Phytosanitary Products Action to Control Leaf Miner, Rust and their Influence on Coffee Vigor and Productivity

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***Abstract*—** *The Coffee Leaf Miner - CLM and coffee rust are the main pests and coffee diseases, respectively. One of the rust and CLM handling ways is the preventive use of active ingredients of joint action (fungicide + insecticide) via soil. These products are generally evaluated for their efficiency in the chemical control of pests and diseases; however some of these products may promote a tonic effect by improving plant vigor. Thus, the objective in this work was to verify the influence of the phytosanitary products application on the rust and leaf miner control, on the coffee trees development and production. The assay was installed in Random Block Design - RBD, with twelve treatments T1 - Premier Plus, T2 - Premier Plus and Actara, T3 - Verdadero, T4 - Verdadero and Actara, T5 - Actara, T6 - Actara (Nov/Feb), T7 - Altacor, T8 - Altacor and Actara, T9 - Impact, T10 - Opera, T11- Control and T12 - Practical and three replicates in a Catuaí IAC-144 crop. Number of nodes per branch, productivity, incidence of rust and CLM were evaluated. There was no difference in the coffee trees growth submitted to the application of different phytosanitary products for the control of rust and leaf miner. The application of Thiamethoxan + Cyproconazole in november with a complementary application of Thiamethoxan in february were more efficient for the coffee leaf miner control and provided greater vigor and productivity to the coffee tree.*

Keywords*— *Hemileiavastatrix, Leucopteracoffeela, tonic effect.

I. INTRODUCTION

The scientific research development combined with the rural extension has provided considerable gains in coffee productivity [1]. These gains in productivity are mainly due to the development of new cultivars and management techniques that allow a greater plant stand and a more efficient control of pests and diseases.

Some coffee regions, such as the Cerrado region, has a hot and dry climate, which favors the intensity occurrence of certain pests, especially the coffee leaf miner - CLM (*Leucoptera coffeella*), considered a key pest in coffee growing since the 1970s [2], and may be harmful throughout the year, with greater intensity in the dry season [3]. In other regions, such as the south of *Minas Gerais*, the mild climate combined with some climatic adversities that raise humidity generate a microclimate, which favors the coffee rust occurrence (*Hemileia vastatrix* Berk. et Br.), that is considered the main crop disease, causing lesions on the leaves, reduction of the photosynthetic area and defoliation, which ends up compromising coffee productivity, being more aggressive in years of high fruit load than in years with low fruit load [4].

In the coffee crop, one of the rust and leaf miner handling ways is the preventive use of active principles of joint action (fungicide + insecticide). Thus, there has been an increase in the use defensive agents via soil, mainly fungicides and systemic insecticides in the coffee crop in recent years. These insecticides and fungicides are usually evaluated for their efficiency in the pests and diseases control, however some of these can promote a leaf growth increase, an improvement in the plant vigor and a change in the green tone of the leaves, and this effect is known as the tonic effect [5]. The tonic effect is considered beneficial, increasing the plant resistance and decreasing the infection possibility, which has been attributed to hormonal effect, indirectly influences plants root growth, increasing the absorption of water and nutrients [6].

However, action on coffee vigor and productivity may vary depending on the product and the combination of the phytosanitary applied. Research carried out by [6] verified that the insecticide thiamethoxam caused higher growth and greater diameter of stem in coffee seedlings and the opposite was verified when the imidaclopride was applied. Assays made by [7] observed that the application of cyproconazole + thiamethoxam in Coffea canephora seedlings impaired the development of all clones of the 'Vitória Incaper 8142' cultivar. Therefore, the objective in this study was to evaluate the

action of various phytosanitary products on the leaf miner and rust control and on the vigor and productivity of the coffee tree.

II. MATERIAL AND METHOD

The experiment was installed at the Experimental Farm of *São Sebastião do Paraíso – MG*. It belongs to the Agricultural Research Company of *Minas Gerais* (*EPAMIG*), in a 5-year-old crop of Catuaí IAC 144 cultivar, spaced 3.5 x 0.7m. The treatments were applied in November, February and March of each year (harvests 2009/2010 and 2010/2011), as described in table 1.

