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The Time of Application of Maturing Herbicides Affects the Physiological Quality of Canola Seeds

Thalita Pedrozo Pilla[1], Leandro Galon[1], Daiani Brandler[1], Rodrigo Tonin[1], César Tiago Forte[2], Felipe Bianchessi[1]

[1]Universidade Federal da Fronteira Sul, Erechim, Rio Grande do Sul, Brasil. Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul, Brasil.Corresponding author: cesartiagoforte@hotmail.com

***Abstract*— *Canola (Brassica napus L. var. oleifera) is a winter growing option for producers, however, harvesting is the phase that requires the most care and decision making to avoid losses in productivity. One of the alternatives that can be used to solve this problem is the application of maturing herbicides. Thus, the objective of this study was to evaluate the physiological quality of canola seeds with the use of herbicides, applied in two seasons, for pre-harvest maturation of the crop. The experimental design was a randomized block design, arranged in a factorial scheme 7x2 + 2 (herbicide x season + control) with four replications. Hybrid 50 canola plants received ammonium glufosinate, paraquat, glyphosate, diquat, saflufenacil, 2,4 - D and paraquat + diuron at two times in the crop cycle (G3 - when the first ten the main stem silica has a width greater than 4 cm, and G4 - when the first ten silicas of the main stem begin to mature), in addition to two unselected controls, for each season, the first being harvested on the day of application of the products, and the second kept in the field until the final cycle of the culture. First germination, germination, seedling length, dry mass, cold test and accelerated aging tests were performed. Herbicides applied in the first season (G3) cause the greatest damage to the seeds, and the plants that remained in the field until the end of the crop cycle and did not receive herbicide application (additional control), result in seeds with better physiological quality. The treatments with diquat, paraquat + diuron and glufosinate of ammonium presented higher efficiency with respect to seed quality, being the best period to carry out the maturation practice in the canola crop in the G4 season.*

Keywords*— *Anticipation of the harvest, Brassica napus L., Maturation of seeds.

I. INTRODUCTION

The canola (*Brassica napus* L. var. Oleifera) is an alternative winter cultivation for the producers due to the lower risk of losses with frost occurrence compared to the wheat crop, which suffers many diseases in the cold season. In addition to the interest of the industry, where bran and oil present excellent quality for human and animal food, canola also stands out for the production of biodiesel (Silva et al. 2011).

There are many factors that have caused losses in canola productivity, among which the harvest is one of the phases that requires the most care and correct decision making to avoid a fall in grain yield that can reach more than 30% of the final result (Silva et al. 2008).

According to Tomm et al. (2009), the harvesting of canola before the ideal maturation point interrupts the filling and formation of grains, limits productivity potential, as well as increasing the chlorophyll content in the oil, which causes higher costs in the processes of clarification and increase in the percentage of discounts in marketing. On the other hand, if the crop is delayed along with periods of heavy rains and high winds, the silica can open and cause soil loss, fungal attacks, insects and plant tipping (Marcandalli et al. 2011).

One of the alternatives that can be used to solve this problem is the application of herbicides for the purpose of maturation of the canola or even to standardize the harvest, being the application realized when the majority of the seeds are mature (Daltro et al. 2010). Thus, mechanized harvesting is facilitated, resulting in lower impurities, better quality seeds, reduced losses in final production, and lower cost in the post-harvest drying process (Silva Neto, 2011).

It is possible to find in the literature several studies that present positive results in relation to the efficiency of products used in crop maturation, which reduce the moisture content and preserve seed quality in beans (Kamikoga et al. 2009; Coelho et al. 2003), which can be used to evaluate the effect on the production of soybeans (Silva et al. 2009).

However, some fundamental aspects should be considered in relation to the use of maturation herbicides in the pre-harvest of canola, such as the choice of the product, the environmental conditions in which they will be exposed, the phenological stage of the crop, and the influence on the production, germination and seed vigor (Marcos Filho, 2005, Franco et al. 2013). Some authors have verified a loss of herbicide use in soybean seeds (Botelho et al. 2016), wheat (Bellé et al. 2014) and beans (Pinto et al. 2014).

One of the most important factors in relation to the use of maturing herbicides in canola cultivation is the choice of the appropriate season for the application of these products (Franco et al. 2013). According to Silva et al. (2016), the appropriate time of application is of fundamental importance in relation to the efficiency of the product, as well as it prevents losses in productivity. These same authors report that applications carried out far from the physiological maturity of the seeds, or in unfavorable climatic conditions, coinciding with rainy periods, compromise the quality of the seeds, causing their deterioration.

