Australian Journal of Basic and Applied Sciences

2018 October; 12(10): pages 1-6
DOI: 10.22587/ajbas.2018.12.10.1

Research Article
Journal home page: www.ajbasweb.com

AENSI Publications

Trifloxystrobin + Protioconazole in Different Times of Application, Development and Disease Control in Wheat Culture.

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Received date: 12 August 2018, **Accepted date:** 15 October 2018, **Online date:** 4 November 2018

Abstract

The wheat (*Triticum Aestivum*), is a crop that is present in the lives of the human beings since the dawn of agriculture. It is the second most grown cereal in the world, possessing meaning influence on global agricultural economy. In the view of the above, the present work has as its goal to evaluate the effect of trifloxystrobin + prothiocanazole in the control o diseases and on the development on the wheat culture. The experiment was conducted in the Experimental Farm of União de Ensino do Sudoeste do Paraná – UNISEP, located in the city of Dois Vizinhos, southwest of Paraná. The statistical design was a randomized complete block design with five replications. The plots measure 4,84m x 3m out of a total of 20 plots totaling an experiment area of 290.4 m^2, with corridors of 30cm, consisting of four application times, of trifloxystrobin + prothioconazole being tilling (A), elongation (B), rubber (C) and gouging (D), with application interval of 17 days. The cultivar of wheat utilized was the CD 150. The data obtained were evaluated through the test F ($p<0,05$), being that the significant were compared by the Tukey Test ($p<0,05$), using the statistic assistance program, Assistat Software. The analyzed variables number of tills, height of the plants, the dry mass material and disease severity. The evaluations of disease severity were made in five periods of time. The wheat leaf diseases had a severity reduced with an application of the fungicide in all the treatments. The application of the fungicide with active principle in different times of the wheat culture, did not present interference on the number of tills per plant and on the height of those. The application of the fungicide with active principle in four different stages, caused an increase in de dry mass during the stage of crop's rubber. In view of the presented results, it is concluded that with four applications (ABCD), better results were achieved in the variables analyzed in the culture.

Key words: fungicide; *Triticum Aestivum* phenological stages.

INTRODUCTION

The wheat (*Triticum Aestivum*), is a crop that is present in the lives of the human beings since the dawn of agriculture. It is the second most grown cereal in the world, possessing meaning influence on global agricultural economy. In Brazil, the South, Southwest and Midwest regions are the ones that concentrate the largest production of wheat in the country.

Cultivated in winter season, the culture may have massive losses due to constant frost, being that the reason why most farmers are often apprehensive to cultivate this crop. This makes the production of the wheat crop in Brazil present low productivity of average in the crops, also attributing this fact to the small participation of fertile tills in the formation of the final yield of the crop (MUNSDTOCK, 1999).

Today's biggest challenge to make wheat sowing viable in the country is to overcome the barriers imposed by diseases. The culture conditions can vary significantly, as well as the occurrence and activity of diseases, as well as the need for control.

When it comes to grain yield, among the factors that may present interference in production, we relate the high rainfall index and accumulation of cloudy weather, thus we have a potentiality of foliar diseases, which can be controlled with a good management of fungicide, most of the times.

Foliar diseases are responsible for the great intervention in the potential of grain production, due to the obstruction of the healthy leaf area, due to the damages caused. (REIS; CASA, 2005).

However, diseases such as giberela (*Gibberella zeae Schwain*) and brusone (*Pyricularia grisea*), may cause reduction in grain yields of more than 50%, which contributes for two big impasses on the growth of wheat production in the country (GONÇALVES et al., 2012; GARCIA, 2006).

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An adoption of integrated practices such as resistant cultivars, healthy seeds, appropriate seed treatment with fungicide, respecting a sowing season indicated for cultivation, crop rotation and fungicide application are adequate management for disease control. However, the diseases are still not satisfactorily controlled by resistant cultivars, since they are not yet sufficient to reduce their damage due to their resistance level.

The use of the fungicide trifloxystrobin (estrobirulin) + prothioconazole (triazolinthione), in general, is still a case to be studied for wheat cultivation. There are few studies related to the same in the culture, the different times, as well as the best phase of the culture for application, are still pertinent doubts. When well-managed, wheat is a culture that presents a high production potential and above all, quality of its production.

