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Perceptions and attitudes among milk producers in Minas Gerais regarding cattle tick biology and control

Percepções e atitudes entre produtores de leite em Minas Gerais relacionado a biologia e controle de carrapatos em bovinos

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Abstract

This study evaluates milk producers' knowledge regarding cattle ticks and practices for controlling them. Ninety-three dairymen in Minas Gerais were interviewed. These producers had no information regarding acaricide efficiency tests. To analyze the information, open responses were categorized through "content analysis", and descriptive analysis consisting of extracting the profile highlighted by the highest frequencies. The association between schooling level and knowledge was tested by means of chi-square trend tests. It was observed that 92.3% had no knowledge of the non-parasitic period. For 96.4%, what determined the time to apply treatment was the degree of tick infestation; 93.3% used spray guns to apply the acaricide. In seeking to cross-correlate the biological and control variables with education, cooperative action, length of experience and herd size, it was found that there was a linear association between schooling level and implementation of acaricide solution preparation. The other factors didn't show any significant association. These data demonstrated the need to instruct the producers in relation to the biology and control of *Rhipicephalus* (*Boophilus*) *microplus*. It was concluded that the majority of milk producers were unaware of cattle tick biology and the factors that influence choosing an acaricide, which makes it difficult to implement strategic control.

Keywords: *Rhipicephalus* (*Boophilus*) *microplus*, knowledge, EMBRAPA dairy cattle.

Resumo

Este estudo teve como objetivo avaliar o conhecimento dos produtores de leite sobre o carrapato dos bovinos e seu controle. Foram entrevistados 93 produtores de leite de Minas Gerais. Estes produtores não tinham informação sobre testes de eficiência de carrapaticidas e controle de carrapatos. Foi testada associação entre a escolaridade e as práticas e conhecimento sobre os carrapatos e constatou-se que 92,3% dos produtores nada sabiam sobre o período não-parasitário. Para 96,4%, o que determinava o momento do tratamento era o grau de infestação de carrapatos; e 93,3% utilizavam bomba-costal para aplicação do carrapaticida. Ao buscar o cruzamento entre as variáveis de biologia e controle com a escolaridade, cooperativismo, tempo de experiência e tamanho do rebanho, verificou-se que a associação linear entre a escolaridade e a efetivação da pré-diluição no preparo de banhos carrapaticidas. Esses dados demonstraram a necessidade de instrução dos produtores em relação à biologia e ao controle do *Rhipicephalus* (*Boophilus*) *microplus*. Conclui-se que a maioria dos produtores de leite de MG desconhece a biologia dos carrapatos e os fatores que influenciam as escolhas do carrapaticida, o que dificulta a implementação do controle estratégico e que a escolaridade não está relacionada a um controle mais eficiente dos carrapatos nas propriedades.

Palavras-chave: *Rhipicephalus* (*Boophilus*) *microplus*, conhecimento, EMBRAPA gado de leite.

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Introduction

Rhipicephalus (*Boophilus*) *microplus* (Canestrini, 1887) is a cattle tick. It originated from Asia (NUÑEZ et al., 1982; KESSLER; SCHENK, 1998), and is distributed throughout Brazil, with greatest frequency in the southern, southeastern and central-western regions. In Brazil and in other countries (GRISI et al., 2002; ANGUS, 1996; JONSSON et al., 2001), cattle ticks cause great losses through diminished milk production and leather quality, acaricide consumption, transmission of pathogenic agents and even increased mortality, especially among calves.

Lack of knowledge about tick biology and strategic tick control among cattle producers worsens the losses (HONER et al., 1990; JONSSON; MATSCHOSS, 1998; ROCHA, 2005). This draws attention to the need for knowledge about ticks and how to correctly choose and apply acaricides at the right moment (FURLONG, 2005), such that selection and proliferation of acaricide-resistant populations is delayed (FURLONG et al., 2007; CHEVILLON et al., 2007). Despite the risks involved in using chemical acaricides, there is no way of doing without chemical control over *R.* (*B.*) *microplus*, given the intensity of cattle rearing systems, especially in relation to dairy cattle.