TABLE 1
TREATMENTS, ACTIVE INGREDIENT, COMMERCIAL NAME, DOSAGES AND APPLICATION MONTH OF THE PLANT PROTECTION PRODUCTS USED TO CONTROL RUST AND COFFEE TREE MINE

Treatments	Active ingredient	Commercial name	Dosages Kg or L/ha	Application Month
1	(Imidacloprid + Triadimenol)	Premier Plus	3.0 l	November
2	(Imidacloprid + triadimenol) and Thiamethoxan	Premier Plus and Actara	3.0 l/ 1.0 Kg	November February
3	(Thiamethoxan + Cyproconazole)	Verdadero	1.0 Kg	November
4	(Thiamethoxan + Cyproconazole) and Thiamethoxan	Verdadero and Actara	1.0 Kg 1.0 Kg	November February
5	Thiamethoxan	Actara	1.0 Kg	November
6	Thiamethoxan	Actara	1.0 Kg	November and February
7	Chlorantraniliprole	Altacor	0.09 Kg	November
8	Chlorantraniliprole and Thiamethoxan	Altacor and Actara	0.09 Kg 1.0 kg	November February
9	Flutriafol	Impact	5.0 L	November
10	(Pyraclostrobin + Epoxiconazole)	Opera	1.5 L	March
11	Control			
12	(Imidacloprid + Flutriafol)	Practical	2.0 L	November

The incidence evaluations and rust severity were carried out monthly, from January to September of each year (harvests 2011/2012 and 2012/2013), collecting on the middle third of both plant sides, 10 leaves of the 3rd or 4th pair per plants, in the six central plants, totaling 50 leaves per plot.

The rust incidence was determined in percentage, counting the number of coffee leaves with sporulated pustules in the 50 leaves collected. The area under disease progress curve (AUDPC) was calculated by integrating the disease progress curve for each treatment using the formula:

$$AUDPC = \sum_{i}^{n-1} \frac{(\mathrm{Xi} + \mathrm{Xi}+1)(\mathrm{ti}-1-\mathrm{ti})}{2}$$

where, n is the number of evaluations, Xi is the disease proportion and (ti-1-ti) is the interval of consecutive evaluations.
The leaf miner infestation was analyzed by calculating the percentage from the number of leaves with lesions in the 50 leaves collected:

Leaf miner infestation = (number of leaves with lesions x 100) / total number of leaves collected.

The vegetative vigor was evaluated in each harvest, with notes being assigned to an arbitrary scale of 10 points, note 1 being given to the worst plants, with much reduced vegetative vigor and marked depletion symptom, and note 10 to plants with excellent vigor, with more leaves and marked vegetative growth of the productive branches, as suggested by [8].

For growth analysis, two plagiotropic branches were marked in the upper middle third of the plants, and evaluated two plants per plot. In these branches, it was counted the number of nodes per branch at 0, 8, 13 and 18 months after the beginning of the treatment application.

The productivity (bags 60kg of coffee benefited/ha) was evaluated in the 2009/2010, 2010/2011 and 2011/2012 harvests. The fruit production was evaluated annually in liters of "farm coffee" per plot, and the harvests were carried out in July of each year considering an average yield of 480 liters of "farm coffee" for each bag 60 kg of coffee benefited [5].

The Experimental Design Was A Randomized Block Design, With 12 Treatments And Three Replicates, With Parcels Of 10 Plants, And The Six Central Plants Were Considered As A Useful Plot.

The data obtained in the evaluations were submitted to variance analysis, using the computer program SISVAR [9]. The percentage data of mined leaves were transformed $\sqrt{x} + 1$ for variance analysis. The averages obtained were compared to each other by the Scott Knott test at 5%. The percentage efficiency was calculated by Abbott's formula [10].