In order to acquire a more accentuated production response of this culture, it is fundamental that the fungicide is correctly used, for it improves the sanity and productivity of the culture. Thus, one seeks which is the best period of time for its appliance, considering it suffers from a huge incidence of diseases that are prejudicial to the plant's development, expressing the right time to applicate, there is a bigger optimization of the culture.

In the view of the above, the present work has as its goal to evaluate the effect of trifloxystrobin + prothiocanazole in the control o diseases and on the development on the wheat culture in the Southwest of Paraná.

MATERIAL AND METHODS

The experiment was conducted in the Experimental Farm of União de Ensino do Sudoeste do Paraná – UNISEP, located in the city of Dois Vizinhos, southwest of Paraná, with its latitude being between 25º46'17.1'' South and 53º02'51.9'' West. According to the Koppen Classification it possesses a mesothermic wet subtropical climate (Cfa – C = Temperate rainy climates, the coldest month's temperature between 18ºC and -3ºC; f = Always humid, rains every month of the year; a = the hottest temperature above 22ºC), (MAACK, 1968), and soil with classification of Nitrous Red dystrophic umbric and wavy relief, clayey texture (BHERING, 2008).

The statistical design was a randomized complete block design with five replications. The plots measure 4,84m x 3m out of a total of 20 plots totaling an experiment area of 290.4 m², with corridors of 30cm, consisting of four application times, of trifloxystrobin + prothioconazole being tilling (A), elongation (B), rubber (C) and gouging (D), with application interval of 17 days.

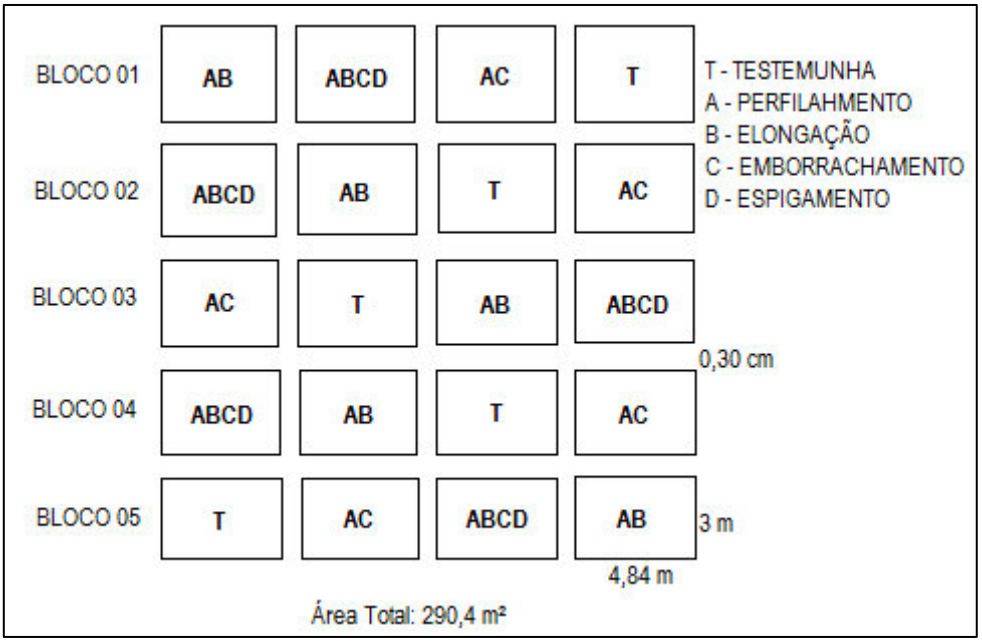

Fig 1: A sketch of the experimental area, treatments arrangements, Dois Vizinhos - PR, 2016.

The cultivar of wheat utilized was the CD 150. This cultivar has as its main characteristics the high productivity in elevated fertility soils, an early cycle, it presents a big percentage of protein in the grain, besides being gluten strong, making it a cultivar that is being well adapted in the region of the Southwest of Paraná, assorted as improver wheat (COODETEC, 2016).

For a better conduction of the experiment, as well as a bigger development of the culture, the area had been dried out 40 days before the seeding. The characteristics of the soul of the experimental area were taken from a depth of 0-20 cm. The fertilizing was carried on according to the soil fertile analysis recommendation (Chart 1), in this case 8-20-18 (NPK), with 292 kg ha^{-1}.

Tabela 1 - Results of the chemical analysis of the soil utilized for composition of substrates. UNISEP, Doiz Vizinhos – PR, 2014.

