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Artigo Científico

Plant morphological characteristics and yield of potato cv. Ágata in function to fungicides application

Edina Cristiane Lopes[1]
Sidnei Osmar Jadoski[2]
Larissa Romão Saito[3]
Moisés Scheifiter de Ramos[4]

Abstract

The study was conducted in the experimental area of the Department of Agronomy – Universidade Estadual do Centro Oeste - UNICENTRO, in Guarapuava-PR/ Brazil. The objective was to assess the additives effects of the fungicides methiram + pyraclotrobin on the plant development and cultivation of potatoes. We carried out the experiment in completely randomized design with five treatments and four repetitions, of which the T1 is the control with fluazinam, T2, T3, T4, T5 are treatments with different doses of methiram + pyraclotrobin in the planting furrow and ridging. It was found that the parameters number of leaves and leaf area index are benefited by the application of methiram (2.75 kg i.a. ha^{-1}) + pyraclostrobin (0.25 kg i.a. ha^{-1}) applied in the ridging or divided in the furrow and in the ridging. This result was similar to tubers production, that in addition don´t presented differences in the classification in relation to the diameter.

Keywords: *Solanum tuberosum*, production, pyraclostrobin.

Características morfológicas das plantas e produção da batata Cv. Ágata em função da aplicação de fungicidas

Resumo

A pesquisa foi desenvolvida em área experimental do Departamento de Agronomia - UNICENTRO, em Guarapuava – PR. O objetivo foi avaliar os efeitos aditivos dos fungicidas metiram + piraclostrobina no desenvolvimento vegetativo e produção de batata. Realizou-se o experimento em delineamento inteiramente casualisado, com 5 tratamentos e 4 repetições, dos quais o T1 é a testemunha com fluazinam, T2, T3, T4, T5 são tratamentos com diferentes doses de metiram + piraclostrobina no sulco de plantio e na amontoa. Verificou-se que os parâmetros número de folhas e índice de área foliar são beneficiados pela aplicação de metiram (2,75 kg i.a. ha^{-1}) + piraclostrobina (0,25 kg i.a. ha^{-1}) aplicado na amontoa ou dividido no sulco e na amontoa; Este resultado foi similar para a produtividade de tubérculos, que em adição a isto não apresentaram diferenças na classificação em relação ao diâmetro.

Palavras-Chave: *Solanum tuberosum*, produção, piraclostrobina.

Características morfológicas de las plantas y producción de la patata cv. Ágata en función de la aplicación de fungicidas

Resumen

El estudio se realizó en área experimental del Departamento de Agronomía, Universidad Estadual do Centro Oeste – UNICENTRO, en Guarapuava – PR Brasil. El objetivo fue evaluar los efectos aditivos del fungicida Metiram + piraclostrobina en el crecimiento vegetativo y rendimiento de la papa. El diseño experimental fue completamente al azar con 5 tratamientos y 4 repeticiones, en que T1 es el testimonio con uso de Fluazinam, y T2, T3, T4, T5 son los tratamientos con diferentes dosis de metiram + piraclostrobina en el surco de plantío y aporque. Se encontró que los parámetros número hojas y índice de

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1 Doctoral student of Agronomy. Universidade Federal do Paraná- UFPR. Rua dos Funcionários 1540, Juvevê, Post Office Box 19061, CEP: 80035-050. Curitiba, PR- Brasil. E-mail: edinacristiane@hotmail.com, corresponding author.

2 Dr. in Agronomy, Professor Department of Agronomy – Universidade Estadual do Centro Oeste/UNICENTRO; Av. Simeão Camargo Varela de Sá, 03 - CEP 85040-080, Guarapuava - PR, Brasil; Email: sjadoski@unicentro.br.

