trees eat ticks (46).

Now a day, widespread use of chemicals for control of ticks resulted in drastic decrease the number of such birds that eat ticks. In cattle sheds, poultry chick raising is very helpful because they pick the ticks from the animal's body and decrease ticks from the surrounding area of the farm too. If chicken eats one single engorged female tick that can diminish several thousand larvae (47).

Biological control is the best option to control the ticks because of the resistance against acaricides and residues of insecticides in animal origin food (48). Certain herbs and plants have the ability to kill the ticks, inhibit their growth, against molting and repel the ticks. There are so many reports on the extracts of the plant's effect on the species of the ticks. (47) studied that Sitaphal (*Annona squamosa*) and Neem (*Azadirachta indica*) alcoholic extracts could be very effective against *Boophilus* and *Hyalomma*.

Many people in Punjab province feed 250 mg of powdered *Tara mira* (*Roquette, Eruca sativa*) to cattle for control of. Tick load is reduced by this recipe and it also increases the milk yield. In Punjab, sometimes farmers apply the common salt solution on the body of animal for the control of ticks. Development of vaccine against ticks is also a useful option to reduce the ticks (47). Vaccines can be used to protect animals against ticks and tick borne diseases. Due to harmful effects of acaricides in many European countries recombinant vaccines against ticks became commercially available in the early 1990s. Second method is vaccination of animals against tick borne diseases. In Argentina, Australia and Israel attenuated vaccines against babesiosis have been used with great success (48,49).

Conclusion

We should try to limit the use of pyrethroids and macrocyclic lactone for control of ticks as these chemicals adversely affect the environment and kill many other useful insects. Biological control and vaccine against ticks are good options to control ticks without damaging normal fauna.

Author's contribution

AI and MA conceived the idea. AI and MU gathered the literature and all authors participated in write up and approved the manuscript.

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