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Prohexadione-calcium isolated or in association with herbicides and other products in the handling of cotton pre-harvest[1]

Prohexadione-calcium isolado ou em associação com herbicidas e outros produtos no manejo em pré-colheita do algodão

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Abstract - To maintain the quality of the cotton fiber, as well as to provide great yields on the harvest, some aspects must be taken into account such as the uniformity of the bolls and the defoliation; therefore, the use of herbicides and maturators become indispensable. Thus, the objective of this paper was to evaluate the efficiency of the prohexadione-calcium regarding its isolate application and in association with other products in the uniformity and opening of the cotton bolls, as well as the defoliation effect and regrowth of the crop. For such, a field experiment was carried out in the municipality of Diamantino - MT. The outline adopted was of randomized blocks with four repetitions and thirteen treatments, those being composed of control without application; prohexadione-calcium + ethephon + cyclanilide; prohexadione-calcium + flumiclorac-pentyl; prohexadione-calcium + diuron + thidiazuron; prohexadione-calcium + pyraflufen-ethyl; prohexadione-calcium; prohexadione-calcium + iharol. The treatments were applied when approximately 85% of the bolls of the crop 975 WS were open. The variables: apple opening, regrowth and defoliation were analyzed at 0, 3, 6, 10 and 15 days after the application (DAA) and, finally, the productivity of seed cotton was determined. Regardless of the dose, the plants that received prohexadione-calcium associated with ethephon + cyclanilide, diuron + thidiazuron and pyraflufen-ethyl presented a greater number of open bolls and greater defoliation. We can conclude that the different chemical treatments did not provide statistical differences regarding the regrowth of cotton before the harvest, at 15 DAA, and that the use of prohexadione-calcium, isolated or in association with other products, regardless of the dose, did not influence in the productivity of the seed cotton.
Keywords: defoliation; *Gossypium hirsutum* L.; maturing; uniformity of the bolls

Resumo - Para manter a qualidade da fibra do algodão, bem como proporcionar ótimos rendimentos na colheita, alguns aspectos devem ser levados em consideração como, por exemplo, a uniformidade dos capulhos e a desfolha, desta forma, a utilização de herbicidas e maturadores tornam-se imprescindíveis. Assim, o objetivo deste trabalho foi avaliar a eficiência do prohexadione-calcium quando aplicado isoladamente e em associação com outros produtos, na

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uniformização e abertura dos capulhos do algodão, assim como o efeito na desfolha e rebrota da cultura. Para tanto, conduziu-se um experimento de campo no município de Diamantino-MT. Adotou-se o delineamento de blocos casualizados, com quatro repetições e treze tratamentos, sendo estes compostos por: testemunha sem aplicação; prohexadione-calcium + ethefon + cyclanilide; prohexadione-calcium + flumiclorac-pentyl; prohexadione-calcium + diuron + thidiazuron; prohexadione-calcium + pyraflufen-ethyl; prohexadione-calcium; prohexadione-calcium + iharol. Os tratamentos foram aplicados quando aproximadamente 85% das maçãs da cultivar 975 WS estavam abertas. As variáveis: abertura das maçãs, rebrota e desfolha foram analisadas aos 0, 3, 6, 10 e 15 dias após a aplicação (DAA), e por fim, determinou-se a produtividade do algodão em caroço. Independente da dose, as plantas que receberam prohexadione-calcium associado à ethefon + cyclanilide, diuron + thidiazuron e pyraflufen-ethyl apresentaram maior número de maçãs abertas e maior desfolha. Conclui-se que os diferentes tratamentos químicos não proporcionaram diferenças estatísticas com relação a rebrota do algodão antes da colheita, aos 15 DAA, e que a utilização de prohexadione-calcium, isolado ou em associação com outros produtos, independente da dose, não influenciou na produtividade do algodão em caroço.

Palavras-chaves: desfolha; *Gossypium hirsutum* L.; maturador; uniformidade dos capulhos

Introduction

Cotton crop is one of the most important agricultural activities in the Brazilian agribusiness (Ferreira Filho et al., 2009). The state of Mato Grosso is the greatest domestic producer, with an increment of 57.5% in planted area (IBGE, 2015). The crop has great potential and versatility in generating raw material for the manufacturing of a number of consumption products, besides producing the most important textile fiber at a worldwide level (Silva et al., 2009).