The hypothesis of this study is that the applied herbicides differ in relation to their efficiency under the physiological quality of the canola seeds, and that applications at times closer to the physiological maturity of the crop cycle, stand out as the most appropriate.

In this sense, we objective to evaluate the physiological quality of canola seeds with the use of herbicides, applied in two seasons, for pre-harvest maturation of the crop.

II. MATERIALS AND METHODS

The survey was conducted in two stages, both at the Federal University of Fronteira Sul (UFFS), Campus Erechim/RS. The first phase consisted of the installation of the experiment and application of the herbicides to the field, conducted in the experimental area of the UFFS, and the second one, characterized by the physical and physiological analysis carried out in the Sustainable Management of Agricultural Systems (MASSA) of UFFS, during the years 2017 and 2018.

The area used for sowing of canola was previously managed with the herbicide glyphosate, at the dose of 1080 g.ha-1 of acid equivalent, to eliminate the present vegetation.

Fertilization of the soil was carried out along with the canola sowing, and according to the physico-chemical analysis, following the technical recommendations for the crop (Rolas, 2016), using 350 kg.ha^{-1} of fertilizer with the formulation 05-20-20 (NPK).

Each experimental unit (plot) consisted of an area of 15 m² (5 x 3 m), with sowing performed in the no-tillage system on 06/14/2017, using a seeder/fertilizer with six lines, spacing of 0,5 m between rows, depth of 1 to 2 cm and density of 50 plants m-^{2}.

The experimental design was the randomized blocks arranged in a 7 x 2 + 2 factorial scheme, with four replications. In factor A, the herbicides (ammonium glufosinate, paraquat, glyphosate, diquat, saflufenacil, 2,4-D and paraquat + diuron) were allocated as described in Table 1. In factor B, the two desiccation canola Hyola 50, (G3 - when the first ten main stem cells have a width greater than 4 cm, and G4 - when the first ten main stem cells begin to mature), in addition to two unapplied the first harvested on the day of application of the products, and the second kept in the field until the final cycle of the crop, to be harvested.

Table.1: Herbicide treatments and their respective doses, used for the maturation of canola, hybrid Hyola 50. UFFS, Erechim, 2017.

Active ingredient	**Dose** (g ha^{-1} de i.eore.a)	**Commercial Product**	**Dose** (L/kg ha^{-1})
Ammonium Glufosinate	400	Finale	2,0
Paraquat	400	Gramoxone	2,0
Glyphosate	1440	Roundup Original	3,0
Diquat	400	Reglone	2,0
Saflufenacil	49	Heat	0,07
2,4 – D	806	DMA 806 BR	1,0
Paraquat + diuron	400+200	Grammocil	2,0

The herbicides were applied using a CO_2 pressure pressurized precision sprayer equipped with four DG 110.02 fan-type spray tips, spaced at 0.50 m, under a constant pressure of 2.0 kgf cm^{-2} and displacement of 3.6 km ha^{-1}, with flow of 150 L ha^{-1} of herbicide syrup.

Harvesting of each experimental unit was carried out seven days after herbicide application in each season, and it was performed manually using pruning shears, and only the plants of the two central lines of each plot were harvested when 40 to 60% of the seeds of the main branch began to change from green to brown, that is, reaching a maximum of 18% moisture in the field. After harvesting, the plants were packed in paper bags and then subjected to oven drying with forced air circulation and temperature of 35 °C until reaching 9 to 10% humidity. This same operation was carried out for the controls that were harvested on the same date of application of the maturing herbicides.

The other control treatments were collected when the seeds presented to the field, water content of approximately 18%, that is, when the crop cycle was completed.

After the drying of all the treatments and the manual threshing of the silica to obtain the seeds, the second stage of this study was started in the Laboratory of Sustainable Management of Agricultural Systems of UFFS, Campus Erechim. For the determination of the physical and physiological quality of the seeds, the following analyzes were were carried out:

First germination count: was performed together with the germination analysis. On the fifth day after the test installation, the normal seedlings were computed, the results being expressed as a percentage (Brasil, 2009).

Germination: it was conducted according to the criteria established by RAS (Brazil, 2009). Four replicates of 50 seeds per plot were used, totaling 200 seeds per treatment, which were arranged in rolls of germitest paper, moistened with water, in the proportion of 2.5 times the mass of the dry paper, and later packed in a germinator chamber at 20°C. The evaluation was performed at five and seven days, counting the number of normal seedlings, and the results are expressed as percentage of germination.