Since 1996, Embrapa Dairy Cattle has been providing testing of tick sensitivity to acaricides, free of charge. These tests help producers to determine which product is the right one to use on each farm property, and they also allow researchers to ascertain the degree of resistance shown by ticks to the acaricides used. Together with the test results, guidance regarding correct application at the right time is provided.

With the aim of verifying how strategic control was implemented on farm properties that had had access to tests and guidance provided by Embrapa Dairy Cattle, a survey was conducted among these producers, from which it was observed that only 7% gave correct responses regarding strategic control (AMARAL, 2008).

Thus, in the present study, the aim was to assess the degree of knowledge among milk producers that had not had previous contact with Embrapa Dairy Cattle, regarding the acaricide efficiency test and the strategic control program against ticks.

Material and Methods

Information was gathered by means of semi-structured interviews, using forms that had previously been validated through the studies by Rocha (1996) and Rocha et al. (2006), which can be found as an annex in Rocha (1996). In addition, for validation in this study, the forms were previously tested on the target population (ROJAS, 2001). The interviews had the aim of gathering information to characterize the farm properties and producers, and also to quantify and qualify producers' perceptions regarding knowledge of cattle tick biology and control, and the types of control used.

The producers interviewed were chosen at random, at various courses provided by Embrapa Dairy Cattle, which is located in Juiz de Fora, Minas Gerais, and at events that took place in Minas Gerais during the months of March to August 2007. Producers who said that they had had previous contact with Embrapa Dairy Cattle regarding acaricide efficiency tests and tick control were excluded. For this purpose, the interviewees were preselected by asking them about previous contacts.

To analyze the questionnaires, the "content analysis" technique was used on the responses obtained (BARDIN, 1977; MINAYO, 2006). Through this, the data were categorized and then a database was drawn up in the Epidata 3.1 software. The producers' responses relating to the questions on biology were compared with the information on ticks that has become established in the literature, as done by Rocha et al. (2006).

To investigate associations between the qualitative variables of interest, the chi-square test was used. In cases in which one of the cells of the contingency table presented fewer than five repetitions, Fisher's exact test was used instead. A confidence interval of 95% was used for taking associations to be significant. The analyses were performed using the Epi Info 6.04 software and the Statistical Package for the Social Sciences (SPSS, version 12.0).

Associations were tested by taking the responses relating to biology and control to be dependent variables with regard to the following independent variables: 1) schooling level (elementary, high school or university level); 2) cooperative actions (yes or no); and 3) length of experience (up to five years or six years and over). To analyze schooling levels, the chi-square test for trend was used.

Results and Discussion

One hundred and three producers were interviewed. After analyzing the questionnaires, ten producers were excluded because of inconsistencies in the responses or because they were not located in the state of Minas Gerais. Thus, 93 producers were taken into consideration, of which 38 (40.9%) were members of a cooperative (Table 1).

Out of the total number of interviewees, milk was the main source of income for 35 (37.6%), while it was the only source for 29 (31.2%). The management was semi-extensive on 60 farm properties (65.9%) and milking was done manually on 89% of them. The average milk production on these properties was 106 L per day, and crossbred cattle predominated (59.1%). The herd size ranged from 18 to 400 cows. On 93.5% of the properties, horses were present. Only 15.1% of the producers were in the habit of making some type of record in relation to reproduction (50%), birth of calves (14.3%), tick control (14.3%) or vaccination (21.4%) (Table 1).

Out of the total number of producers, 59 (64.1%) had more than ten years of experience of milk production activities. The labor force consisted exclusively of members of the family on 61 farm properties (66.3%) and was exclusively hired labor on 15 properties (16.3%). In the present study, it was observed that most of the producers (59.1%) had been educated up to elementary school level (Table 1).

This study can be compared with the study by Rocha et al. (2006). In the latter, the same interview form was applied, but the producers in Passos, Minas Gerais, presented a higher schooling level and longer professional experience, and predominantly used hired labor. Thus, the profile of the producers in that study differed slightly from the present study.