3 Master in Agronomy - UNICENTRO; Guarapuava - PR, Brazil; E-mail: gardin@unicentro.br Email: larissaromaosaito@gmail.com

4 Undergraduate of Agronomy - UNICENTRO, Scientific Initiation Scholarship - CNPq, E-mail: moises_scheifiter@hotmail.com

área foliar se benefician de la aplicación de metiram (2,75 kg ia ha^{-1}) + piraclostrobina (0,25 kg ia ha^{-1}) aplicado en el aporque o dividido en el surco y aporque. Este resultado fue similar al rendimiento de los tubérculos que, además no presentaran diferencias en la clasificación considerando el diámetro.

Palabras clave: *Solanum tuberosum*, producción, pyraclostrobin.

Introduction

Nowadays the potato is the 4th food most consumed around the world, after the rice, wheat and corn (FAO, 2010). However, to satisfy the increasing need of food, it is important the enlargement not only of the cultivated area, but especially of the productivity (THE ECONOMIST, 2006).

The clear description of the growth and development of the plant, or parts of it, allows the comparisons between distinct situations, being possible to be applied to the most diverse modalities of studies (BARCELLOS et al., 2007), including in studies of physiological effects of fungicides as for the growth of the potato plant.

The potato crop is highly affected by different pathogens, especially fungi, which damage both the vegetative canopy as well as the produced tubers. For this reason the fungicides are widely used in the crop cycle, with preventive or healing character. A question that needs to be reassessed is the possibility of these fungicides exercises also a effect of the increasing yield, not acting only as a protector, increasing its efficiency with action spectrum with the promotion of additive effects in the plant physiology. The verification and domain of these properties, which can be developed by some fungicides, can cause reduction of financial resources waste and reduction of the environmental impacts, by the overuse of agrochemicals on the crops.

The fungicides of agricultural use were developed for the control of pathogens on the crops, still, it is observed on the cultivation fields that some active principles can allow additional results to the control phytopathologic. One example is the case of the strobilurins, which show having additive effect to the fungicide control, promoting some alterations in the plants physiology, generally with positive consequences on the crops.

On the additive effect, KOEHLE et al., (2002) describe that among the used fungicides on the potato crop, the fungicides class belonging to the chemical group of the strobilurins comprehend a variety of composts which protect the plant, with wide fungicide activities and possess acting properties in the plants physiology, generally elevating the crop quality and yield.

With greater knowledge about the growth of the Ágata cultivar and the effects of the strobilurin on certain characteristics of this cultivar, it will be possible to establish new alternatives and improvements in the crop management, which can result in economical benefits in relation to quantity and characteristics of quality of the production, as well as on the environment, with the more efficient use of some fungicides. The objective of the study was to assess the effect of different doses of the fungicide pyraclotrobin + methiram, on the plant growth, productivity and size of the tubers of the potato crop produced on field conditions.

Material and Methods

The experiment as conducted in the agricultural year of 2010, in an experimental area of the Department of Agronomy, in the Campus Cedeteg of the Universidade Estadual do Centro Oeste – UNICENTRO, in the municipality of Guarapuava – PR, located in the latitude 25°23'36'' S and longitude 51°27'19'' W, with an altitude of approximately 1025m. The regional clime is classified as Cfb – subtropical mesothermal humid, according with the Köeppen classification. The weather data of the period were obtained from the meteorological station of the University, situated along to the experimental area.

The local soil is characteristic of the region, being classified as Latossolo Bruno Distroférrico (EMBRAPA, 2006)[1]. The area was in fallow for approximately ten years, and it had been cultivated with wheat during the winter. The chemical analysis done in December of 2009 presented the following data (layer of 0-20cm) pH ($CaCl_2$): 5.3; M.O.: 34.9 mg dm^{-3}; P (Mehlich):1.9 mg dm^{-3}; K_2O: 0.34 cmol dm^{-3}; Ca: 3.9 cmol dm^{-3}; Mg: 2.1 cmol dm^{-3}; Fe: 41.5 mg dm^{-3}; Cu: 1.3 mg dm^{-3}; Mn: 41.2 mg dm^{-3}; Zn: 0.9 mg dm^{-3}.