III. RESULTS AND DISCUSSION

Leaf miner infestation through the mined leaves percentage measured at 60 and 70 days after the first application, January and February 2010, respectively, ranged from 0 to 6.0%, statistically the same in all treatments (Table 2). From March, the leaf miner infestation developed and differences among treatments were detected, with treatments T2, T3, T4 and T8 showed lower infestation values in all months from March to August. These treatments have in common the association of different active principles fungicides and/or insecticides with the insecticide thiamethoxan. According to [13], insecticides base on thiamethoxan are more efficient in the leaf miner control, than insecticides base on imidacloprid. In Treatment 2, it was observed the action of thiamethoxan applied in February was potentiated when associated with imidacloprid + triadimenol applied in November. The thiamethoxan action was also increased when associated with chlorantraniliprole (T8), wherein the chlorantraniliprole application with a sequential application of thiamethoxan was highly efficient in the leaf miner control. These results also resemble those other works, wherein the use of insecticide from the chlorantraniliprole group was highly effective in many pests control, mainly in lepidoptera control [11]; [12].

Considering the leaf miner control index to the South of *Minas Gerais* is greater than or equal to 30.00% of mined leaves (in the middle thirds limits and lower of the coffee trees), except for the T12 treatment, in the other treatments were verified incidence values lower than 30% until June. Of these, highlight treatment 3 that kept the leaf miner incidence less than 30% until September, with control efficiency (CE) ranged from 100.0% in February to 30.0% in July. The T3 (thiamethoxan + cyproconazole), although only one application was performed in November 2009, they were more efficient, differently to the other treatments that received a sequential dose of another product in February 2010, that is, T3 in a single application (November 2009) was as or more efficient than the others which received a second application later (February 2010).

TABLE 2
INCIDENCE (I%) AND CONTROL EFFICIENCY (CE%) COFFEE LEAF MINER, 2010. *SÃO SEBASTIÃO DO PARAÍSO - MG.*

Trat	JAN		FEB		MAR		APR		MAI	
	I	CE	I	CE	I	CE	I	CE	I	CE
1	1 a	83.3	4 a	0.0	14 b	22.2	9 c	55.0	15 c	28.6
2	0 a	100.0	3 a	25.0	3 a	83.3	2 a	90.0	3 b	85.7
3	1 a	83.3	0 a	100.0	8 b	56.6	3 a	85.0	5 b	76.2
4	0 a	100.0	3 a	25.0	9 b	50.0	3 a	85.0	3 b	85.7
5	0 a	100.0	2 a	50.0	13 b	27.8	6 b	70.0	13 c	38.1
6	1 a	83.3	1 a	75.0	13 b	27.8	7 b	65.0	11 c	47.6
7	1 a	83.3	1 a	75.0	14 b	22.2	10 c	50.0	20 c	4.8
8	1 a	83.3	4 a	0.0	3 a	83.3	1 a	95.0	0 a	100.0
9	1 a	83.3	5 a	-25.0	14 b	22.2	15 d	25.0	17 c	19.0
10	2 a	67.7	3 a	25.0	17 b	5.6	17 d	15.0	23 c	-9.5
11	6 a	-	4 a	-	18 b	-	20 d	-	21 c	-
12	1 a	83.3	3a	25.0	11 b	38.9	3 b	85.0	16 c	28.6
Trat	**JUN**		**JUL**		**AUG**		**SEP**			
	I	**CE**	**I**	**CE**	**I**	**CE**	**I**	**CE**		
1	23 c	-9.5	24 a	27.3	41 a	22.6	49 b	12.5		
2	3 a	85.7	17 a	48.5	35 a	34.0	40 b	28.6		
3	5 a	76.2	23 a	30.3	29 a	45.3	25 a	55.4		
4	5 a	76.2	27 a	18.2	39 a	26.4	41 b	26.8		
5	13 b	38.1	27 a	18.2	49 b	7.5	57 b	0		
6	12 b	42.9	25 a	24.2	42 a	20.8	40 b	8.6		
7	19 c	9.5	25 a	24.2	40 a	24.5	45 b	19.6		
8	4 a	81.0	16 a	51.5	36 a	32.1	51 b	8.9		
9	14 b	33.3	20 a	39.4	36 a	32.1	47 b	16.1		
10	23 c	-9.5	35 b	-6.1	47 b	11.3	47 b	16.1		
11	21 c	-	33 b	-	53 b	-	56 b	-		
12	16 b	23.8	37 b	-12.1	51 b	3.8	53 b	5.4		
VC1 (%) = 22.61VC2 (%) = 17.11										

The averages followed by the same letter in the column do not differ of each other by Scott Knott's test at the 5% probability level. * Treatments highlighted in bold that had active ingredients with insecticidal action, directed to CLM control.