Cotton presents undetermined growth characteristics, where the plant continues to grow even after its production. Because of that, the plant continues to produce growth hormones and floral buds, not contributing to the economic production of the agriculture (Henrique & Laca-Buendia, 2010). With that, the plant produces a great amount of leaves and it reaches undesired heights for the mechanized harvest, and it can harm the quality of the cotton fiber and damage the harvesters (Çopur et al., 2010).

Because of those factors, some handling techniques must be carried out in order to provide the efficacy of the harvesters and preserve the quality of the fiber produced, such as the application of growth regulators, maturators and/or defoliators and isolated herbicides or in association, which powers up the planning and improves the development of a manual or mechanical harvest, reducing the humidity of the fibers and the seeds in the field, also providing a cleaner material and reducing the costs for beneficiation (Ferreira & Lamas, 2006).

The use of a growth regulator is indispensable in the efficiency of the mechanized harvest, once it controls the height of the plant and acts by inhibiting the synthesis of gibberellin (Oliveira et al., 2012). The defoliants induce the premature fall of leaves from the cotton plant, avoiding regrowth. That way, some herbicides are used for that end because they cause death by contact, causing the abscission of leaves. The maturator, in turn, has a single target, the fruit, accelerating its maturation and providing uniformity in the opening of bolls (Ferreira & Lamas, 2006).

Prohexadione-calcium is a growth regulator of the cyclohexanedione chemical group. It has been used as an alternative in the handling of cotton pre-harvest, because it acts by inhibiting the action of the biosynthesis of gibberellin, ethylene and flavonoids (Kim et al., 2010). Therefore, the product reduces the vegetative growth of the aerial part and length of the buds, giving more balance in the vigor of the plants, in addition to a greater uniformity in the opening of the bolls (Bekheta et al., 2009).

In the literature, there is a lack of information on the effect of prohexadione-calcium in the uniformity of the opening of cotton bolls, as well as its effect in crop defoliation. Thus, the objective of this paper was to evaluate the efficiency of the prohexadione-calcium regarding its isolate application and in association with other products, such as herbicides, defoliants and growth regulators for the uniformity and opening of cotton bolls, as well as their effect on defoliation and regrowth of the crop.

Material and Methods

The experiment was carried out during the months of June and July 2013, at Guapirama Farm, located at BR 364, Km 288, in the municipality of Diamantino - MT, latitude 13º 54' 24,6" S and longitude 57º 17' 47,6" W, at 560 m altitude. The physical-chemical characteristics of the Sandy Clay Rhodic Hapludox are presented on Table 1.

The experimental outline adopted was of randomized blocks with four repetitions. The treatments corresponded to the application of prohexadione-calcium in different doses, both isolated and in association with ethephon + cyclanilide, flumiclorac-pentyl, diuron + thidiazuron, pyraflufen-ethyl and iharol (Table 2).

The parcels were composed of 5 m length and 3.04 m width, totalizing 15.20 m², being composed of 4 rows with spaces of 0.76 m among each other. The two central rows of each parcel, except 0.5 m of each end, was the useful area considered for the evaluations.

Table 1. Physical-chemical characteristics of the soil present in the area in which the experiment was carried out. Diamantino (MT), 2013.

pH		Al^{3+}	$H^+ + Al^{3+}$	$Ca^{+2} + Mg^{2+}$	Ca^{2+}	K^+
($CaCl_2$)	(H_2O)		($cmol_c\ dm^{-3}$)			
5.20	6.00	0.10	3.50	4.20	3.30	0.17
P	M.O.	CTC	V	sand	silt	clay
($mg\ dm^{-3}$)	($g\ dm^{-3}$)	($cmol_c\ dm^{-3}$)	(%)		($g\ kg^{-1}$)	
11.50	32.00	7.90	55.50	459.00	83.00	458.00

Source: Laboratório Agro Análise, Cuiabá, MT.

Table 2. Treatments and their respective doses, applied in pre-harvest of cotton crops. Diamantino (MT), 2013.