Table 1. Characterization of the farm properties and producers that participated in the study on the perceptions of milk producers in Minas Gerais regarding cattle tick biology and control.

Characteristics*	Categories				Respondents** (% loss of information)
Municipality of origin***	Senador Firmino 12 (21%)	Divinésia 11 (19.2%)	Juiz de Fora 9 (15.8%)	B. de Monte Alto 8 (14%)	57 38.7%
Participation in cooperatives	No 55 (59.1%)	Yes 38 (40.9%)	- -	- -	93 0%
Main activity	Livestock-rearing 47 (54%)	Both 39 (44.8%)	Crop agriculture 1 (1.2%)	- -	87 6.5%
Importance of milk production activity for the farm property	Main activity 35 (37.6%)	Sole activity 29 (31.9%)	Secondary activity 29 (31.2%)	- -	93 0%
Cattle management	Semi-extensive 60 (65.9%)	Extensive 29 (31.2%)	Intensive 2 (2.2%)	- -	91 2%
Type of milking	Manual 81 (89%)	Mechanical 10 (11%)	- -	- -	91 2%
Cattle breed	Crossbred 55 (59.1%)	Other breeds 23 (24.8%)	Friesian 8 (8.6%)	Zebu 7 (7.5%)	93 0%
No. of head of cattle	Up to 100 86 (92.4%)	100 to 200 5 (5.4%)	200 to 300 1 (1.1%)	300 to 400 1 (1.1%)	93 0%
Presence of horses	Yes 87 (93.5%)	No 6 (6.5%)	- -	- -	93 0%
Labor	Family members 61 (66.3%)	Employees 15 (16.3%)	Both 16 (17.4%)	-	92 1%
Length of experience in milk production activity	10 to 20 years 59 (64.1%)	6 to 10 years 21 (22.8%)	2 to 5 years 10 (10.9%)	Up to 1 year 2 (2.2%)	92 1%
Education level	Elementary school 55 (59.1%)	High school 19 (20.4%)	University level 12 (12.9%)	Able to read 7 (7.5%)	93 0%

*The percentages do not take into consideration the losses. **Respondents – corresponding to the absolute number of producers who provided information; (% loss) – percentage of questions that remained unanswered, considering n = 93; ***Senador Amaral 7 (12.2%) and other municipalities 10 (12.6%).

Most of the producers, 77 (83.7%) conformed that they had problems caused by ticks among their herds (Table 2). Furthermore, 56 producers (60%) said that ticks were one of the main problems of dairy husbandry. Among the 37 producers who did not cite ticks as their main problem, 25 (67.6%) put labor in first place; and 12 (32.4%) cited certain diseases, such as mastitis (58.3%), abortion (16.7%) and diarrhea (25%).

When asked whether ticks parasitized other animals, a large proportion of the producers said that they saw infestations in dogs and horses concomitantly (47.4%), while some producers also saw ticks in capybaras (10.3%). This demonstrates that ticks were observed, but that there was a lack of differentiation between tick species.

When asked whether they knew how to differentiate ticks that infest cattle from those that infest horses, 36 (42%) of the producers reported that they had observed differences. However, only two (2%) were able to explain the differences correctly. On the other hand, 49 producers (58%) demonstrated a lack of knowledge through denying that different tick species exist, which would lead to a situation in which control was not directed towards each species.

Thus, producers might conclude that the acaricide that they were using was no longer having the desired effect. They would thus not take into consideration the difference in natural resistance that exists between *Amblyomma* sp. and *R.* (*B.*) *microplus*. This would favor indiscriminate changing of acaricides. Rocha et al. (2006) observed that 56% did not know that different tick species were present in different hosts, and that this lack of knowledge caused difficulty in characterizing the month of greatest tick infestation in cattle.