P	MO	pH $CaCl_2$	H+Al	Al^{3+}	K^+	Ca^{2+}	Mg^{2+}	SB	CTC	V
(mg dm^{-3})	(g dm^{-3})	(0,01mol L^{-1})	(mmol$_c$. dm^{-3})							%
44,31	13,98	4,6	6,69	0,35	0,29	1,92	0,96	3,17	9,86	32,15
mg dm^3			%							
F-remanescente	SAND		SILTE		CLAY		SOIL CLASSIFICATION			
6,21										

Source: Solanalise-Laboratório de Análises Agronômicas, Cascavel – PR, 2016

Besides the base fertilizing, the appliance of 150 kg ha^{-1} of Nitrogen in coverage has been executed, considering urea has been used as source of this element. The appliance was effected in two applications of 75 kg ha^{-1}, in the tillering and rubber stages of the culture.

The seeding was executed on 4th of July, 2014, with continuous flux seeding. The spacing between the lines utilized was of 0,17m, with a density of 450 plants per m2. The seeds utilized were treated with imidacloprid and thiodocarb active principles, of which present systemic characteristics of contact and ingestion respectively (MF RURAL, 2016).

The parcels were isolated using a plastic tarp for the application of the treatments. The pulverization was made with a precision sprung manual sprayer, with constant pressure, equipped with a fan beak XR 11002 and a volume of application of 200 L ha^{-1}.

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The cultural dealings were made based on the necessity of the culture, being that for the control of invasive plants, Iodosulfuron-methyl herbicide based has been used, which belongs to the chemical group of Sunfonylureas on the dose of 0,1 Kg ha^{-1}. As to the control of plagues such as the wheat caterpillar (Pseudaletia sequax), the leaf aphid (Metopolophium dirhodum), and the green belly bug (Dichelops melacanthus) the active principle imidacloprid + betacifluthrin (0,75 L ha-1) and Triflumurom (0,03 L ha^{-1}) based insecticides were respectively used.

The fungicide application for the control of diseases such as the wheat rust (Puccinia triticina), the Giberela (Gibberella zeae) and the Brusone (Pyricularia grisea), occurred with the defensive analyzed in the experiment (Trifloxystrobin + Prothioconazole) based and dose of 0,5 L ha-1), altogether with the adjuvant Soybean Methyl Ester based (0,25% (250 ml/100 liters of water). The effect of the dealings on the final productivity of the culture was evaluated through the productive aspects being, number of tillers, disease severity and dry mass.

The evaluations of disease severity were made in five periods of time, tilling, elongation, rubber and maturation, being fulfilled with a gap of 17 days within the applications. The procedure performed to the accomplishment of that occurred by collecting three plants per parcel, respecting 0,20m of the surroundings for further evaluation. As a comparative base, the Empresa Brasileira de Pesquisa Agropecuária's (EMBRAPA, 2016) diagrammatic scale has been used.

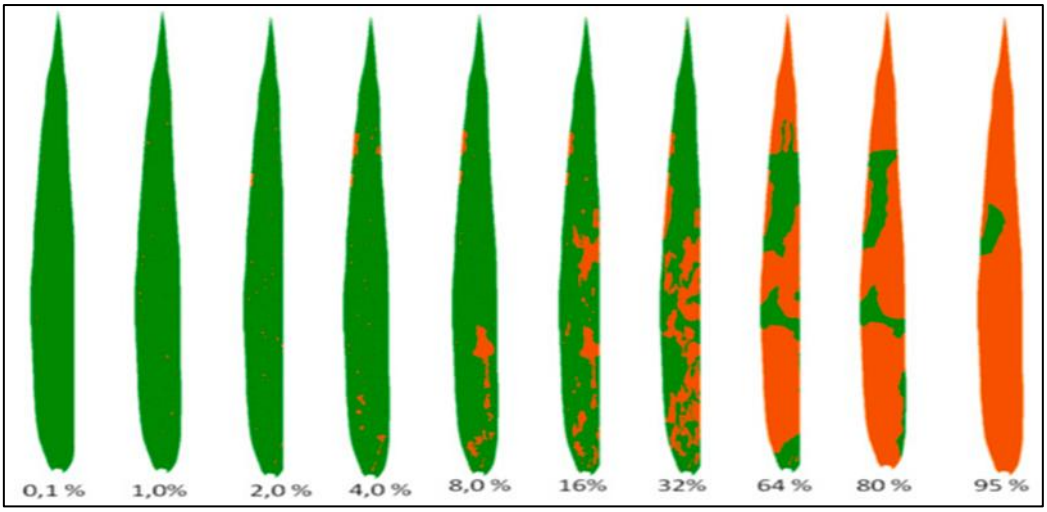

Fig 2: Diagrammatic scale of foliar diseases on the wheat culture.
Fonte: EMBRAPA, Trigo 2014.