Treatments	Acronyms	Doses i.a. ($g\ ha^{-1}$)
1	TEST	-
2	PR+E+C	55.0 + (720.0 + 90.0)
3	PR+E+C	82.5 + (720.0 + 90.0)
4	PR+F	55.0 + 60.0
5	PR+F	82.5 + 60.0
6	PR+D+T	55.0 + (24.0 + 48.0)
7	PR+D+T	82.5 + (24.0 + 48.0)
8	PR+P	55.0 + 4.0
9	PR+P	82.5 + 4.0
10	PR	55.0
11	PR	82.5
12	PR+I	55.0
13	PR+I	82.5

TEST = control, PR = Prohexadione-calcium, E = ethephon, C = cyclanilide, F = flumiclorac-pentyl, D = diuron, T = thidiazuron, P = pyraflufen-ethyl, I = iharol (0.5% v v^{-1}).

The cotton sowing was carried out in a tillage system on January 20, 2013. For that, crop 975 WS was used, with a population of 8 plants by linear meter, 3 cm in depth, totalizing 105 thousand plants ha^{-1}.

The application of treatments was carried out 160 days after sowing, when approximately 85% of the bolls were open. To do that, a backpack sprayer pressurized by CO_2 was used, equipped with four tips like a XR 110.02 fan, kept at a constant working pressure of 2,5 kgf cm^{-2}, which gave the water volume of 200 L ha^{-1}. A distance of 0.50 was kept between the target and the application bar. During application, the soil was dry, the minimum temperature was 19.5°C and the maximum 1.8°C, relative humidity was 50.1%, wind speed was 5.5 km h^{-1}, the sky was with a few clouds and with no dew. The meteorological data during the period of the test was collected in the meteorological station located close to the experimental area (Figure 1).

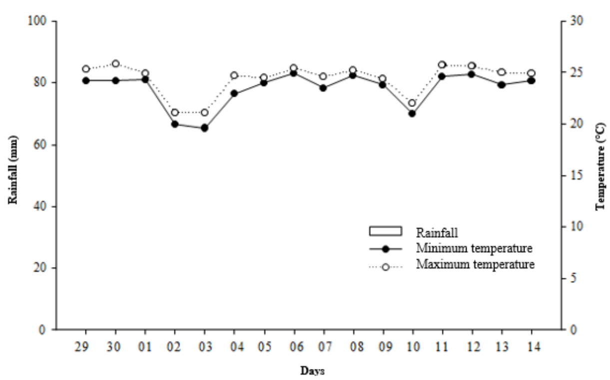

Figure 1. Rainfall (mm), daily minimum and maximum temperatures (ºC) of the air during the period of the experiment (06/29/2013 to 07/14/2013). Diamantino (MT), 2013.

The opening, regrowth and defoliation of the bolls were evaluated at 0 (approximately 3 h after application), 3, 6, 10 and 15 days after application (DAA) of the treatments. In the evaluation of the apple opening, it was counted the number of open and closed bolls in 10 random plants in the useful area of each parcel, getting the percentage of open bolls compared to the total number of bolls. To evaluate regrowth, we counted the regrown branches in 10 random plants of each parcel, obtaining their means. The defoliation was determined by visual evaluation of the percentages of defoliation, attributing scores from 0 to 100%, where zero means the absence of defoliation regarding the control without application and 100 corresponds to totally defoliated plants.

The cotton productivity was evaluated by manual harvest of the parcel, removing the fibers. After that, the materials were weighted and the final productivity was determined by extrapolating the data for kg ha^{-1}.

The data obtained was submitted to the variance analysis by the F test and the means were compared by the Scott-Knott test ($p<0.05$).

Results and Discussion

At 0 DAA, the percentage of open bolls was not influenced by the different chemical treatments, proving the uniformity of this characteristic in the moment of the application (Table 3).

At 3 DAA, the use of PR + E + C (55.0 + (720.0 + 90.0 g ha^{-1})) and (82.5 + (720.0 + 90.0 g ha^{-1})); PR + P (82.5 + (60.0 g ha^{-1})); PR (55.0 g ha^{-1}) e (82.5 g ha^{-1}), e PR + I (55.0 g ha^{-1} + 0.5 % v v^{-1}) and (82.5 g ha^{-1} + 0.5 % v v^{-1}) caused an increase in the opening of bolls (>77%).

At 6 DAA, the percentage of open bolls was higher, with values between 81.82 and 92.45% (Table 3). In this evaluation period, the results kept similar to the evaluation at 3 DAA, proving the superiority of the treatments composed by PR + E + C, which provided an apple opening percentage of more than 87%.