Regarding the parasitic lifespan of cattle ticks (GONZALES, 1975; FURLONG, 1993; GUIMARÃES et al., 2001), only 20.7% of the producers came close to the reality, with answers of between 17 and 26 days. Another 25% of the producers did not respond correctly and 54.3% were unable to answer the question (Table 2). This lack of knowledge regarding the parasitic lifespan demonstrates the impossibility of rational action for controlling this parasite, thus leading to increased frequency of spraying, which increases the selection pressure towards resistant strains and increases the presence of residues in the milk.

It seems necessary to undertake explanatory work on the biology of cattle ticks in order to achieve greater understanding among producers regarding the interval between sprayings so that strategic control can be established in such a way that excessive application of acaricides is avoided. Through this, contamination of the milk and the environment and acceleration of the process of establishing tick resistance can also be avoided.

In the present study, only 32 (34.8%) of the producers gave correct responses regarding the prolificness of females of *R.* (*B.*) *microplus* (Table 2). This knowledge is important, since if producers were aware that each female that resists the acaricide spray treatment is capable of generating two to three thousand

Table 2. Study on the perceptions of milk producers in Minas Gerais regarding cattle tick biology and control, conducted in 2007.

	Responses in order of frequency								
Information from producers*	**1st place**	**%**	**2nd place**	**%**	**3rd place**	**%**	**4th place**	**%**	**Respondents** (% losses)**
Problems with ticks on farm property	Yes 77	83.7	No 14	15.2	Don't know 1	1.1	- -	- -	92 1%
Placement of ticks among dairy cattle rearing problems	1st place 46	49.5	Not cited 37	39.8	2nd place 8	8.6	3rd place 2	2.1	93 0%
Other animals that became infested	Dogs and horses 37	47.4	Horses 27	34.6	Capybaras and horses 8	10.3	Dogs 6	- 7.7	78 16%
Description of cattle and horse ticks	No difference 49	58	There is a difference Incorrect 33	39	There is a difference Correct 2	2	There is a difference Don't know 1	1	85 8.6%
Description of parasitic lifespan	Don't know 50	54.3	Incorrect 23	25.0	Correct 19	20.7	- -	- -	92 1%
Description of cattle tick reproduction	Don't know 41	44.5	Correct 29	31.5	Incorrect 22	24.0	- -	- -	92 1%
Description of oviposition capacity	Don't know 43	46.7	Correct 32	34.8	Incorrect 17	18.5	- -	- -	92 1%
Description of non-parasitic lifespan	Don't know 66	72.5	Incorrect 18	19.8	Correct 7	7.7	- -	- -	91 2%
Description of problems caused by cattle ticks***	All described 30	46.1	Diseases in humans and animals 16	24.7	Financial 13	20.0	No problems caused 6	- 9.2	65 30%

* The percentages do not take into consideration the losses. ** Respondents – corresponding to the absolute number of producers who provided information; (% loss) – percentage of questions that remained unanswered, considering n = 93. *** More than one response was accepted for this question.

offspring (FURLONG, 1993), they would take greater care with the spraying, so that occurrences of survival are avoided as far as possible, and success in tick control is increased. In particular, comprehension regarding selection of resistant populations and the fact that acaricides act through contact might be gained.

The results demonstrated that 91% of the producers did not know what the ticks' lifespan in the pastures was. This makes it difficult to implement strategic control, especially with regard to the correct moment to apply acaricide and the number of acaricide spray treatments to apply. Only 7.7% of the producers gave correct responses (between 30 days and one year) (Table 2). Moreover, knowledge of the length of survival of the larvae in pastures is important in relation to implementing grazing rotation, which may contribute towards controlling cattle ticks.

In relation to the problems caused by the action of ticks, 9.2% of the producers stated that cattle ticks did not cause any problems, while 28 producers (30%) did not give any response to this question (Table 2). Lack of knowledge regarding the losses caused by cattle ticks may be a factor limiting greater effort towards combating ticks among producers.