The research organization on the field was done with experimental unities which had dimensions equivalent to 5 m of length with four lines of cultivation spaced in 0,80m.

1 Brazilian soil classification.

The assessments of vegetative and production growth were done considering as useful area the two central lines of the plot, not considering 0.5m of each edge and the lateral lines.

The experimental design was entirely randomized with five treatments and four repetitions, making a total of twenty experimental unities for the morphology assessment of the plants. The treatments consisted of four alternatives of fungicides management (Cabrio-Top®) with active ingredient (i.a.), pyraclostrobin (concentration of 50g kg^{-1}) + methiram (concentration of 550g kg^{-1}) in the formulation WG (dispersible granule) and a control treatment, (Frowncide®) with active ingredient (i.a.), fluazinam (concentration of 500g L^{-1}) in the formulation CS (Concentrated Suspension). The description of the applied treatments is presented in Table 1.

It is highlighted that the use of the fluazinam product in the control plot was defined considering some factors, being:

a) The objective of the assessment of the products was to quantify the additive effects on the plants development and production and post harvest characteristics, and not directly as the effect of the fungi control;

b) fluazinam, methiram + pyraclotrobin are products widely used, being well known in the region and presenting efficiency approximately similar in the fungi control;

c) The potato crop is affected by many different fungi diseases controlled by these products, being that a control treatment without receiving any treatment fatally will be impracticable, because the plants would be damaged by diseases, losing the possibility of use for the experimental assessments.

Table 1. Treatments, used products, doses e time of application.

TREATMENT	COMERCIAL PRODUCT	TIME OF APPLICATION/Dose	
		Cultivation furrow	Ridging (26 DAP)
1	Fluazinam	3 L ha^{-1}	2 L ha^{-1}
2	Methiram + pyraclotrobin	5 kg ha^{-1}	-
3	Methiram + pyraclotrobin	-	5 kg ha^{-1}
4	Methiram + pyraclotrobin	2.5 kg ha^{-1}	2.5 kg ha^{-1}
5	Methiram + pyraclotrobin	5 kg ha^{-1}	5 kg ha^{-1}

Regarding this, AZEVEDO (2003) states that in cultivations normally attacked by diseases, the non use of preventive measures transfers all the control responsibility to the "luck".

d) The fluazinam did not present action with additive effects similar to the methiram + pyraclotrobin. Due to the fluazinam being a fungicide – acaricide of contact of the chemical group fenilpiridinilamina, which enables to assess if it will be occurrence of the additive effects by the use of the products methiram + pyraclotrobin, systemic fungicide of the chemical group alkylenobis (dithiocarbamate) and strobilurin.

The soil preparation consisted of operations of 1st harrow, rotary tiller, 2nd harrow, crossed scarification and furrower for installation of ridges. The fertilization in the furrow was of 3,3 t ha^{-1} of the formula NPK 4-14-8, this done during the sowing.

The sowing was done manually, in January 30th of 2010. The tubers – seed Ágata cultivar used were of the Type III (30-40 mm of diameter) according to the classification of PEREIRA and DANIELS (2003), distributed with spacing of 0.25 m in the line and 0.80 m between the lines with a density of plating of 50.000 tubers per hectare.

In each experimental unity were selected 10 plants randomly, at the beginning of the vegetative development, being marked with stakes, tagged and fixed close to thew plants. The same plants were submitted to not destructive phenometric assessments: number of stems, length of the bigger stem, leaves number and length and width of the leaves, it was done during the whole cycle in intervals of 10 days starting from the 26 DAP (Days after planting). I was also done the number of tubers per plant, number of tubers per stem, medium weight of the tubers, classification of the tubers according to the size and productivity.

Results and Discussion

The number of stems did not significantly differ between the treatments. It was observed that the values of number of stems per plant were very similar between the averages of the five treatments, being that the overall average was of 3.2 stems $plant^{-1}$,

having similar results that GARCIA (2003), who for the cultivar Aracy had an average of 4.2 stems not differing between four treatments, highlighting that this behavior can be explained because it was used only one potato cultivar.