In 2011, the leaf miner infestation in the control developed from 52.0% (May) to 87.0% (September), values higher than those observed in 2010, when the observed variation from May to September was from 21 to 56% (Table 3). In general, in 2011, treatments T2 and T3 resisted the pest pressure below 30% until July, but those that maintained the values of leaf miner incidence less than 30% longer (until August) were T1, T4 and T6.

TABLE 3
INCIDENCE (I%) AND CONTROL EFFICIENCY (CE%) OF COFFEE LEAF MINER, 2011. *SÃO SEBASTIÃO DO PARAÍSO - MG.*

Trat	JAN		FEB		MAR		APR		MAI	
	I	CE	I	CE	I	CE	I	CE	I	CE
1	4 a	50.0	1 a	85.7	8 b	57.9	13 b	61.8	11 a	78.8
2	15 b	-87.5	5 b	28.6	13 b	31.6	19 b	44.1	24 b	53.8
3	5 a	37.5	1 a	85.7	4 a	78.9	8 a	76.5	22 b	57.7
4	5 a	37.5	1 a	85.7	1 a	94.7	6 a	82.4	8 a	84.6
5	11 b	-37.5	2 a	71.4	4 a	78.9	11 b	67.6	21 b	69.6
6	5 a	37.5	3 a	57.1	5 a	73.7	13 b	61.8	9 a	82.7
7	9 b	-12.5	6 b	14.3	15 c	21.1	40 c	-17.6	45 c	13.5
8	7 a	12.5	1 a	85.7	19 c	0	27 c	20.6	45 c	13.5
9	11 b	-37.5	5 b	28.6	19 c	0	21 c	38.2	36 c	30.8
10	12 b	-50.0	12 b	-71.4	27 c	-42.1	41 c	-20.6	61 d	-17.3
11	8 b	-	7 b	-	19 c	-	34 c	-	52 d	-
12	15 b	-87.5	3 a	57.1	20 c	-5.3	35 c	-2.9	53 d	-1.9
Trat	**JUN**		**JUL**		**AUG**		**SEP**			
	I	**CE**	**I**	**CE**	**I**	**CE**	**I**	**CE**		
1	11 a	84.5	14 a	79.6	23 a	64.6	43 a	50.6		
2	26 b	63.4	15 a	67.4	35 b	46.2	59 b	32.2		
3	28 b	60.5	18 a	60.9	39 b	40.0	66 c	24.1		
4	9 a	87.3	8 a	82.6	19 a	70.8	34 a	60.9		
5	38 c	46.5	26 b	43.5	36 b	44.6	57 b	34.5		
6	11 a	84.5	10 a	78.3	17 a	73.8	35 a	59.8		
7	53 c	25.4	49 c	-6.5	61 d	6.2	82 d	5.7		
8	51 c	28.2	34 b	26.1	49 c	24.6	87 d	0		
9	49 c	31.0	31 b	32.6	45 c	30.8	52 b	40.2		
10	72 d	-1.4	49 c	-6.5	69 d	-6.2	88 d	-1.1		
11	71 d	-	46 c	-	65 d	-	87 d	0		
12	59 d	16.9	46 c	0	73 d	-12.3	92 d	-5.7		
VC1 (%) = 21.16 VC2 (%) = 13.50										

The averages followed by the same letter in the column do not differ by Scott Knott's test at the 5% probability level. * Treatments highlighted in bold that had active ingredients with insecticidal action, directed to the control of the CLM.