PR associated with E + C enabled the use of a lower dose of PR (differences between isolated PR and in association with other products) regarding the percentage of apple opening in a short term (up to 6 DAA), because at 10 DAA, the treatments were not different from each other (Table 3). That fact can be justified by the efficiency in the associated applications of E + C, which provides results related to the percentage of open bolls more efficiently than when compared to the isolated application of ethylene (Stewart et al., 2000).

Mondino & Peterlino (2004) also found results similar to the ones obtained in this paper, where by assessing the percentage of bolls opening in Guazuncho cotton crops 2 at 7, 14 and 21 DAA, they observed higher percentages upon the treatment composed by E + C, with an increase compared to the control without application of 26; 37 and 36%, respectively.

Table 3. Percentage of open bolls after the application of prohexadione-calcium isolated or in association with other pre-harvest products in the cotton crops. Diamantino (MT), 2013.

Treatments	Open bolls (%)									
	0 DAA		3 DAA		6 DAA		10 DAA		15 DAA	
1. TEST	72.25	a	72.29	b	81.82	b	87.46	a	99.07	a
2. PR+E+C	72.79	a	79.71	a	92.45	a	95.32	a	98.04	a
3. PR+E+C	75.18	a	77.28	a	91.22	a	96.44	a	97.65	a
4. PR+F	66.53	a	75.19	b	87.46	a	92.29	a	94.80	a
5. PR+F	75.18	a	73.03	b	85.39	b	91.28	a	95.89	a
6. PR+D+T	71.89	a	71.96	b	83.90	b	93.06	a	97.02	a
7. PR+D+T	75.47	a	71.04	b	85.23	b	92.10	a	96.53	a
8. PR+P	72.86	a	71.92	b	84.83	b	90.56	a	98.13	a
9. PR+P	73.69	a	77.86	a	83.68	b	91.32	a	97.50	a
10. PR	77.12	a	79.52	a	85.50	b	93.33	a	96.09	a
11. PR	74.04	a	80.61	a	90.27	a	92.03	a	96.97	a
12. PR+I	74.57	a	80.82	a	87.78	a	93.41	a	98.22	a
13. PR+I	74.18	a	79.51	a	83.67	b	91.96	a	95.53	a
CV (%)	7.87		6.28		4.76		3.69		1.85	

T1 = TEST, T2 = PR (55.0 g ha^{-1}) + E + C (720.0 + 90.0 g ha^{-1}), T3 = PR (82.5 g ha^{-1}) + E + C (720.0 + 90.0 g ha^{-1}), T4 = PR (55.0 g ha^{-1}) + F (60.0 g ha^{-1}), T5 = PR (82.5 g ha^{-1}) + F (60 g ha^{-1}), T6 = PR (55 g ha^{-1}) + D + T (24.0 + 48.0 g ha^{-1}), T7 = PR (82.5 g ha^{-1}) + D + T (24.0 + 48.0 g ha^{-1}), T8 = PR (55.0 g ha^{-1}) + P (4.0 g ha^{-1}), T9 = PR (82.5 g ha^{-1}) + P (4.0 g ha^{-1}), T10 = PR (55.0 g ha^{-1}), T11 = PR (82.5 g ha^{-1}), T12 = PR (55.0 g ha^{-1}) + I (0.5% v v^{-1}) e T13 = PR (82.5 g ha^{-1}) + I (0.5% v v^{-1}). Means followed by the same letter in the column do not differ by the Scott-Knott test ($p<0.05$).

In the evaluations performed at 10 and 15 DAA, there was no difference between the treatments, which provided, on average, values of 87.46 and 99.07%, respectively, for each evaluation (Table 3), proving the uniformity of the crop. This may have occurred because at this point the cotton plants were in a final stage of maturation.

Regarding defoliation, in the evaluation carried out at 0 DAA (Table 4), only the association of PR + E + C in the doses of 55.0 + 720.0 + 90.0 g ha^{-1} and 82.5 + 720.0 + 90.0 g ha^{-1} were different from the other treatments with superior values of defoliation, being 28.75 and 31.25%, respectively. These results remained in the evaluation at 3 DAA (Table 4), where the treatments composed by the PR association with E + C, regardless of the dose used, provided the best results regarding this characteristic, with 51.50 and 48.0% defoliation.

