ACARICIDE RESISTANCE IN BRAZIL AND THE USE OF MIXTURES AS CHEMICAL ALTERNATIVE FOR TICK CONTROL.

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Resume

Like in others areas of the world where infestation by *Boophilus microplus* ticks is a reason for concern, acaricide resistance in Brazil remains a problem, since chemical control is the basis for the most reliable methods of tick control. Essentially, most of the concentrated emulsionable acaricides applied by spray or immersion dips showed low efficacy in regions where monitoring of resistance were carried out. Active ingredients alone, like organophosphates, synthetic pyrethroids and amitraz, have showed low control in the majority of ticks populations that have been submitted to *in vitro* common tests to confirm field resistance suspicions. In order to control these resistant populations, several associations of active ingredients are available by chemical industry. Associations of Synthetic Pyrethroids and Organophosphates acaricides, most in spray formulation, constitutes the majority of available mixtures, showing distinct and interesting results. Cypermethrin and Chlorpyriphos are the ones whose results have showed efficiency in the control of certain resistant populations. At least 3 of these formulations are also available for use in immersion dips. Cypermetrhin and Ethion is another association available for both immersion and spray application with variable results in the country. Coumaphos and Flumethrin, Amitraz and Chlorpiriphos, Cymiazol and Cypermethrin are available only for spray application. What draws attention is the fact that commercial associations of distinct organophosphates like Chlorfenvinphos and Dichlorvos, have shown some "in vitro" efficiency in the control of resistant field populations. Results of tests with tick field populations in which amitraz resistance was suspected in Rio Grande do Sul, showed that in 25 adult immersion tests carried out in 2007, 23 (92%) strains were susceptible to chlorpiriphos + cipermethrin[1], and from 28 tests with cipermethrin + ethion, 25 were susceptible (89,2%), and from 12 tests with chlorpiriphos + cipermethrin[2], 9 were susceptible (75%) while in 29 tested populations against amitraz, 10 were susceptible (34,4%), confirming field failures. In the southeast area, mainly in ticks collected on dairy cattle, average of efficiency with an association containing chlorpiriphos + cypermethrin + piperonil butoxide + cytronel, was 99.8% in 231 tests carried out, whereas another association of cypermethrin + chlorpiriphos showed average of efficacy of 98.6% from 407 performed tests between 1997 to 2007. The amitraz + chlorpiriphos association was 93.3% efficient in 241 tests in the same period. An association of two OP (Chlorfenvinphos + Diclorvós) showed 88.0% of efficacy in 1382 performed tests. The obtained results demonstrated that acaricide association can contribute for chemical control of tick resistant populations, mainly to amitraz, OP and SP in Brazil.

Introduction

The cattle tick *Boophilus microplus* was able to create resistance mechanism in order to survive to the majority of chemical products used in its control. Aknowledgement on active ingedientes (a.i.), methods of application and correct choise of the acaricide are parts of the available strategies to minimize damages caused by ticks. The situation in terms of availability of efficient acaricides to the tick populations in Brazil is a reason for concern, mainly in the South and in the Southeast region of the country. Amitraz is the main a.i. in immersion dips in Rio Grande do Sul state for the last 25 years, and the field situation shows that monitoring tick susceptibility is an important step to avoid continuing selection of resistant ticks to this molecule. Previous tests results in other areas of the country confirm this situation (Furlong et al., 2007). A brief report on resistance situation with emphasis on the use of emmulsionable concentrates and the use of acaricide associations in southern areas of Brazil is presented.

Materials and Methods

Adult immersion tests (Drummond et al., 1973) were routinely performed at IPVDF, Eldorado do Sul, RS, and Embrapa Dairy Cattle, Juiz de Fora, MG. Ticks were sent by producers and field vets that were facing tick control failures or even only for testing with a brief history of acaricide using in each farm. Ticks are sent to lab by post or by transportation services as biological material for routine diagnoses. General procedures on tick handling after collecting them are available and farms are strongly orientated that they should arrive at the lab soon as possible after been collected.

Results and Discussion

It seems that the increase in the use of acaricide associations is an immediate alternative in order to overtake the onset and spread of amitraz resistance in Southern Brazil whereas in Southeast the problem is already established. Amitraz is available in the acaricide brazilian market since 1977 and remains as the main a. i. for immersion dips in Rio Grande do Sul, southern Brazil. However increasing cases of field failures is a reason for concern. The obtained results with amitraz in the Southeast region are parameters to other regions of the country and should be take as an alert (Tab. 3). From 2004 to 2007 a total of 179 "in vitro" tests were performed at IPVDF, Eldorado do Sul, RS, against amitraz 12.5%. The table 1 shows a gradual increment of amitraz resistant populations in the last years which was not unpredictable. In Australia, amitraz resistance shows also a slow dissemination in comparison to SP and OP (Jonsson & Hope, 2007). The fact that acaricide associations are controlling most of the amitraz resistant populations is not a reason for resting. Table 2 confirm this findings and, at same time, is also an alert for the future, since some populations are already resistant to these formulations. Previous cases of OP and SP resistant are well disseminated, and several cases of multiple resistant also has been documented (FAO, 2003).

