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Integrated pest management: An eco-friendly approach to control and manage ticks in cattle

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Abstract
In tropical nations like India, ectoparasitic diseases account for a serious threat to both human and animal health. Ectoparasite infestation costs India's economy and health significantly each year. Ectoparasites such as ticks can cause irritation, skin infections, anaemia, Lyme disease, tick fever, and they can spread a number of deadly diseases. Ticks have comparatively fewer natural enemies, but with the use of some predators, parasites, such as ants, spiders, bird etc has been investigated for tick control. The prevalence of tick predation makes it challenging to document it.
The majority of arthropod predators are generalists and opportunistic and likely have little impact on ticks. Controlling ticks is therefore a major concern. Several chemical acaricides have been prescribed since the past 50 years. However, their aftereffects, negative side effects, and resistance are a matter of concern now days. As a result, biological control of ectoparasites becomes crucial in various parasite control program. The present research article critically analyses the various techniques for managing the ectoparasites, with a focus on the management, biological, pheromone-assisted control, and more recent biological and genetics methods.

Keywords: IPM, Ticks, biological control, hormone-assisted control, vaccine

1. Introduction

Ectoparasites like ticks, flies, mites, and lice depend on the skin of their hosts for survival, growth, and reproduction. Because of a lack of awareness, unclean habits, inadequate and subpar veterinary services, poor control measures techniques, and favourable climatic conditions for the proliferation of ectoparasites, ticks and flies are more common among these ectoparasites in the various regions of India. For almost a century, tick control has generated a lot of attention. The goal of tick control is to get rid of all ticks that are infesting people or other vertebrate animals, or at least get their numbers down to an acceptable level.

Ticks are exclusive vectors for various pathogenic protozoans, virus and bacteria. Ticks may cause various diseases such as Babesiosis, Bovine anaplasmosis, East coast fever, which are the most common tick-borne diseases of cattle which ultimately cause severe damage to cattle health and financial damage to livestock production industry.

There is no way to ignore tick control. Lack of it makes rearing cattle hard in many tropical and subtropical areas of the world. This has proven to be a challenging task despite its evident relevance. Almost entirely for more than a century, animals have been treated with huge doses of acaricides that are then applied to their body surfaces in an attempt to reduce tick infestations. The principles of ticks control are correct identification of tick species, accumulation of scientific biological data related to life history and habitat of the tick species, determination of the intensity of damage been done by the ticks, estimation of amount of which could be spent profitably in reducing the damage and determination and execution of the most efficient approach to the pest control (Knipling, 1979) [14].

The prevention of ticks and TickBorne Diseases can be accomplished through a number of di fferent methods. There are numerous strategies available to control ticks and Tick-Borne Diseases. Tick prevention and control should cover the whole period during which ticks are active. The most common method of controlling or preventing hard tick attacks still includes the use of synthetic drugs known as acaricides with the aim of inhibiting the spread of pathogens with the use of acaricides, ticks can be controlled either on the host or in their free-living phases in the surrounding environment. However, their aftereffects, negative side effects, and resistance are a matter of concern now days. Following are some eco-friendly strategies to manage and control ticks.

2. Current control methods of ticks

2.1Management control

Changes to the landscape may make an area undesirable to the primary tick hosts and reduce the number of ticks that are present in certain areas of the yard. Ticks are less common on well-kept lawns, with the exception of those located near wooded areas, stone walls, or locations with a lot of groundcover and ornamental vegetation. It has been proven that removing leaf litter and woodchip barriers can help lower the number of ticks on the grass. However, using landscaping techniques to establish a lower risk tick zone won't completely get rid of ticks, so you might want to think about integrating other tick control techniques into the overall programme. There are various basic concepts in modifying the landscape to create an area with fewer ticks and eco-friendly management practices. In order to eliminate tick and small animal habitat and cover, expose the land to direct sunlight and include the area of the landscape that family members commonly use or travel over. Ticks are less prone to live in bright, sunny regions. Ticks can also be found in groundcover. Use groundcovers only in the yard's less-trafficked sections. Since purebred exotic and crossbred cattle are more prone to a tick infection than native cattle and buffalo, it is advisable to keep cattle and buffalo sheds as tick-free as possible, especially for housing. The buildings shouldn't have any fissures or crannies (As the ticks hide and breed there).

A simple solution that greatly reduces the tick burden is to caulk the walls of the animals' sheds. The female ticks typically lay their eggs in the cracks and crevices of the animal shed walls, so scraping farm waste (faeces and feed waste, etc.) against the walls of vacant paddocks and slowly burning it over the course of one or two days is a very effective way to reduce the tick burden on the animals. This action needs to be repeated on a regular basis. While using this technique, all reasonable safety precautions should be taken.