At 6 DAA PR + E + C in doses of 55.0 + 720.0 + 90.0 g ha^{-1} and 82.5 + 720.0 + 90.0 g ha^{-1} provided higher defoliation percentage, being 83.0 and 79.5%, respectively. However, PR associated with D + T, corresponding to a dose of 55.0 + 24.0 + 48.0 g ha^{-1} and 82.5 + 24.0 + 48.0 g ha^{-1}, PR + P (55.0 + 4.0 g ha^{-1}) and (82.5 + 4.0 g ha^{-1}) provided a defoliation intermediate effect, with values between 51.75 and 54.75%, differentiating from the isolated PR (55.0 g ha^{-1}) and (82.5 g ha^{-1}) that did not differentiate from the control without application (20.25%), showing that the isolated PR applied provided a non-satisfactory effect, and that can be justified by the interaction of synergy (Table 4). Thus, it is recommended the association with other pre-harvest products in cotton crops in these conditions of the experiment.

In the evaluation carried out at 10 DAA, upon association of PR + E + C in doses of 55.0 + 720.0 + 90.0 g ha^{-1} and 82.5 + 720.0 + 90.0 g ha^{-1}; PR + D + T (55.0 + (24.0 + 48.0 g ha^{-1})) and (82,5,0 + (24.0 + 48.0 g ha^{-1})); PR + P (55.0 + 4.0 g ha^{-1}) and (82.5 + 4.0 g ha^{-1}), the defoliation levels obtained were $\geq$ 79%, superior to the other treatments. It is also seen that the PR + F in doses of 55.0 + 60.0 g ha^{-1} and 82.5 + 60.0 g ha^{-1} provide intermediate results in this evaluation period with 53.75 and 55.0% of defoliation, respectively. Inferior values were provided with isolated application of PR (55.0 g ha^{-1}) and (82.5 g ha^{-1}), and applications of PR + I (55.0 g ha^{-1}) + (0.5 % v v^{-1}) and (82.5 g ha^{-1}) + (0.5 % v v^{-1}), were not different from the control without application.

The results of the evaluation at 15 DAA have kept similar to the evaluation carried out at 10 DAA, where the association of PR + E + C; PR + D + T and PR + P provided defoliation above 88%. Studying the effect of isolated applications of E (0.067 kg ha^{-1}) or in combination with C (0.067 kg ha^{-1}) in different temperatures, a higher percentage of defoliation was verified through the combination of E + C, where in 5 days after the treatment the defoliation reached 75 to 85% in the crops of beans, while the isolated application of E provided 26% of defoliation in 5 days after treatment (Pedersen et al., 2006).

Table 4. Percentage of defoliation after the application of prohexadione-calcium isolated or in association with other pre-harvest products in the cotton crops. Diamantino (MT), 2013.

Treatments	Defoliation (%)									
	0 DAA		3 DAA		6 DAA		10 DAA		15 DAA	
1. TEST	8.75	b	15.00	b	20.25	d	34.50	c	42.25	c
2. PR+E+C	28.75	a	51.50	a	83.00	a	91.75	a	95.00	a
3. PR+E+C	31.25	a	48.00	a	79.50	a	91.25	a	95.00	a
4. PR+F	9.25	b	18.75	b	33.50	c	53.75	b	68.50	b
5. PR+F	9.25	b	16.25	b	31.50	c	55.00	b	69.00	b
6. PR+D+T	7.25	b	13.25	b	52.50	b	89.00	a	94.75	a
7. PR+D+T	8.25	b	14.25	b	52.75	b	89.25	a	94.75	a
8. PR+P	12.50	b	21.75	b	51.75	b	79.50	a	88.25	a
9. PR+P	13.25	b	24.25	b	54.75	b	82.50	a	90.25	a
10. PR	8.50	b	15.50	b	22.75	d	35.25	c	42.50	c
11. PR	7.50	b	14.00	b	26.00	d	36.25	c	44.25	c
12. PR+I	9.50	b	17.25	b	31.75	c	38.00	c	49.00	c
13. PR+I	11.25	b	17.75	b	30.75	c	39.00	c	52.00	c
CV (%)	40.09		41.97		16.13		15.84		13.29	