Seedling length: was performed in conjunction with the germination test and according to the procedures described by Nakagawa, (1999), adapted from AOSA (1983). Ten random seedlings of each replicate were used for each of the treatments, counted as normal at the end of the germination test. The measurements were performed using a millimeter ruler. For the determination of the seedling length, the entire seedling was measured from the apical meristem to the base of the hypocotyl, the results being expressed in centimeters.

Dry mass: only the normal seedlings of each replicate, from the germination test, were considered. After the cotyledons were removed, the seedlings were packed in paper bags and kept in forced air circulation, regulated at 65 ± 2ºC for 24 hours. After the samples were weighed in analytical balance to determine the weight of the total dry mass per repetition. Then, the weight expressed in g was divided by the number of normal seedlings of each replicate, which resulted in the weight of dry mass per seedling, expressed as mg/seedling (Nakagawa, 1999).

Cold test: 200 seeds were used for each treatment, which were distributed in germitest paper previously moistened in the proportion of 2.5 times the dry paper weight. The rolls were packed in sealed plastic bags and refrigerated at 10°C, where they remained for 72 hours (Abrates, 1999). Afterwards, the rolls were removed from the plastic bags and transferred to the germinator, set at a temperature of 20°C, where they remained for five days, when the evaluation was performed, computing the percentage of normal seedlings (Brasil, 2009).

Accelerated aging: 200 seeds per treatment were used, which were arranged in a single layer on a metallic screen, coupled in plastic boxes (gerbox), containing 40 mL of distilled water at the bottom. The boxes were sealed and maintained at 42°C and 100% relative humidity for 72 hours in a BOD type germination chamber. After this period, the seeds were submitted to the germination test described above and after five days the percentage of germination was determined by counting the normal seedlings (Brasil, 2009).

Data were submitted to analysis of variance by the F test, and when significant effect was detected, the variables were compared by the Tukey test ($p < 0.05$). The analyzes were performed using the statistical software Winstat - version 2.11.

III. RESULTS AND DISCUSSION

Significant interactions were observed for all variables studied in all tested treatments (herbicides x times). It can be observed in Table 2, in relation to the first counting variable, that in the G4 season (when the first ten main stem silica begins to mature), the seeds presented greater vigor in relation to the first application period (G3 - when the first ten of the main stem are longer than 4 cm).

Comparing the herbicides with each other in the first application period, it was observed that the diquat and the paraquat + diuron stood out in relation to the others (Table 2). In the second application period the additional control presented the best results, followed by the herbicides diquat and paraquat + diuron again. According to Delgado et al. (2015) the reduction or not in the germination of the seeds after application of maturing herbicides, depends on the hybrid and the product used.

Table 2. First count (%) of canola seeds, hybrid Hyola 50, according to the application of treatments and maturation times.

Treatments	Dose	Application times	
	($g\ ha^{-1}$ de i.eore.a)	G3	G4
Control	---	17,00 cB[1]	30,00 dA
Ammonium Glufosinate	400	19,25 cB	38,50 cA
Paraquat	400	21,00 bcB	39,25 cA

Glyphosate	1440	17,25 cB	28,00 dA
Diquat	400	38,00 aB	50,75 bA
Saflufenacil	49	24,75 bB	36,50 cA
2,4-D	806	20,00 cB	28,00 dA
Paraquat+diuron	400+200	34,75 aB	49,00 bA
Additional Witness	---	16,75 cB	75,00 aA
General Media	---	32,43	
CV (%)	---	6,36	

[1] Means followed by the same lowercase letter in the column and upper case in the row do not differ significantly from each other by the Tukey test ($p \leq 0.05$).

Regarding the germination of canola seeds (Table 3), it was verified that independent of the time, the highest indices were in the additional control, which was left in the field until the crop cycle had ended and did not receive application of the herbicides. Beyond to the additional control, the treatments with diquat and paraquat + diuron presented significant values, regardless of the season in which they were applied.

The variation of temperature and humidity during the maturation time of the silica, associated with the hybrid and type of herbicide to be used, are factors that lead some products to stand out more than others (Mathias et al. 2017).

As in the previous variable, the highest germination rates of the canola seeds were obtained in the G4 season, independent of the applied herbicides (Table 3). It was also observed that the herbicide glyphosate was the one that most affected the germination of the canola in the two periods of evaluation. What can be noticed is that glyphosate is a systemic herbicide (circulates within the plant), influences the metabolism of plants, and consequently, the physiological quality of the seeds, causing phytotoxicity in them.

Table 3. Germination (%) of Hyola 50 hybrid canola seeds as a function of treatments and maturation times.