The count of the number of tills was made altogether with the first mass cut, with the help of a regular scissor, it was possible to collect 0,25m2 of plants per parcel and, afterwards, having counted the number of tills per plant, the same was accomplished manually.
The height of the plants (cm) was measured using a graduated ruler, in 40 plants per parcel, in an aleatory way and in three different development stages of the culture, those being tilling, rubber and gouging.

For the evaluation of the dry mass material (g), were collected 0,25 m2 of still raw plants, being those conditioned to a paper bag, favoring the water loss on them. Shortly after collected, the plants were weighted using a digital scale, considering four decimal places after the comma and afterwards, took them to the continuous airflow greenhouse where in the period of three days they remained on a unaltered temperature of 55º C, weighting the dry mass after.
The data obtained were evaluated through the test F ($p<0,05$), being that the significant were compared by the Tukey Test ($p<0,05$), using the statistic assistance program, Assistat Software (SILVA; AZEVEDO, 2009).

RESULTS AND DISCUSSION

Statistically the results did not differ to the tilling (Chart 2), due to that the culture was in its initial phase and could not expose its potential. In the species in which tilling occurs, such as in wheat and rice, beneficial structures, increasing the number of inflorescence per area and contributing to the increase of grain yield (ALMEIDA et al, 1998).

Chart 2 – Number of wheat culture tills due to different times of the fungicide application (trifloxystrobin + prothioconazole) UNISEP – Dois Vizinhos/PR, 2014/2015

Treatment	Tilling (Unity)
T	10,98ns
AB	10,39
AC	12,05
ABCD	10,80
CV (%)	18,29

CV (%): coefficient of variation
NS = Averages not significant by the Tukey Test ($p<0,05$)
T: Witness; A: Tilling; B: Elongation; C: Rubber; D: Gouging

The culture which is able to produce tines, still has a certain plasticity capable of filling the spaces between one plant and another (MUNDSTOCK, 1999). Thus, the adjustment of the individuals' number can be determinant to the yield of the referred culture.
In Langer's (1963) view, tilling depends on the intrinsic condition (of the plant itself) and extrinsic (temperature, luminosity, humidity, etc.). Still according to him, tilling is mainly regulated by genotype, balance, hormonal, flowering, light, temperature, photoperiod, watering and mineral nutrition.
The variable height of the plant, evaluated in three times, tilling, rubber and gouging, did not present significant results (Chart 3). Even not being significant, all the treatments resulted in a bigger height of the plant, in relation to the witness and as increased the number of applications, there was also an increase in the wheat plants' height.

Similar results were found by Casa (2001), when applying the fungicide with active principle on the group of triazoles (trifloxistrobin + prothioconazole), there were not significant results for height and length of the wheat's ear.

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Chart 3 – Height of the plant (cm) in the culture of wheat due to different times of application of the fungicide (trifloxistrobin + prothiconazole). UNISEP – Dois Vizinhos/PR, 2014/2015.

Times of application			
Treatment	Tilling NS	Rubber NS	Gouging NS
	Height (cm)	Height (cm)	Height (cm)
T	33,05	80,66	78,20
AB	33,30	81,25	81,65
AC	35,17	82,17	79,67
ABCD	35,07	83,97	81,82
CV (%)	5,39	4,70	3,91

CV (%): Coefficient of variation
NS = Averages not significant by the Tukey Test (p<0,05)
T: Witness; A: Tilling; B: Elongation; C: Rubber; D: Gouging

In the conception of Teixeira and Rodrigues (2003), the plant's height can be influenced directly by the arrangement of plants, which may affect its photosynthetic capacity and its growth due to the dependence of luminosity.
The dry mass (DM), was not statistically different during tilling and gouging. However, in the rubber analysis, the application of the fungicide in four different moments, presented a bigger weight of dry mass, phase where the plant obtained a great protection due to this number of applications (Chart 4). In this stage, the tip of the wheat develops and becomes visible through the sheath on the stem, the same finishes when the edges begin to appear.
The application of fungicides promotes a bigger protection to the plants, which consequently, creates a bigger mass production. Its efficiency depends on the moment of application and the quality of pulverization (PICININI; FERNANDES, 2000).