Results of the research with the Ágata cultivar showed that this factor presents great variability. FERNANDES (2010) obtained average of 2.3 stems per plant, now FAVORETTO (2005), in hydroponic cultivation of potato, the greatest value obtained by him was of four stems per plant. Considering results like these, ZAAG (1993) states that besides the tuber-seed size, other factors directly interfere on the production of main stems by the potato plant, like the physiologically age and the number of shoots of the used tuber-seed, the planting density, the characteristics of the soil of the cultivation area and the weather conditions during the crop cycle on the field. It was observed that the length of the bigger stem had a continuous increase until 76 DAP, where it reached average value of 50 cm, afterwards stabilized (Figure 1).

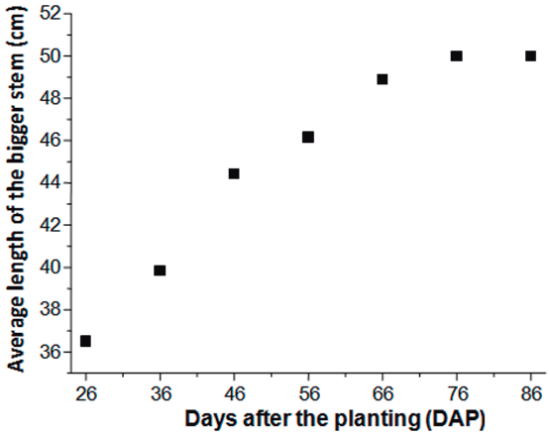

Figure 1. Leaf area index during the vegetative cycle of the potato plants submitted to different managements with fungicides.

It can be observed that the effects of the treatments presented meaningful differences only on the assessment done at the 36 DAP, afterwards this date, the obtained results for the length of the bigger stem did not statistically differ, because they kept with similar lengths until the cycle ends (Table 2). Similar results were also obtained by FERNANDES (2010) for the Ágata, Asterix and Atlantic cultivars, which presented length of the bigger stem similar during the whole cycle of the development, that is, from the 49 DAP to the 98 DAP with average value of 45 cm. Being that at the 62 DAP, the cultivar Mondial stood out in relation to the others, presenting average length of 79 cm in the bigger stem.

In this assessment, it is observed in Table 3 that the treatments which contained application of methiram + pyraclotrobin (T5) (in the furrow and in the ridging) presented averages of length superior to the treatment (T1) with fluazinam, which did not contain application of methiram + pyraclotrobin. Observing that the results of average length of the bigger stem were inferior to 60 cm, MELO et al. (2003) states that the Ágata cultivar can be characterized as a small size cultivar, that is, inferior to 60 cm, in relation to the other cultivars as the Asterix and Atlantic, according to BAARVEL and LIEFRINK (2000) these have average stem length of approximately 62 and 64 cm, respectively.

Averages followed by the same letter do not differ statistically between themselves by Tukey test at 5% probability ($p>0.05$).

Table 3. Results of the statistical analysis by the comparison of averages for the length of the bigger stem of the potato plants at the 36 DAP.

Treatment	36 DAP (cm)
1	35.550 c
2	37.250 bc
3	42.000 ab
4	41.000 abc
5	44.525 a
DMS	5.948

Table 2. Results of the variance analysis for the length of the bigger stem (cm) of the potato plants submitted to different fungicide managements.