Tick infestations are more common in cattle than in buffalo, especially in those with oversea blood. Except under the most extreme situations, buffaloes rarely carry cattle ticks. They aren't the typical host for cattle ticks. The buffaloes can experience severe tick infestations when cattle and them are kept together. Cattle and buffaloes should therefore be housed separately. It is not advisable to immediately mix newly purchased animals with the farm's existing stock. Before introducing new newcomers into the herd, all ticks on their bodies should be removed with acaricides. Farmers typically remove the ticks manually while milking when there are very few cattle or buffaloes that are tick-infested. By placing the ticks on a nearby burning dung cake, ticks that have been so removed are destroyed. Ticks can be manually removed by grasping them close to the animal's body with the forefingers and twisting them in the opposite direction.

Fig 1: Manual removal of ticks

2.2 Biological control

Biological control of ticks seems to be a suitable alternative that can reduce the frequency of use of chemical acaricides and the need for treatment of Tick-borne diseases. Biological control agents are remarkably desirable, but their narrow host specificity, often relatively less efficacy, high costs of manufacture, some application problems and sometimes low stability present serious challenges. Numerous pathogens attack ticks, including bacteria, fungi and nematodes (Samish M. G., 2004) [13]. Several papers have reported the testing of entomopathogens for the control of ticks in laboratories, and the use of these novel biocontrol techniques on animals (Alonso-Díaz, 2007) [2] Among the potential biocontrol agents, entomopathogenic (insect pathogenic) fungi, nematodes and parasitic wasps are the most promising candidates (Samish M. a., 1999) [8].

A strategy that holds promise for reducing tick populations is the use of insect pathogenic fungus. Several fungi have been identified, including Beauveria bassiana and Metarhizium anisopliae. It has been demonstrated to be pathogenic to I. scapularis both in the lab and in the field entomopathogenic fungi attack their host by piercing the host's cuticle. After the attached spore's germination, appressoria are created, which release histolytic enzymes and result in the formation of hyphae. After the hyphae have successfully penetrated, yeast-like blastospores are formed and propagate. When the host dies, the fungus grows out of the carcass and sporulates. The relative ease with which these fungi's spores may be created and artificially spread makes them promising potential tick-controlling agents.

For the management of ticks, other targeted methods of introducing fungal pathogens into the environment are needed. The pathogens that affect ticks typically also affect other arthropods (Brownbridge, 2007) [3]. So, while developing techniques for using biocontrol materials, researcher should have to consider there should be no side effects on non-target arthropods. A promising alternative to the use of entomopathogenic fungi is biological control through the use of entomopathogenic nematodes (EPNs) (Samish M. G., 2004) [13]. The genus Ixodiphagus, which contains chalcid wasps, is an obligatory parasite of ixodid ticks, and the majority of its species will only lay their eggs and develop during the tick's nymphal stage. Arthropods can also be used to biologically control of tick populations. Several wasp larvae can successfully develop in a single engorged nymph, which is killed during this process (Mwangi, 1997) [6]

Domestic chickens, ducks, emu are opportunistic predators of ticks and can be used for tick control in most of the rural areas all over the world. More precisely, the indigenous breeds of Galliformes such as turkeys, quails if allowed to scavenge among the cattle, so they can consume considerable numbers of ticks that can be cost effective method for biological control of ticks.

2.3 Pheromone or hormone-assisted Control

One of the most important approaches being utilised to manage hard tick populations is pheromone-assisted tick management. Study using tick pheromones suggests that, ticks are unlikely to become resistant to their own pheromones, pheromone plus acaricide mixtures can be substantially more successful at controlling ticks than acaricide alone.

In all species of ticks, mating occurs according to a ritualistic pattern. A male that makes contact with a sexually active female mounts onto its dorsum, attaches its legs and mouthparts to the body surface, flips, and crawls over the posterior edge onto the ventral surface of the female. As soon as the male locates the female's genital pore, it inserts its mouthparts into the female's vulva and it begins to form a spermatophore. When ready, the copulating male inserts the spermatophore into the female’s genital pore to inseminate the female. Most of our knowledge of tick courtship behaviour has been obtained from studies of mating in the Meta-striate ticks of the family Ixodidae (All Ixodidae except the genus Ixodes).

Once feeding on host begins, (Gametogenesis) spermatogenesis and oogenesis are initiated, and within 1 or 2 days. (Sonenshine D, 1984) [10] Sexually mature females begin to secrete the attractant sex pheromone (ASP) 2, 6-DiChloro Phenol. Males feeding close by are stimulated to detach from host surface and start looking for the pheromone-secreting females. Males detect the pheromone and crawl over the host until they contact the emitting female. After male - female contact, recognition is facilitated when the males detect cholesteryl esters on the female's body. The mixture of compounds, which comprise the mounting sex pheromone (MSP), stimulates the male to mount the dorsal surface, clasp the female, tum to the female's venter, and search for the genital pore. The chemical composition of the MSP is also critical to the completion of the mating process. Even though attracted by attractant sex pheromone (ASP) from a feeding female, males will not mate with a female unless it recognizes the MSP (specific for that species) upon contact with the female body surface males could even be induced to mount inanimate objects, e.g., plastic beads, coated with a mixture of 2, 6-DCP and the cholesteryl esters.