Chart 4 – Dry mass in the wheat culture due to the different times of application of the fungicide (trifloxistrobin + prothiconazole) UNISEP – Dois Vizinhos/PR, 2014/2015.

Times of application			
Treatment	Tilling	Rubber	Gouging
	Dry Mass (g) NS	Dry Mass (g) NS	Dry Mass (g) NS
T	39,6	76,00 b	34,8
AB	40,4	89,20 ab	49,2
AC	38,8	82,40 b	46
ABCD	44,4	109,60 a	46,8
CV (%)	29,35	14,14	25,61

CV (%): Coefficient of variation
NS = Averages not significant by the Tukey Test (p<0,05)
T: Witness; A: Tilling; B: Elongation; C: Rubber; D: Gouging
*Averages followed by the same letter do not differ from each other

Navarini (2010), reports that studies of strobilurins behavior in plants shows that, besides the disease control, it also provides a bigger grain productivity, dry mass, the chlorophyll and proteins content and in the delay of leaf senescence. In the conception of the experiment conducted by Navarini (2010), the best results achieved in the dry mass, were the active principle strobilurin which is found in the fungicide and has presented better development of the plans and bigger mass accumulation.
Fioreze and Rodrigues (2014), report that the bigger the emission of tills, the bigger the accumulation of individual plants' dry mass, varying according to its management and that it indeed can have a significant influence with the use of fungicides based on prothiconazole.
The first analysis of severity (Chart 5), did not obtain significant results, due to the little disease index in the time of evaluation. To wheat, the leaf application of fungicides to control the leaf stains in indicated after the appearing of the first symptoms, when the threshold of the economic damage is attained (REIS et al, 2011) or the incidence of 70% (REUNIÃO, 2009).

Chart 5 – Severity (%) of leaf diseases evaluated in five different stages of developments of the wheat culture, due to different times of application of the fungicide (trifloxistrobin + prothiconazole) UNISEP – Dois Vizinhos/PR, 2014/2015.

Times of application					
	Tilling	Elongation	Rubber	Gouging	Maturation
Treatment	Severity 1	Severity2	Severity 3	Severity 4	Severity 5
(%) NS	(%)	(%)	(%)	(%)	(%)NS
T	2,00 a	26,83 a	28,33 a	35,40 a	85,66 a
AB	1,36 a	9,51 b	5,40 b	18,86 b	90,00 a
AC	1,52 a	12,04 ab	14,40 ab	26,73 ab	79,66 a
ABCD	1,64 a	8,16 b	6,51 b	18,28 b	80,00 a
CV (%)	81,27	55,7	56,15	39,98	16,17

CV (%): Coefficient of variation
NS = Averages not significant by the Tukey Test (p<0,05)
T: Witness; A: Tilling; B: Elongation; C: Rubber; D: Gouging

In the second severity analysis (Chart 5), better results were obtained with the treatments in which received applications on the stages of tilling and elongation 2 (AB) and 4 (ABCD), however both did not differ statistically. Dallagnol (2006), discuss that the reduction on the yield of grains has a correlation with the leaf stains and diseases that attack the leafs, he verified that this bigger correlation happened severely on the flag leaf.
It is really important to maintain the flag leaf healthy, thus the application on the rubber stage is very important, although when attached to the application also on the elongation stage, it achieves even better results, says (DALLAGNOL, 2006).

The third severity analysis, applied on the rubber stage, presented superior numbers (Chart 4), being that the best results were obtained with the treatments which received the applications on the stages of tilling and elongation (AB) and (ABCD), although both did not differ statistically.
On the third and fourth severity analysis (Chart 4), the results follow the same line of sense, where the better results occurred with the treatment 2 (AB) and 4 (ABCD). The third had the infection of diseases on the time of the elongation stage, which increases its severity on the third collection of data and consequently

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also on the fourth collection. Santos et al. (2011), verified that the control was effective in blast panicles, when the plants were treated with trifloxistrobin + prophiconazole and with trycyclazole. It is important to emphasize the prominence of applying the fungicide in the time of elongation.