Treatments	Dose (g ha^{-1} de i.eore.a)	Application times	
		G3	G4
Control	---	27,00 eB[1]	51,00 dA
Ammonium Glufosinate	400	43,00 cB	58,00 cA
Paraquat	400	38,75 dB	59,00 cA
Glyphosate	1440	23,00 fB	41,00 fA
Diquat	400	51,00 bB	70,00 bA
Saflufenacil	49	41,00 cdB	59,25 cA
2,4-D	806	29,00 eB	46,00 eA
Paraquat+diuron	400+200	49,25 bB	68,00 bA
Additional Witness	---	74,75 aB	94,00 aA
General Media	---	51,28	
CV (%)	---	3,27	

[1] Means followed by the same lowercase letter in the column and upper case in the row do not differ significantly from each other by the Tukey test ($p \leq 0.05$).

In a study by Pizolotto et al. (2016) when evaluating different canola crop management systems, concluded that the application with the diquat herbicide reduced harvest losses by 31% to 66%, obtaining higher productivity and reducing costs with drying, which is in agreement with as reported by Esfahani et al. (2012) and Albrecht et al. (2013).

The use of diquat, paraquat and paraquat + diuron did not influence the physiological potential (germination and vigor) in soybean seeds, but when applied glyphosate the damage occurred in the root system of the seedlings (Daltro et al. 2010). These results corroborate with those found with Marcandalli (2011) when observing that glyphosate negatively influenced the physiological quality of soybean seeds.

There were fewer normal seedlings in the germination test when the ammonium glufosinate was used in the bean crop (Pinto et al. 2014). Lamego et al. (2013) tested the ammonium glufosinate in soybean plants, also noticed a reduction in the percentage of germination of the seeds, when applied later.

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Mata et al. (2015) verified differences in the percentages of germination among eight bean cultivars, using different pre-harvest herbicides, among them, diquat, saflufenacil and glufosinate ammonium. On the other hand, Agostinetto et al. (2001) reported, in rice surveys, that paraquat, ammonium glufosinate and glyphosate, when applied during physiological maturation, did not affect the qualitative characteristics, besides bringing benefits to accelerate the harvest period of this crop.

The same observation made by Kappes et al. (2009) and Botelho et al. (2016), where they verified that the percentage of germination was superior in seeds from soybean plants without application of maturing herbicides (harvested along with the other treatments), compared with the use of diquat and paraquat.

As for the first germination count (Table 2), it was verified that the performance of the seedlings was not significant, however, comparing the application times, it is noticed that the G4 season presented a higher percentage of seedlings considered normal. In addition, germination percentages lower than the standard established by Normative Instruction No. 45, dated 09/17/13, of the Ministry of Agriculture (ABRASEM, 2014), where the minimum germination required for the marketing of canola seeds is 80%. With the exception of the additional control in the second season of application, which germinated 94%, all other treatments, in both seasons, obtained inferior results.

The highest seedling lengths were obtained in the second application season, regardless of the treatment that was used, except for the additional control that there was no differentiation between the G3 and G4 seasons (Table 4). Once again, the additional control and diquat herbicide stand out in relation to the others in both seasons of herbicide application, revealing that this product causes less phytotoxic effect for canola. In contrast, treatments with glufosinate ammonium and 2,4-D showed the smallest lengths of seedlings. This divergence of results can be explained by the existence of biotic (fungi) and abiotic factors (environmental conditions) that tend to influence plant maturation.

The use of the diquat herbicide in pre-harvest of two soybean cultivars did not cause significant differences in seedling length when compared to the control without desiccant application (Daltro et al. 2010). Already, Toledo et al. (2012) verified a reduction in the development of soybean seedlings, due to the use of the herbicide glyphosate, compared to the absence of the application, regardless of the season used.

Similar results to this work were observed by Vanzolini et al. (2007), where they concluded that the test of seedling length is effective to detect differences in vigor level, where the larger the seedling, the greater the viability of the seed. Unlike Braccini et al. (2003), where the seedling length test for the evaluation of the physiological potential of soybean seeds is not considered adequate.

In a study by Krenchinski et al. (2017) evaluated the application of maturing herbicides in the wheat crop and their effects on seed productivity and quality, concluded that carfentrazone - ethyl and clethodim reduced the vigor of the seeds produced, and paraquat reduced the length of seedlings. There was also a reduction in productivity when the herbicides glufosinate ammonium, paraquat, glyphosate, clethodim and diquat were used.

Table 4. Length of seedlings (cm) of Hyola 50 hybrid canola seeds as a function of treatments and maturation times.