T1 = TEST, T2 = PR (55.0 g ha^{-1}) + E + C (720.0 + 90.0 g ha^{-1}), T3 = PR (82.5 g ha^{-1}) + E + C (720.0 + 90.0 g ha^{-1}), T4 = PR (55.0 g ha^{-1}) + F (60.0 g ha^{-1}), T5 = PR (82.5 g ha^{-1}) + F (60 g ha^{-1}), T6 = PR (55 g ha^{-1}) + D + T (24.0 + 48.0 g ha^{-1}), T7 = PR (82.5 g ha^{-1}) + D + T (24.0 + 48.0 g ha^{-1}), T8 = PR (55.0 g ha^{-1}) + P (4.0 g ha^{-1}), T9 = PR (82.5 g ha^{-1}) + P (4.0 g ha^{-1}), T10 = PR (55.0 g ha^{-1}), T11 = PR (82.5 g ha^{-1}), T12 = PR (55.0 g ha^{-1}) + I (0.5% v v^{-1}) and T13 = PR (82.5 g ha^{-1}) + I (0.5% v v^{-1}). Means followed by the same letter in the column do not differ by the Scott-Knott test ($p<0.05$).

There was evolution in the defoliation as the evaluations went by, in which at 15 DAA, higher values were obtained (Table 4). Similar results were described by Santos et al. (2014), that observed the evolution in defoliation, reaching 100% at 15 DAA, with the application of (D + T) + (E + C), corresponding to the dose (18 + 36 g ha^{-1}) + (720 + 90 g ha^{-1}). This means that, the closer to the maturation final phase, the higher the plant defoliation percentage.

Regarding regrowth, regrown branches were not seen in the evaluations carried out at 0, 3 and 6 DAA (Table 5). In the evaluation carried out at 10 DAA, PR + F in doses of 55.0 + 60.0 g ha^{-1} and 82.5 + 60.0 g ha^{-1}; PR + D + T (55.0 + (24.0 + 48.0 g ha^{-1})) and (82,5,0 + (24.0 + 48.0 g ha^{-1})); PR + P in dose (82.5 + 4.0 g ha^{-1}); PR

(55.0 g ha^{-1}) and (82.5 g ha^{-1}) and PR + I ((82.5 g ha^{-1}) + 0.5 % v v^{-1}) provided the lowest number of regrown branches.

Table 5. Regrowth average after the application of prohexadione-calcium isolated or in association with other pre-harvest products in the cotton crops. Diamantino (MT), 2013.

Treatments	Regrowth				
	0, 3, and 6 DAA	10 DAA		15 DAA	
1. TEST	-	2.00	b	3.75	a
2. PR+E+C	-	2.52	b	5.70	a
3. PR+E+C	-	3.32	b	4.40	a
4. PR+F	-	1.32	a	5.65	a
5. PR+F	-	1.60	a	4.12	a
6. PR+D+T	-	1.02	a	4.40	a
7. PR+D+T	-	0.80	a	3.15	a
8. PR+P	-	2.42	b	5.32	a
9. PR+P	-	1.25	a	3.25	a
10. PR	-	1.75	a	2.45	a
11. PR	-	1.70	a	1.77	a
12. PR+I	-	2.30	b	3.75	a
13. PR+I	-	1.57	a	3.37	a
CV (%)	-	49.29		61.52	

T1 = TEST, T2 = PR (55.0 g ha^{-1}) + E + C (720.0 + 90.0 g ha^{-1}), T3 = PR (82.5 g ha^{-1}) + E + C (720.0 + 90.0 g ha^{-1}), T4 = PR (55.0 g ha^{-1}) + F (60.0 g ha^{-1}), T5 = PR (82.5 g ha^{-1}) + F (60 g ha^{-1}), T6 = PR (55 g ha^{-1}) + D + T (24.0 + 48.0 g ha^{-1}), T7 = PR (82.5 g ha^{-1}) + D + T (24.0 + 48.0 g ha^{-1}), T8 = PR (55.0 g ha^{-1}) + P (4.0 g ha^{-1}), T9 = PR (82.5 g ha^{-1}) + P (4.0 g ha^{-1}), T10 = PR (55.0 g ha^{-1}), T11 = PR (82.5 g ha^{-1}), T12 = PR (55.0 g ha^{-1}) + I (0.5% v v^{-1}) and T13 = PR (82.5 g ha^{-1}) + I (0.5% v v^{-1}). Means followed by the same letter in the column do not differ by the Scott-Knott test ($p<0.05$).