According to the results, the best performance of T4 and T6 treatments, in the year of leaf miner most incidence may be related to the fact that these treatments are composed of two thiamethoxan applications (one in November and other in February). The application in February also contributed to the product residual power increase, acting on the pest control later in the dry seasons of the year [13]. Already, in the Treatment 1 that was not efficient in 2010, possibly due to the low CLM infestations, proved to be efficient in 2011, when CLM infestations were higher, which may have favored imidacloprid expressing its control potential.

It was observed in 2010 that there was a significant difference between the treatments, with T4 (Actara + Verdadero), T5, T6 and T10 (Opera) were the ones with the lowest values from the area under the progression curve of rust disease (Table 4). The treatments T4 and T10 present active ingredients with fungicide action, directed to the coffee rust control. However, treatments 5 and 6 that present active ingredients with only insecticidal action, possibly had a positive effect on the plants vigor and thus provided a lower rust incidence. In 2011, there was no significant difference in AUDPC among treatments. However, comparing the AUDPC for the 2011 in relation to 2010, it is verified that the AUDPC in 2011 was lower than in

2010 for most treatments, except T4 (Actara + Verdadero), T5, T6 and T10 (Opera), whose values did not differ between the two years.

TABLE 4
AREA UNDER DISEASE PROGRESS CURVE (AUDPC) AVERAGE FOR COFFEE RUST IN THE YEARS - 2010 AND 2011.

Treatment	AUDPC 2010	AUDPC 2011
1	3130 c B	1455 a A
2	2470 b B	1200 a A
3	1665 b B	305 a A
4	1270 a A	615 a A
5	925 a A	655 a A
6	970 a A	885 a A
7	4025 c B	885 a A
8	3520 c B	930 a A
9	2385 b B	940 a A
10	385 a A	280 a A
11	5140 d B	1280 a A
12	3620 c B	695 a A

The average followed by the same lowercase letter in the column and uppercase in the row does not differ from one another by the Scott Knott test at the 5% probability level.

In figures 1 and 2, the evolution curve of coffee rust (*Hemileiavastatrix*) can be observed in the years 2010 and 2011, respectively. Treatment 10 (pyraclostrobin + epoxiconazole) in 2010 was the only product that kept the rust incidence curve less than 5% infestation, that is the infection maximum limit adopted to enter its control [14]. In 2011, all products used, except treatment 1 (Premier Plus: imidacloprid + triadimenol) maintained the infection level less than 5% infestation until May. From that month, the rust incidence increased, with only treatments 10 (Opera: pyraclostrobin + epoxiconazole) and 3 (Verdadero: thiamethoxan + cyproconazole), maintaining the rust incidence under the control level.