It was noted that almost all the producers (96.4%) performed the chemical treatment consequent to seeing higher levels of tick infestation among their cattle (Table 2). This goes against the principle of strategic control, which is that acaricide spraying should be performed during the periods of lower infestation, before the explosion of the first generation in the spring, i.e. at a time when the ticks' free life phase is shorter.

With increasing numbers of ticks, the number of sprayings consequently increased, since this was the criterion determining product application for almost all the producers (Table 3). Magalhães and Lima (1991) and Rocha et al. (2006) had already observed that the number of acaricide spray treatments in Minas Gerais, for controlling cattle ticks, was based on observations of the adult ticks. The main consequence of this is disorderly control caused by increased numbers of sprayings, and spraying performed at incorrect times (ROCHA et al., 2006). Infestations that determine the moment for acaricide spray treatment are very subjective and variable (LEITE; ROCHA, 1999).

In addition to this, there is the difficulty of finding the ideal acaricide for each case. Other errors are committed through increasing the concentration and dosage of the product, and carrying out the spraying incorrectly (Table 4).

For example, 50.6% of the producers were spraying using up to three liters of acaricide solution per animal, 85.7% were using several products concomitantly and 96.7% were doing their spraying using backpack spray guns (Table 4). Seventy-eight of the producers (85.7%) were using several (more than five) alternating acaricides, such as phosphorates, amidines, pyrethroids, macrocyclic lactones and pyrethroids/phosphorates (Table 4). This is a practice that favors a situation of establishment of multiple resistance,

Table 3. Characterization of tick control on the farm properties that participated in the study on the perceptions of milk producers in Minas Gerais regarding cattle tick biology and control, conducted in 2007.

Information from producers*	1st place	%	2nd place	%	3rd place	%	4th place	%	Respondents** (% losses)
Tick control methods***	Acaricide		Grazing rotation		Blood grade		Homeopathy	-	93
	61	65.6	17	18.3	10	10.7	4	4.3	(0%)
Reason for acaricide application	Higher infestation		Time of the year		-		-		82
	79	96.4	3	3.6	-	-	-	-	11 (11.8%)
Average infestation at time of highest incidence (ticks/ animal)	> 50		10-50	-	< 10	-	-	-	90
	67	74.4	22	24.4	1	1.2	-	-	3 (3.3%)
Description of resistance	Correct		Incorrect		-		-	-	45
	40	88.9	5	11.1	-	-	-	-	48 (51.6%)
Description of reason for changing acaricide	Product not effective		Advertising		Price		Quality	-	73
	51	69.9	13	17.8	5	6.8	4	5.5	20 (21.5%)
Description of how acaricide product was chosen	Advertising		Quality		Price		-	-	67
	45	67.2	13	19.4	9	13.4	-	-	26 (28%)
Length of time using acaricide	0 to 2 years		> 2 years		Three months		-		64
	32	50	16	25	16	25	-	-	29 (31%)
Description of personal protection equipment	Incorrect		Correct		-		-		41
	36	87.8	5	12.2	-	-	-	-	52 (56%)

* The percentages do not take into consideration the losses. ** Respondents – corresponding to the absolute number of producers who provided information; (% loss) – percentage of questions that remained unanswered, considering n = 93. *** 1 (1.1%) other methods.

and there may even not be any further chemical basis capable of controlling tick populations in certain regions, as seen in the south of Minas Gerais between 2008 and 2010 by Daher (2011).

All these factors lead to the current situation of selection and proliferation of populations that are resistant to the acaricides that exist on the market.

Since there is little technical knowledge among the producers when it comes to choosing between the different modes of action shown by different products, and there are few launches of products with different mechanisms of action, it is becoming increasingly difficult to rotate the product basis rationally.

Out of the 73 producers (78.5%) who gave a response regarding the reasons why they changed the acaricides that they used, 69.9% cited lack of efficiency (Table 3). However, the lack of success that they attributed to product inefficiency often reflects errors in product application, such as low volume of acaricide solution and incorrect application. The only way of diagnosing inefficiency in an acaricide product is the sensitivity test, which had never been used among this population, since this was an exclusion criterion.