Conversely, on the fifth severity analysis (Chart 4), the results were statistically all equal, that is probably due to the rainy weather (Figure 1) and warm on the final crop cycle which influenced for a great infection of severity in all the treatments.

According to Ranzi and Forcelini (2013), as time increases, in days, between the inoculation of the plants with pathogen and the subsequent applications of triazole, rates of lesion expansion also increase, indicating a decrease on the effectiveness of the fungicide.

Azevedo (2007) describes that fungicides of the chemical group of the strobilurins are less systemic then the triazoles, which limits its action in dead tissues where the necrotrophic pathogens are more active.

However, in addition to the effect of the greater number of applications of the fungicide and that it provides a better control of the diseases that attack the wheat, the applications influence by collateral effects the crop's yield. Its effects provide the maintenance of the leaf blade, maintaining those in good conditions to intercept solar radiation, thus contributing to the production of assimilates, resulting in increases in the crop's yield.

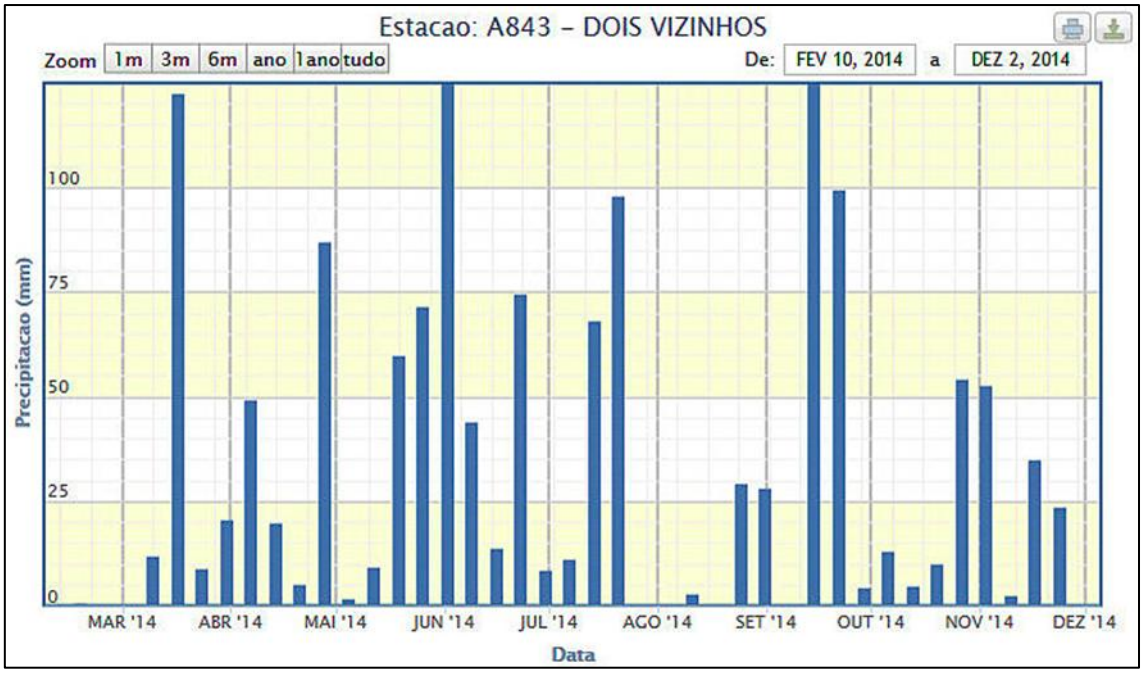

Fig 3: Precipitation on the time of the experiment.
Source: INMET, Institute national meteorology (2014).

CONCLUSION

The application of the fungicide with active principle (trifloxistrobin + protichonazole) in different times of the wheat culture, did not present interference on the number of tills per plant and on the height of those.

The application of the fungicide with active principle (trifloxistrobin + protichonazole) in four different stages, caused an increase in de dry mass during the stage of crop's rubber.

The wheat leaf diseases had a severity reduced with an application of the fungicide (trifloxistrobin + protichonazole) in all the treatments.

In view of the presented results, it is concluded that with four applications (ABCD), better results were achieved in the variables analyzed in the culture.

Within the foregoing, we arrive at the conception, as orientation of crops that the use only in tillering and elongation, with two applications, bring the same results as four applications, that is, viable to the farmers of the region thus the cost is smaller.

Future works

Application of fungicides in accordance with the application and the influence of rainfall.

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