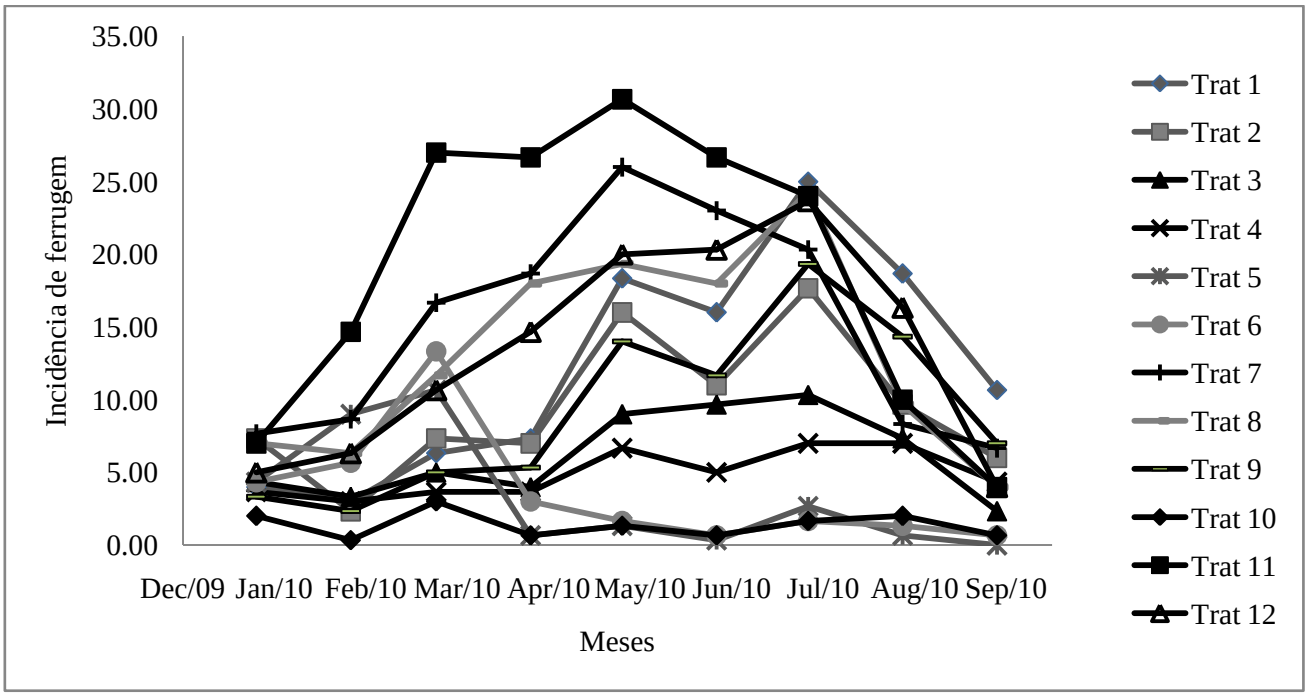

FIGURE 1. PROGRESS CURVE OF COFFEE RUST INCIDENCE AFTER FUNGICIDES AND INSECTICIDES APPLICATION IN THE RESPECTIVE CROP - 2010