Hawerroth et al. (2012a) affirmed that the use of PR was efficient in the control of vegetative growth of pear trees from the ‘Hosui’ variety, and the highest doses (550 e 825 g ha^{-1}) provided a better vegetative control, generating an increase in the reproductive capacity of those fruits. That happened due to the form of action of this product, which acts in the inhibition of the hormone that stimulates the plant growth (Kofidis et al., 2008). That is, the results from Hawerroth et al. (2012a) and the ones found in this paper prove that PR may control the vegetative development of plants, and it has potential to be used for such end.

Hawerroth et al. (2012b) saw a reduction in the development of vegetative branches in the ‘Imperial gala’ apple tree, through the application of 330 g ha^{-1} of PR carried out at 20 and 28 days after flowering. At 15 DAA, there was no difference between the numbers of regrown branches in all treatments (Table 5).

Although there are statistical differences observed between the treatments for the variables open apple, defoliation and regrowth (Tables 3, 4 and 5), there was no significant difference regarding productivity of the cotton tree in seed (Table 6).

Table 6. Productivity (kg ha^{-1}) after the application of prohexadione-calcium isolated or in association with other pre-harvest products in the cotton crops. Diamantino (MT), 2013.

Treatment	Productivity (kg ha^{-1})	
1. TEST	3,733.55	a
2. PR+E+C	4,051.53	a
3. PR+E+C	3,536.18	a
4. PR+F	4,539.47	a
5. PR+F	4,451.75	a
6. PR+D+T	4,764.25	a
7. PR+D+T	3,947.37	a
8. PR+P	4,665.57	a
9. PR+P	4,292.76	a
10. PR	4,161.18	a
11. PR	4,166.66	a
12. PR+I	4,194.07	a
13. PR+I	3,859.65	a
CV (%)	14.57	

T1 = TEST, T2 = PR (55.0 g ha^{-1}) + E + C (720.0 + 90.0 g ha^{-1}), T3 = PR (82.5 g ha^{-1}) + E + C (720.0 + 90.0 g ha^{-1}), T4 = PR (55.0 g ha^{-1}) + F (60.0 g ha^{-1}), T5 = PR (82.5 g ha^{-1}) + F (60 g ha^{-1}), T6 = PR (55 g ha^{-1}) + D + T (24.0 + 48.0 g ha^{-1}), T7 = PR (82.5 g ha^{-1}) + D + T (24.0 + 48.0 g ha^{-1}), T8 = PR (55.0 g ha^{-1}) + P (4.0 g ha^{-1}), T9 = PR (82.5 g ha^{-1}) + P (4.0 g ha^{-1}), T10 = PR (55.0 g ha^{-1}), T11 = PR (82.5 g ha^{-1}), T12 = PR (55.0 g ha^{-1}) + I (0.5% v v^{-1}) and T13 = PR (82.5 g ha^{-1}) + I (0.5% v v^{-1}). Means followed by the same letter in the column do not differ by the Scott-Knott test ($p<0.05$).

That shows that the association of PR with the other products did not influence directly the cotton productivity. This may have happened because the harvest was manual, so all the bolls were selected and collected. However, the application of these products improved the technological characteristics of cotton in order to make easier and increase the development of mechanized harvesters. These results are in accordance with the ones obtained by Santos et al. (2014), who when evaluating the efficiency of saflufenacil (SA), SA + (E + C), SA, SA + (E+ C), (D + T) + (E + C), (D + T), in the dose of 49 g ha^{-1}; 49 + (720 + 90) g ha^{-1}; 70 g ha^{-1}; 70 + (720 + 90) g ha^{-1}; (18 + 36) + (720 + 90) g ha^{-1} and (30 + 60) g ha^{-1}, respectively, did not find differences regarding productivity of seed cottons either, with values between 4,079.32 and 4,743.67 kg ha^{-1}; however, there were differences in the other variables analyzed.

Conclusions

Considering the above, it is possible to conclude that the association of PR with E + C in the doses of 55.0 + (720.0 + 90.0) g ha^{-1} and 82.5 + (720.0 + 90.0) g ha^{-1} provided the best results in all variables analyzed, recommending the uniformity and opening of cotton bolls, just like in defoliation, except when the crop is regrown. PR, isolated or in association with the other products used, did not influence in the productivity of seed cotton.

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