When dealing with a field resistance situation is recommended that investigations on failures occurs over the handling of the product or genetic factors. In many situations, dealing with emulsionable concentrates, initial failures are results of inadequate acaricide concentration in the dip tank or sprayer, causing an inefficient tick control. Due to this reason, control of correct concentration of the product is one of the first measures that need to be taken. There is a general consensus that once the problem of resistance is detected it became permanent (Furlong et al., 2004). So, when the resistance is recognized and identified, dispersion of resistant ticks has already occurred. The so called temporary measures (increase of concentration, short intervals of treatments or even change of a. i.) can be necessaries to overtake the situation for a certain (and short) period of time. One measure long lasting in order to postponed the arising and dissemination of the problem is based in the local use of epidemiological information which offers the dynamics of population around the year and gives options about the more appropriate time for the starting of treatments.

On other hand, dissemination of gathered information on resistance, involving exchanges among industry, producers, field veterinarians and research is essential to achieve the target. To keep producers and vets well informed, must be a permanent task to all interested in the adequate control of the cattle tick. In some areas, conventional acaricides (organophosphates, synthetic pyrethroids and amidinics) show low or none efficiency against ticks. This situation justify changes in handling strategies, which might be more expensive to producers under certain circumstances, if molecules like fluazuron, fipronil and spinosad are the only available and efficient to control tick populations.

References

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Table 1. Results of adult immersion tests (Drummond) against amitraz at IPVDF/FEPAGRO, Eldorado do Sul, RS, Brazil (2004-2007).

Year	Nº of tests with amitraz	Efficacy < 85% (Nº of tests)	Resistant strains (%)	Average of efficacy (%)
2004	28	13	46.43	67.32
2005	32	16	50.00	62.91
2006	42	24	57.14	64.21
2007	77	49	63.64	60.56

Table 2. Results of "in vitro" tests with acaricide associations available for use in immersion dips in Rio Grande do Sul, southern Brazil (2007).

Active ingredient	**Nº of tests**	**Efficacy < 85% (Nº of tests)**	**Resist ant strains (%)**	**Average of efficacy (%)**
Cypermethrin + Chlorpiriphos	3	0	0.0	100.00
Cypermethrin + Chlorpiriphos + Piperonil butoxide + Citronel	25	2	8.00	74.99
Cypermethrin + Chorpiriphos + Citronel	12	3	25.00	66.44
Cypermethrin + Ethion	28	3	10.71	82.07

Table 1. Results of acaricides tests on populations of the cattle tick *Boophilus microplus* carried out at Embrapa Dairy Cattle, Juiz de Fora, MG, Brazil (1997-2006).

Active ingredient	**Nº of tests in 2006**	**Efficiency in 2006 (%)**	**Nº of tests 1997-2006**	**Average of efficiency 1997–2006 (%)**
Cypermethrin + chlorpiriphos + piperonil butoxide + citronel (1)	231	99,8[a]	231	99,8[a]

Cypermethrin + chlorpiriphos (2)	282	98,9[a]	407	98,6[a]
Amitraz + chlorpiriphos (3)	241	93,3[a]	241	93,3[b]
Fipronil (4)	259	87,2[b]	723	88,5[c]
Chlorfenvinphos + diclorvos (5),	281	90,3[a]	1382	88,0[c]
Chlorpiriphos + diclorvos (6)	200	63,5[d]	1088	76,7[d]
Cypermethrin + chlorpiriphos + citronel (7)	254	71,6[c]	896	74,1[d]
Cypermethrin + chlorpiriphos (8)	237	53,8[e]	1053	66,1[e]
Cymiazol + cypermethrin (9)	229	44,6[f]	1213	61,2[f]
Cypermethrin + piperonil butoxide (10)	140	41,4[f]	821	50,8[g]
Coumaphos (11)	-	-	425	48,0[g]
Amitraz (12)	-	-	196	47,9[g]
Coumaphos + Flumethrin (13)	-	-	426	47,4[g]
Amitraz (14)	266	41,2[f]	1517	44,0[h]
Cypermethrin + Diclorvos (15)	-	-	388	43,8[h]
Cypermethrin + Diclorvos (16)	195	45,5[f]	473	42,2[h]
Cypermethrin + Chlorfenvinphos (17)	71	26,2[g]	990	41,2[h]
Amitraz (18)	-	-	65	40,4[i]
Cypermethrin + Chlorpiriphos + Piperonil butoxide (19)	-	-	344	39,8[i]
Cypermetrin + Ethion (20)	204	33,3[f]	692	38,6[i]
CYpermetrin + Diclorvos (21)	183	24,3[g]	1059	36,1[i]
Alphametrin (22)	-	-	589	17,7[j]
Deltamethrin (23)	216	10,9[h]	1363	15,3[j]
Cypermetrin (24)	42	9,1[h]	42	9,1[k]

(1) Cyperclor Plus Pulverização (Vetbrands); (2) Flytion SP (Clarion); (3) Amiphós (IIntervet); (4) Topline Pour-on (Merial); (5) Carbeson (Leivas Leite); (6) Ectofós (Valeé); (7) Colosso Pulverização (Ouro Fino); (8) Aspersin (Biogênesis); (9) Ektoban (Novartis); (10) Cythal (Minerthal); (11) Asuntol (Bayer); (12) Amitracid (Intervet); (13) Bovinal (Bayer); (14) Triatox Pulverização (Schering-Plough); (15) Ectoplus (Novartis); (16) Alatox (Fort Dodge); (17) Supocade (Fort Dodge); (18) Ectop (Valeé); (19) M3Ecto (Minerthal); (20) Ciperthion (Schering-Plough); (21) Cypermil Plus (Ouro Fino); (22) Ultimate (Pfizer); (23) Butox P CE 25 (Intervet); (24) Beltox C (Indubras).

Equal letters in the same column are indicative of absence of significance differences among efficiency of products (ANOVA followed by test of Scott-Knott, α=5%)

- product not tested in the period.