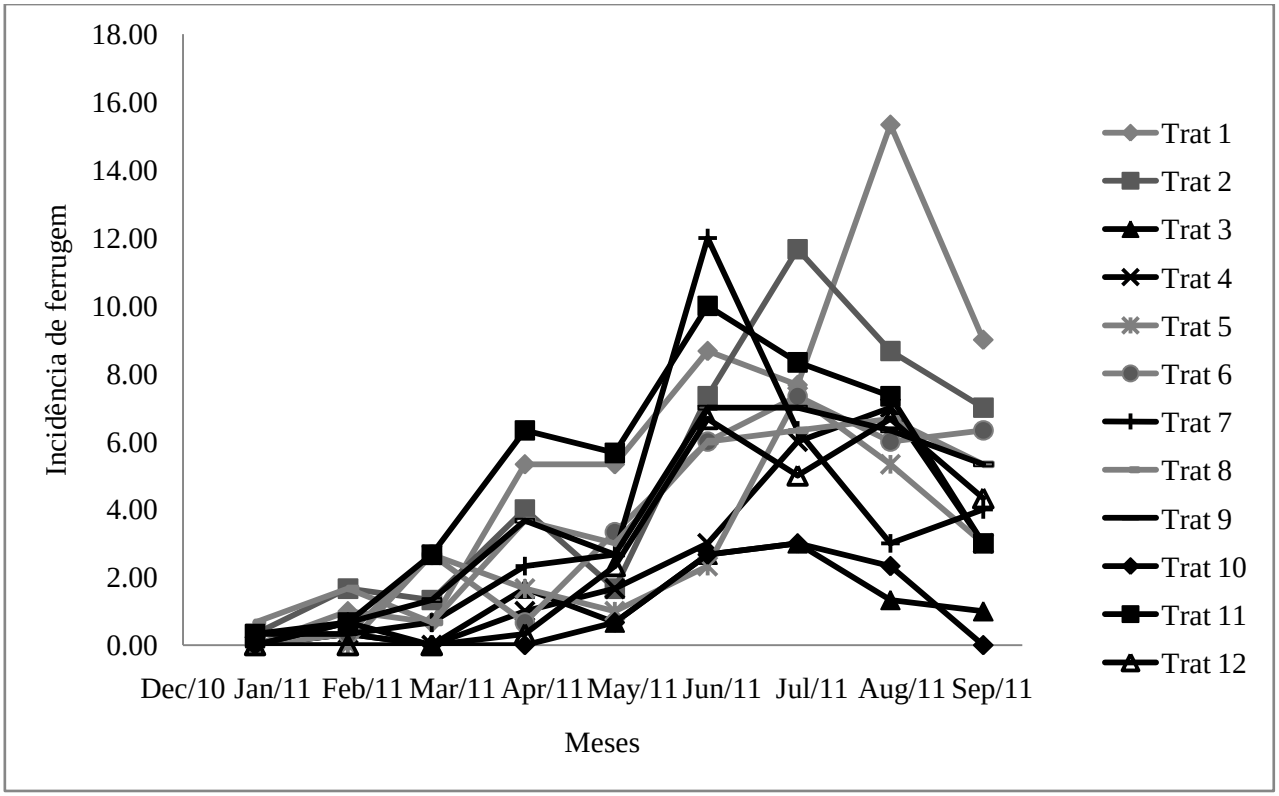

FIGURE 2. PROGRESS CURVE OF COFFEE RUST INCIDENCE AFTER FUNGICIDES AND INSECTICIDES APPLICATION IN THE RESPECTIVE CROP – 2011.

Among the treatments with fungicide action, T10 was one of the best in rust control. This fact may be associated with the effect of the active ingredient pyraclostrobin, belonging to the chemical group of strobilurins, present in the fungicide formulation consisting of the mixture of two chemical groups (triazole + strobilurin). Triazoles have recently been associated with composite formulations containing strobilurins, and strobilurin has emerged as a new concept in the fungal diseases control and has provided several physiological effects in varied crops such as soybean, wheat and corn [15].

Also, noteworthy the T3, T4 and T5 treatments, that present in common the thiamethoxan in its composition. The T3 in combined insecticidal fungicide action (cyproconazole + thiamethoxam), but the T4 and T5 has insecticidal action and in this context, the rust control could be justified by the vigor increase and biomass accumulation and, consequently, increase the plants resistance, so reducing infections possibility [6]; [16].

In 2010, there was a higher resistance of pathogen, that is, there was a higher rust incidence than in 2011. This fact is associated with higher coffee productivity in 2010 (Table 5), because in high-load years, coffee tree tends to present higher rust infection levels, making difficult to control it, since the disease pressure is higher than in years of low hanging load, due to the reserves mobilization for fruit nutrition, leaving the plant more vulnerable to pathogens attack [17].

Considering the coffee productivity, the 2009/2010 and 2011/2012 harvests presented higher productivity than the 2010/2011 harvest. This fact may be associated with the coffee bienniality, that is characterized by annual alternation of high and low productivities, and is commonly attributed to the plant reserves decrease in harvests-years with high productivities, which causes, due to the lower plagiotropic branches growth the production in the following year is low [18]; [19]; [20].

In the phytosanitary analysis action on productivity, it was verified that it varied according to the harvest evaluated. According to the table 4, it can be observed that for the 2009/2010 harvest the T1, T2, T4, T6, T7, T8, T9 and T12 presented higher productivities than the control (T11, without pesticides application), ranging from 73.28 to 89.18 bag/ ha. The T3, T5 and T10 treatments did not differ from T11 (without pesticides application), presenting the lowest productivities.

TABLE 5

AVERAGE PRODUCTIVITY, IN 60 KG BAGS OF COFFEE BENEFITED/HA FROM COFFEE TREES TREATED WITH FUNGICIDES AND INSECTICIDES TO RUST AND LEAF MINER CONTROL RESPECTIVELY, IT WAS EVALUATED IN THE HARVESTS - 2009/2010, 2010/2011 AND 2011/2012, IN THE MUNICIPALITY OF *SÃO SEBASTIÃO DO PARAÍSO - MG*