Factor	Average Square – Stem length (cm)							
	G.L.	26 DAP	36 DAP	46 DAP	56 DAP	66 DAP	76 DAP	86 DAP
Treatment	4	40.111^{ns}	52.819**	16.513 ^{ns}	14.581^{ns}	12.875 ^{ns}	10.300^{ns}	7.425^{ns}
Error	15	14.849	7.411	6.630	5.275	4.966	4.800	5.100
Overall Average		36.505	40.065	44.405	46.450	49.000	50.200	51.300

*** Significant at the level of 1% probability ($p<0.01$)*Significant at the level of 5% probability ($0.01< p<0.05$) ns-non significant ($p \geq 0.05$).*

In Figure 2 is presented the behavior of variance of the average number of leaves per plant, verified in the experiment, without distinction of the treatments. It is observed that the maximum values occurred until the 76 DAP. This is a result similar with the one described by MELO et al. (2003) who verified that the vegetative growth of the Ágata cultivar presents the maximum values approximately between 45 and 65 DAP. In another research, FAVORETTO (2005) observed that the number of leaves per plant reached its maximum peak of 59 leaves at the 58 DAP, the author describes that from the maximum values the plant presents a characteristic stabilization of vegetative expansion, which is followed of a posterior and increasing stage of senescence, where the vegetative canopy tends to be gradually reduced.

From the 46 DAP, that is, the third assessment of the leaves number, in all the treatments there was a significant difference (Table 4). It is observed that the control presented the smallest averages of leaves number, being that this behavior was found starting from the 46 DAP (Table 5) and extends to the end of the cycle. It is also verified that the plants submitted to the Treatment 2 presented intermediate values of averages, not differing in the overall, neither the control nor the other treatments. The highest averages were verified between the treatments T3 and T5. According with BERTELSEN et al. (2001) the greater duration of the foliage area is one of the main effects of the plants treated with strobilurins, due to the decrease in the ethylene synthesis and also the increase of the production of cytokinins.

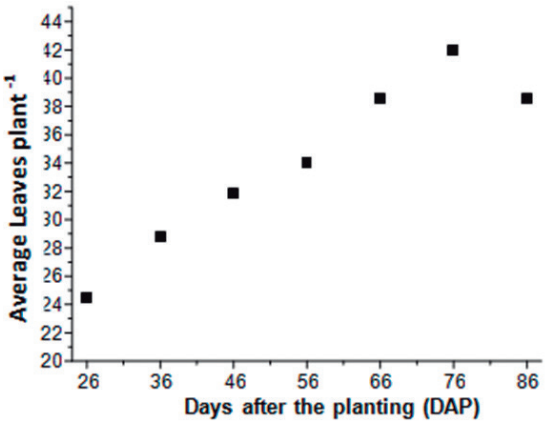

Figure 2. Average number of leaves during the vegetative cycle of the potato plants submitted to different managements with fungicides.

The leaf area index presented maximum values of approximately 4.3 at the 66 DAP (Table 6). It is shown the medium behavior of this parameter during the crop cycle according with WRIGHT and STARK (1990) and BATTILANI and MANNINI (1993), who describe that the values of IAF in potato in general vary between 3.5 and 6.0 depending on the cultivar.

Table 4. Result of the variance analysis for the leaves number of potato plants submitted to different fungicide managements.

Factor	Average Square – Total of leaves							
	G.L.	26 DAP	36 DAP	46 DAP	56 DAP	66 DAP	76 DAP	86 DAP
Treatment	4	43.375ns	40.750ns	89.925**	128.050**	201.700**	140.625**	114.500**
Error	15	16.233	14.583	17.966	10.983	18.400	23.700	17.666
Overall average		24.500	28.750	31.800	34.050	38.600	42.000	38.500

*** Significant at the level of 1% of probability (p<0.01)*Significant at the level of 5% of probability (0.01 < p < 0.05) ns-not significant (p ≥ 0.05).*

Table 5. Result of the statistical analysis by the comparison of averages for the total of leaves of the potato plants at the 46, 56, 66, 76 and 86 DAP submitted to different fungicide managements,

Treatment	46 DAP	56 DAP	66 DAP	76 DAP	86 DAP
1	26.250 b	25.500 c	29.250 c	33.750 b	30.500 b
2	27.000 ab	31.000 bc	33.500 bc	38.500 ab	35.500 ab
3	35.000 ab	37.250 ab	42.750 ab	44.500 a	43.000 a
4	35.750 a	38.000 ab	40.750 ab	44.250 ab	42.000 a
5	35.000 ab	38.500 a	46.750 a	49.000 a	41.500 a
DMS	9.261	7.241	9.372	10.637	9.183

In the column averages followed by the same letter do not differ statistically between themselves by Tukey test at 5% probability (p>0.05).