In the study by Rocha et al. (2006), the interval between replacing the commercial product varied. In the present study, 16 producers (25%) said that they changed it every three months, and the same number of producers cited intervals of more than two years (Table 3). This indicates that there was no criterion regarding the number of sprayings using the same acaricide. Indiscriminate replacement is an important factor in the selection and proliferation of resistant populations.

According to Thullner et al. (2007), studies now exist showing that the selection of resistant populations occurs very rapidly. For this reason, the hypothesis that the same chemical basis, or a different chemical basis with the same mechanism of action, should not be used for more than six successive applications has started to be accepted. This choice is difficult for producers who do not have any knowledge of genetic selection for resistance.

Perhaps the only way of controlling this problem would be to make it obligatory to have a veterinary prescription at the time of buying the acaricide, thus avoiding unjustified product changes.

With regard to the procedure for the acaricide solution, 49 producers (55%) said that they did pre-dilution. However, the producers presented a low rate of accuracy in describing the solution (32.66%). The correct way to spray the cattle was described by 77 producers (89.5%). Out of this total, 37 producers (40%) said that they applied acaricide to the animal's whole body, including the head, ears and udder, and between the legs. However, 32 producers (66.7%) in the present study stated that they did not apply it to the udder (Table 4).

This was because of lack of information regarding the need for acaricide spray treatment covering the animal's entire body surface, given that the spray acts through contact with the ticks. It has been observed that ticks position themselves in places that provide greater shelter, such as the groin, rear feet, udder, pinna, rear flank, head and the post-scapular to pre-crural region (BRUM et al., 1987; GONZALES, 1975; OLIVEIRA; ALENCAR, 1990). Another possible reason for incorrect use of acaricide solutions may have been because 77 producers (96.3%) used backpack spray guns for applying the acaricide. The weight and discomfort of the equipment are very tiring for the workers, and this interferes with the application of acaricide to the animal, such that insufficient pressure may be exerted for the spray to reach the hide (FURLONG et al., 2007) (Table 4). This type

Table 4. Knowledge of acaricide application among the producers participating in the study on the perceptions of milk producers in Minas Gerais regarding cattle tick biology and control, conducted in 2007.

Information from producers*	1st place	%	2nd place	%	3rd place	%	4th place	%	Respondents** (% losses)
Pre-dilution	Yes		No		-		-		89
	49	55	40	45	-	-	-	-	4 (4.3%)
Description of acaricide spraying	Incorrect		Correct		Spraying not done		-		92
	37	40.2	30	32.6	25	27.2	-	-	1 (1%)
Condition of animals during spraying	Contained		Loose		-		-		86
	77	89.5	9	10.5	-	-	-	-	7 (7.5%)
Places on animal's body where acaricide was not applied	Udder		Tail		Ear		Legs		48
	32	66.7	7	14.5	5	10.4	4	8.3	45 (48.4%)
Equipment used for applying acaricide	Backpack spray gun		Injectable		Pour on		-		80
	77	96.3	2	2.5	1	1.2	-	-	13 (14%)
Attitude of producer on rainy days	Spraying suspended		Spraying as usual		-		-		75
	67	89.3	8	10.7	-	-	-	-	18 (19.3%)
Time of day for acaricide spraying	Morning		Afternoon		Evening		-		83
	60	72.3	15	18.1	8	9.6	-	-	10 (10.8%)
Liters of acaricide/ animal	1-3 L		4-6 L		Less than 1 L		More than 6 L		77
	37	48	36	46.8	2	2.6	2	2.6	16 (17.2%)
Use of multiple acaricides on farm property***	More than 5 products		Pyrethroids + phosphorates		Amidines		Phosphorates	-	91
	78	85.7	5	5.5	4	4.4	2	2.2	2 (2%)

* The percentages do not take into consideration the losses. ** Respondents – corresponding to the absolute number of producers who provided information; (% loss) – percentage of questions that remained unanswered, considering n = 93. *** Pyrethroids 1 (1.1%), macrocyclic lactones 1 (1.1%).

of equipment is considered to be the worst of the methods for applying acaricides (JONSSON; MATSCHOSS, 1998).