Treatments	Productivity 2010	Productivity 2011	Productivity 2012
1	76.06 b B	13.50 a A	64.98 d B
2	75.67 b C	14.12 a A	54.40 c B
3	67.61 a C	15.50 a A	47.49 b B
4	74.32 b B	12.52 a A	66.80 d B
5	56.99 a C	16.53 a A	42.33 b B
6	76.53 b C	14.32 a A	63.16 d B
7	73.28 b C	15.87 a A	35.88 a B
8	89.18 b C	13.50 a A	53.90 c B
9	79.57 b C	11.92 a A	47.95 b B
10	67.69 a B	15.87 a A	26.78 a A
11	64.48 a C	14.17 a A	26.95 a B
12	78.22 b C	8.34 a A	41.66 b B
VC1 = 20.48			
VC2 = 15.72			

The averages followed by the same lowercase letter in the column and uppercase in the row do not differ between them Scott Knott's test at 5% probability.

For the 2010/2011 harvest, there was no significant difference as the productivity among all treatments and the control. However, in the 2011/2012 harvest, there was variability among treatments, as there was separation in four groups. The first group consisted of T7, T10 and T11 treatments (productivity ranging from 26.78 to 35.88 bag/ha). The second group consisted of T3, T5, T9 and T12 treatments (41.66 to 47.95 bag/ha). The third group consisted of T2 and T8 treatments (54.44 and 53.90 bag/ha, respectively) and in the fourth group remained T1, T4 and T6 treatments that presented higher productivity, with values 64.98, 66.80 and 63.16 bag/ha, respectively. The T10 treatment (Opera = pyraclostrobin + epoxiconazole) was observed with lower productivity in 2010 and 2012, which did not differ from the T11 control. Similar results were found by Pinto et al., 2011, wherein the strobilurins use did not interfere with soybean productivity, but results differ from those found by [21], wherein the strobilurins application positively influenced bean production and yield.

In this study, independent of the harvest evaluated, it was observed that the exception of T7 (chlorantraniliprole) and T8 (chlorantraniliprole and thiamethoxan) treatments, there was phytosanitary action to increase the plants vigor compared to the control (Table 6). However, there was no significant difference among the number of nodes of plagiotropic branches, indicating that there was no action of different phytosanitary products on the growth of the coffee branch in adult cultivation of *coffea arabica* cv. Catuaí IAC 144. Therefore, the vigor increase can be caused by the controlled rust and the leaf miner, maintaining the plant foliage.

TABLE 6

AVERAGE NUMBER OF NODES IN THE PLAGIOTROPIC BRANCH (NN) AND COFFEE TREES VIGOR TREATED WITH FUNGICIDES AND INSECTICIDES TO CONTROL RUST AND LEAF MINER.

Treatments	NN	Vigor
1	21.90 a	9.5 b
2	21.21 a	9.5 b
3	20.96 a	8.5 b
4	22.01 a	9.0 b
5	21.56 a	9.0 b
6	21.97 a	9.75 b
7	20.77 a	5.5 a
8	20.09 a	6.0a
9	20.94 a	9.5 b
10	20.39 a	8.0 b
11	20.74 a	5.5 a
12	20.80 a	8.0 b
VC1 (%)	11.38	9.52
VC2 (%)	7.38	8.90

Average followed by the same letter does not differ by Scott Knott's test at 5% probability.

In general, the T4 treatment had an efficient action in the miner and rust control, and the T6 treatment in the leaf miner control, allied to greater productivity and vigor in both high-load years (2010 and 2011). It is noteworthy in these treatments, the insecticide thiamethoxan application in two seasons (November and February), so according to [6] can result in high photosynthetic rate, increased vigor expression and deeper roots. This higher photosynthetic rate and deeper root system keeps the plant better nourished and consequently more tolerant to pathogen attack.

IV. CONCLUSION

The Thiamethoxan + Cyproconazole application in November with a complementary Thiamethoxan application in February were more efficient for the coffee leaf miner control and provided greater vigor and productivity to the coffee tree.

ACKNOWLEDGEMENTS

To the National Science and Technology Institute (INCT-Café), to the Coffee Research Consortium and the Research Support Foundation of the State of Minas Gerais (Fapemig) for financial support for the Project . To the fellowship of research productivity (BIPDT) granted by the Fapemig.

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