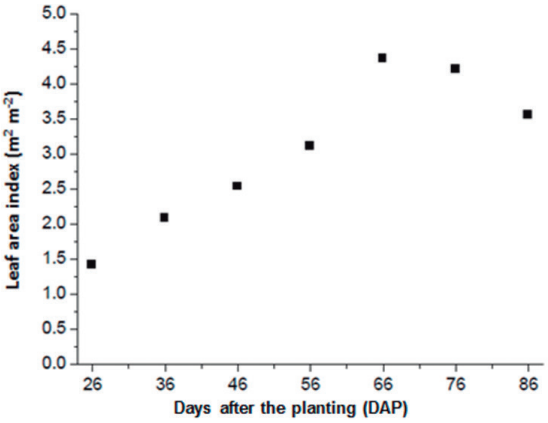

Figure 3. Leaf area index during the vegetative cycle of the potato plants submitted to different managements with fungicides.

It is observed significant differences in the results for the effect of the different treatments (Table 6). This behavior was kept clearly during the period between 36 and 66 DAP where the crop presents the maximum vegetative development, which lasted until the 76 DAP, however without meaningful statistical differences in this assessment. Similar results were obtained by AGUIAR NETO et al. (2000), with the Aracy cultivar, it was found that in the first collection there was no distinction between the treatments, starting from the second collection, at the 30 DAP, it was verified differentiation between the treatments, which significantly progressed during the cycle of the potato crop.

The results of the experiment show that the treatments T3 and T4 obtained higher values for the IAF during the cultivation period in relation to the control (T1). It is observed that in the last assessment in the cycle done at the 86 DAP the plants of the treatment T1 presented smaller IAF in relation to the ones which received treatment with methiram + pyraclotrobin, showing positive effect of this active principle on the maintenance of the active foliage area of the crop in the final of the development cycle, which can be characterized as an additive effect of the applied products in these treatments (Table 7).

Observing the MACACA cultivar in field conditions, BOSCO (2008) found that the IAF reached a maximum value of 1.69, at the 45 DAP, being that in the following observations the IAF decreased considerably, due to the natural senescence of the leaves. In a research developed by NUNES et al. (2006), who assessed the cv. Monalisa, the maximum IAF was obtained at the 61 DAP, similar to the results presented by MELO et al (2003) and MONTEIRO et al. (2005).

However, it is important to observe that even in the control, an IAF of approximately 2,6 still is expressive for this development stage. This behavior is possibly linked with the realization of the planting at the end of January, when the crop cycle occurred in weather conditions that in the region tend to be milder, influencing so as to reduce the rate of vegetative growth, leading to present a smaller plant lodging at the end of the cycle and reducing the leaf senescence rate.

Table 6. Result of the variance analysis for the IAF (m^2 m^{-2}) of the potato plants submitted to different fungicide managements.

Factor	Average Square - IAF							
	G.L.	26 DAP	36 DAP	46 DAP	56 DAP	66 DAP	76 DAP	86 DAP
Treatment	4	0.047^{ns}	0.609**	0.412*	0.764**	1.055**	0.909^{ns}	2.142**
Error	15	0.143	0.098	0.099	0.113	0.188	0.329	0.230
Overall Average		1.417	2.082	2.533	3.112	4.362	4.205	3.557

*** Significant at the level of 1% probability (p<0.01)*Significant at the level of 5% probability (0.01< p<0.05) ns-non significant (p ≥ 0.05).*

Table 7. Result of the statistical analysis by the comparison of the averages for the IAF (m^2 m^{-2}) of the potato plants at the 36, 46, 56, 66 and 86 DAP submitted to different fungicide managements.