Ticks can be killed by a pheromone-acaricide mixture sprayed on a small region of cattle. Another promising method is the "tick decoy," which combines an acaricide and the sex pheromone 2, 6-dichlorophenol with plastic beads on which "mounting" sex pheromone has been applied. (Agustín Estrada-Peña, 2013) [1] Male ticks are attracted to these tick decoys on the animal’s fur coat and get killed. This strategy also interrupts mating activity so that any surviving females will not able to lay viable eggs. Another important technology for killing Ixodes scapularis ticks in their natural habitats was developed by incorporating the components of the tick arrestment pheromone (guanine, xanthine and haematin) along with permethrin into an oily matrix for dispersal on vegetation. These paste-like droplets attracted and killed ticks before they could infest humans or animals. (Sonenshine, 2003) [11]. In laboratory tests, hormones and insect growth regulators (IGRs) like Methoprene have also been employed to obstruct the development of ticks.

Analogues of ecdysteroids and juvenile hormone can kill ticks by postponing development, preventing oviposition, or by killing the larvae that hatch from eggs laid by treated female ticks. Although, these substances don't seem to be equally effective against all tick species.

2.4 Genetic control

Most of the time, the genetic resistance is inherited and lifetime. Although resistance varies between individuals, it can be influenced by environmental factors like stress and nutrition.

An excellent source for finding certain breeds with relatively high resistance to particular tick species is the South American criollo and African taurine breeds. Although no systematic attempt has been made to rank the tropical breeds for resistance to either a single species of ticks or to many species of ticks, there are numerous indications that certain breeds are tick resistant.

The *Boophilus microplus* and Boophilus decoloratus are two tick species against which the Brahman and Nelore cattle breeds have high resistance, and it may be possible that all Indian zebus also have high resistance to all Boophilus species.

Breeds that have had prolonged exposure to a certain species of tick are likely to have evolved genes, each with a little effect on resistance to that species. B. microplus resistance in zebu cattle breeds is caused by polygenic effects. Integrated techniques to control ticks concerned with veterinary importance have been already implemented for selected tick species in many regions of the world. Upcoming decades, the integration strategies for the management of ticks will become the norm rather than the exception.

2.5 Vaccine

Australia is the first county to develop a commercial recombinant antigen vaccine for the control of the cattle tick *Rh. (Boophilus) microplus* based on a concealed antigen (Bm 86) which is found in cells of the tick gut. Also in Cuba, a comparable recombinant vaccine has been developed.

According to recent reports, the recombinant Bm86 can lower tick fecundity by up to 90% (Willadsen, 2006) [12]. Even if it's possible for antigen-resistant cattle tick strains to emerge, widespread vaccination of cattle herds with these recombinant vaccines presents a prospective substitute for or alternative to acaricides. The vaccination is significantly more effective against Rh. (Bo.) annulatus than against the homologous species, while using an antigen from Rh. (Bo.) microplus. A high level of efficacy is necessary to compensate for the fact that vaccinations are costly and carry a considerable measure of risk. Other antigens and different tick species are the subject of ongoing research.

The functional classes of tick antigen targets that have been examined so far are relatively narrow. They comprise membrane-associated proteins with uncertain functions, hydrolytic enzymes and their inhibitors, especially those engaged in haemostatic processes, and structural proteins, particularly those from salivary glands.

Other promising vaccines target tick-cement protein, disrupting the attachment success as well as causing midgut injury and affecting the tick's ability to transmit pathogens (Labuda, 2006) [5]. In contrast to 64TRP vaccination, immunisation with the commercial Tick GARD vaccine greatly reduced transmission rates to nymphs and reduced the number of mice that supported transmission. The transmission-blocking properties of Tick GARD, however, did not offer defence against deadly infection with TBEV, unlike 64TRP-immunization. Tick GARD and Gavac, the equivalent in Cuba, are derived from Bm86, an unidentified midgut antigen. (P, 2004) [7]. These commercial anti-tick vaccines cause an antibody-mediated reaction that targets the midgut cells and leads to midgut rupture, tick mortality, and decreased reproductive efficiency. By reducing tick populations, they seem to lower the prevalence of diseases transmitted by ticks in cattle (Babesiosis and anaplasmosis) (P, 2004) [7].

3. Conclusion

Each control method has limits for high-level, long-term ectoparasites control. In integrated pest management programme, the chemical acaricides are used as a last option due to their increased application cost and hazard associated with their use. In the current environment, IPM is important because it safeguards human health by reducing toxic chemical residues that may cause cancer or neurological disorders, manages vector resistance, conserves biodiversity, which includes beneficial pollinator parasite/predator insects, reduces environmental pollution, and avoids loss of export.

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