Bianchi et al. (2003) stated that incorrectly implemented spraying might develop resistance among tick populations. This demonstrates that interventions among milk producers should be sought, through explanatory leaflets, campaigns, talks and courses provided in reach region by trained technical experts, in order to disseminate the correct way of carrying out spray treatments with regionalized strategic control. Although the spraying stage is the most critical point of the control process, producers who have not received any guidance downplay the importance of this process.

With regard to resistance, 60% of the producers said that they knew what it was. However, most of them did not know how it became established (Table 3). With knowledge about the concept of resistance and the factors that contribute towards its appearance and proliferation, producers can consequently perceive their contribution towards establishing this process. Moreover, resistance can only be proven through the acaricide test. This test is still very little known, despite efforts to publicize it (through talks and radio and television announcements, etc.), made by Embrapa Dairy Cattle.

In preparing and applying the product, personal protection equipment should be used, as affirmed by 50 producers (58%). Among the 41 producers (44%) who described the equipment and the way to apply the acaricide (to be done downwind), only five (12.2%) described the method completely (Table 3). Furthermore, among the producers who used personal protection equipment wrongly or incompletely, 32 were using more than five types of products (phosphorates, amidines, pyrethroids, macrocyclic lactones and pyrethroids + phosphorates), two were using amidines, one was using pyrethroids and one was using pyrethroids with phosphorates on the farm property. Each of these producers was exposed to a variety of chemical groups that are harmful to health.

In seeking to cross-correlate the biology and control variables with schooling level, cooperate action, length of experience and herd size, a linear association was observed between schooling level and performing pre-dilution in preparing the acaricide solutions ($p = 0.010$) (Figure 1). It may be considered that higher education levels improved the care taken in preparing the acaricide.

The other biology and control variables tested in relation to schooling level, cooperative action, length of experience and herd size did not show any significant associations ($p > 0.05$).

Even though higher education levels may have been translated into greater concern to promote improvements in the technological level of production equipment, such as the use of mechanical milking ($p = 0.054$) and greater care in preparing the acaricide, higher levels were not shown to have any effective influence on using controls of greater efficiency against *R.* (*B.*) *microplus*.

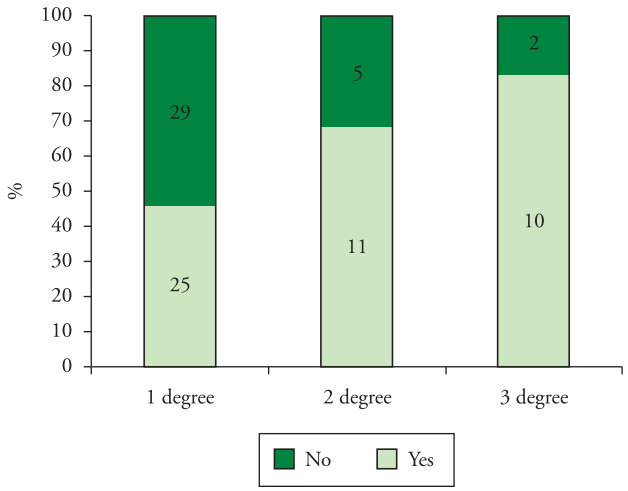

Figure 1. Influence of education level on the presence of pre-dilution among the farm properties participating in the study on the perceptions of milk producers regarding cattle tick biology and control, conducted in 2007. Minas Gerais, 2008. (p = 0.010, chi-square test for trend).

Conclusions

Most of the milk producers were unaware of cattle tick biology and the factors that should influence the choices between acaricides. This makes it difficult to implement strategic control. Applications of acaricides on farm properties were often done incorrectly, using a backpack spray gun, and motivated by visible infestation. Personal protection equipment was used incompletely.

Schooling level was not correlated with greater efficiency of tick control on the farm properties.

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