Treatment	36 DAP	46 DAP	56 DAP	66 DAP	86 DAP
1	1.580 b	2.001 b	2.450 b	3.565 b	2.581 c
2	1.963 ab	2485 ab	2.999 ab	4.217 ab	3.255 bc
3	1.922 ab	2.724 a	3.540 a	4.920 a	4.547 a
4	2.555 a	2.813 a	3.474 a	4.639 a	3.898 ab
5	2.388 a	2.643 ab	3.098 ab	4.469 ab	3.505 abc
DMS	0.684	0.689	0.737	0.947	1.048

In the column averages followed by the same letter do not differ statistically between themselves by Tukey test at 5% probability (p>0.05).

As for the treatments effects with methiram + pyraclotrobin, it is found that in a general way the positive effects on the IAF occurred with few differences in relation to the dosage and time of application, what enables to assert that within the dosage limits and the tested moment of application in this experiment, the effects of the active principle on the foliage area of the plants are positive and occur more under the influence of the presence of the product in the plant, than necessarily in function of the dosage at the moment of its application.

The average of the production components, tubers per plant, tubers per stem and average weight of the tubers, did not present significant differences. Still, it is possible that the average of 7.2 tubers per plant contributed for the occurrence of the differences in the productivity results, as can be verified in the Tables 8 and 9. In this case it is likely that the plants of the treatments T3 and T5, having presented superior values to 10 tubers plant^{-1}, reached the greater productivities, being superior to the control T1, but not statistically differing from the others.

Table 9. Result of the variance analysis for the productivity in (kg ha $^{-1}$), of the potato plants tubers submitted to different fungicide managements.

Treatment	Productivity kg ha^{-1}
1	29328.1 b
2	40000.0 ab
3	42609.2 a
4	38406.2 ab
5	42203.1 a
DMS	11805.6

Averages in the column followed by the same letter do not statistically differ between themselves by the Tukey test at the level of 5% and 1% of probability.

This difference between fluazinam with methiram + pyraclotrobin, verified in the Table 9, demonstrates the strobilurin effect, proving the physiological effect that this promotes on the plant metabolism, resulting thus, in an increasing productivity, making clear that the plant reacts more to the active ingredient that properly to the dosage used, as affirms TROJAN (2009) for treatments with different dosages of strobilurin in the wheat crop.

Table 8. Result of the variance analysis for the productivity in (kg ha^{-1}), of the potato plants tubers submitted to different fungicide managements.

Factor	Average Square – productivity, number and medium weight of the tubers				
	G.L.	Productivity kg ha^{-1}	Tuber plant^{-1}	Tuber stem^{-1}	Average weight of the tuber^{-1} (g)
Treatment	4	116981738.2*	7.151^{ns}	1.358^{ns}	35.613^{ns}
Error	15	29193033.8	2.522	0.568	120.738
Overall average		38509.3	9.300	3.100	83.658

**Significant at the level of 5% probability (0.01< p<0.05) ns-non significant (p ≥ 0.05).*

Still on Table 9 it is observed that the DMS for the statistical significance of differences is of 11.805 kg ha^{-1}, an elevated value considering that the productivities vary between approximately 29.300 and 42.600 kg ha^{-1}. For this situation, possibly the use of experimental unities of a greater area, with increase of the number of assessed plants for the composition of production of averages, or the increase of the number of repetitions may be factors to be considered at the moment of the planning of new experiments with the potato crop, where the statistical differences could be evidenced in a more punctual form.

This results, when associated to the number of stems per plant, number of leaves and IAF (Tables 4 and 6), demonstrated that the plants of the treatments which presented greater vegetative development had also more expressive production results. As for the number of tubers, BURTON (1981) states that is possible that a plant with a less developed aerial part produces less tubers, due, in great part to the reduction of the luminous intensity use, which affects the distribution of the dry matter in the plant, as the cultivation conditions, the photoperiod, the temperature and rainfall.

The classification of potato tubers, according to the methodology of the MAPA (1995) aims, through the separation of the product in plots with more homogeneous size characteristics, unite the market language of the different instances of the production chain. The results referring to this tubers classification, considering the greater diameter, fits completely in the classes II (29%) and III (71%), not having been verified tubers greater than 85mm and smaller than 33mm, represented by the classes I and IV, respectively. Among the classes the greater percentage was verified in the class III. In these assessments were not verified significant differences for the effect of the different treatments (Table 10).

For the production objecting tubers for consumption, the smaller percentage of tubers present in the class II, would not be considered as a highly positive result, because as describe FELTRAN and LEMOS (2005), in the class II the production is paid in full with the market value, being that in the class III the value is proportional and in general 50% smaller in relation to the class II.

On the other hand, the absence of tubers in the class IV is a positive result, because this class practically does not represent commercial value quotation. However, the attributed values to the product within the classifications are widely variable in the Brazilian market, with quick economical responses to the factor offer x search, as state NASSAR and BOTELHO (1999). Now the absence of tubers in the class I, considering MELO et al. (2003), possibly is more associated to the characteristics of the Ágata cultivar than necessarily to the management conditions.

This result with greater percentage of tubers in the class III differs of the results presented by GARCIA (2003) and FERNANDES (2010), who obtained smaller percentages for the class II. However, it must be considered the later planting season and the consequent milder weather conditions in the tubers growth, besides the reduction of the photoperiod, which are factors that must have influenced, reducing the growth rate of the tubers.

The results of this study show the importance of planting in the adequate seasons, agreeing with De PAULA (2005), who studied the modeling of the potato development at the field and obtained greater yield results for cv. Asterix when the planting was done at the end of the winter, beginning of the spring, which corresponds to the "Planting season", and smaller yields for the planting "Off-season", from February to March.

The lack of significant differences between the treatments indicates that, for the cultivation in conditions in which the experiment was developed, the application of the treatments did not present characteristics which show additive effect of the strobilurin on the tubers size, considering the classification in relation to the greater diameter.

Considering all the results, and especially the assessments inherent to the management with the treatment five, with use of 5 kg ha^{-1} of methiram + pyraclotrobin (p. c.) in the furrow and also in the ridging, it makes clear the these fungicide doses are excessive, because do not result in vegetative growth and productivity increase, when compared to the results observed for the effect of the treatments 2, 3 and 4, where was used only half of the total quantity of this fungicide.

Table 10. Result of the variance analysis for the classification in percentage of potato plants tubers, according to the Ordinance nº 69, of 02/21/1995 – MAPA.

Factor	Average Square - CLASSES				
	G.L.	I (>85 mm)	II (45-85 mm)	III (33-45 mm)	IV (<33 mm)
Treatment	4	-	79.408^{ns}	79.705^{ns}	-
Error	15	-	87.778	87.891	-
Overall average (OA)		-	**29.014**	**70.985**	-

ns-non significant ($p \geq 0.05$).

Conclusion

Considering the conditions of conduction of this experiment with the potato cultivar Ágata, it is concluded that during the period of vegetative development, the parameters number of leaves and foliage area index are benefited by the application of methiram (2.75 kg i.a. ha^{-1}) + pyraclotrobin (0.25 kg i.a. ha^{-1}) applied in the ridging or divided in the furrow and in the ridging.

The productivity of the crop is benefited by the application of methiram (2.75 kg i.a. ha^{-1}) + pyraclotrobin (0.25 kg i.a. ha^{-1}) applied in the ridging or divided in the furrow and in the ridging.

In the form of methiram (2.75 kg i.a. ha^{-1}) + pyraclotrobin (0.25 kg i.a. ha^{-1}) the application of strobilurin do not affects the potato tubers classification considering the greater diameter, being that for the planting in the end of the month of January in the region of Guarapuava this classification is approximately 70% class III and 30% class II.

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