Treatments	Dose (g ha^{-1} de i.e or e.a)	Application times	
		G3	G4
Control	---	2,60 gB[1]	3,20 gA
Ammonium Glufosinate	400	2,77 fB	3,09 gA
Paraquat	400	3,53 dB	4,93 dA
Glyphosate	1440	3,90 cB	5,17 cA
Diquat	400	4,10 bB	5,32 bA
Saflufenacil	49	3,01 eB	3,85 fA
2,4-D	806	2,77 fA	2,71 hA
Paraquat+diuron	400+200	2,99 eB	4,78 eA
Additional Witness	---	7,06 aA	7,05 aA
General Media	---	4,04	
CV (%)	---	1,52	

[1] Means followed by the same lowercase letter in the column and upper case in the row do not differ significantly from each other by the Tukey test ($p \leq 0.05$).

The results show for the dry mass variable that in the G3 season the worst treatments were expressed by the application of paraquat + diuron and the additional control, the others all were better or equal than the application in G4. Lamego et al. (2013) when applying pre-harvest maturing herbicides to soybeans, verified that seedlings from the most advanced maturation stage R6 (pods with granulation and 100% green leaves) presented lower weight of mass dry. This in part can be explained by the temperature oscillation in the greenhouse and energy drop when the seedlings were being dried.

Again the herbicides 2,4 - D (first season) and glyphosate (second season) caused the lowest values of dry mass transfer. This result may be due to the lower seedling length and the percentage of germination. In this case, it is suggested that the use of these herbicides coupled to excess moisture, may have been absorbed by the seeds, and, thus, cause delay in the emergence of the same. In addition, because they were two systemic herbicides, they influenced the metabolic processes of the seeds. In both seasons, the additional control has the best dry mass indexes.

Table 5. Dry mass (mg) of Hyola 50 canola hybrid seedlings as a function of the treatments used during maturation periods.

Treatments	Dose (g ha^{-1} de i.e or e.a)	Application times	
		G3	G4
Control	---	2,7 dA[1]	2,2 dB
Ammonium Glufosinate	400	3,0 bA	2,7 cB
Paraquat	400	2,7 dA	2,7 cA
Glyphosate	1440	2,6 dA	2,0 dB
Diquat	400	2,7 dA	2,7 cA
Saflufenacil	49	2,8 cdA	2,7 cA
2,4-D	806	2,3 eA	2,2 dA
Paraquat+diuron	400+200	2,9 bcB	3,3 bA
Additional Witness	---	3,4 aB	3,7 aA
General Media	---	3,0	
CV (%)	---	3,08	

[1] Means followed by the same lowercase letter in the column and upper case in the row do not differ significantly from each other by the Tukey test ($p \leq 0.05$).

The same happened with Ferreira et al. (2007) observed shortening of cotton seedlings caused by phytotoxicity caused by systemic herbicides (glyphosate and 2,4 - D), which is usually more harmful compared to the effects caused by contact products. According to the same authors the systemic herbicides are absorbed in the place where the drop was intercepted, but also perform their function in other parts of the plant, in a toxic way. However, the contact herbicides destroy the plants or the parts on which it is applied, but it has no direct action on roots, bulbs, rhizomes, and generally, its action is less prolonged.

Glyphosate caused abnormalities in soybean seedlings with thickening, longitudinal streaking and hypocotyl yellowing, inhibition of primary root development and secondary root emission (Funguetto et al. 2004). The same was observed by Tillmann and West (2004) when they verified that the glyphosate interferes negatively in the germination and the initial development of the soybean seedlings.

The cold test (Table 6) presented similar results to the other germination and vigor tests, where the additional control in both seasons, together with the herbicides glufosinate ammonium (G3 and G4 epoch) and diquat (G4 epoch) were higher than the other treatments, while paraquat + diuron expressed the lowest percentage of normal seedlings. When comparing the seasons with each other, with the exception of the control, all other treatments presented significant results in the second application period (G4).

Plants that receive the application of maturing herbicides well before the time of physiological maturity, cause seeds with few reserves and consequently less vigor (Lamego et al. 2013). Seed quality loss after physiological maturity depends on the species, the hybrid and the conditions imposed on seeds in the field (Marcandalli et al. 2011).

Table 6. Cold test (% germination) in Hyola 50 hybrid canola seeds as a function of treatments and maturation times.

Treatments	Dose (g ha^{-1} de i.e or e.a)	Application times	
		G3	G4
Control	---	57,25 bA[1]	52,00 cB
Ammonium Glufosinate	400	59,00 bB	68,50 bA

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Paraquat	400	32,50 cB	54,00 cA
Glyphosate	1440	31,00 cB	35,00 deA
Diquat	400	36,00 cB	73,00 bA
Saflufenacil	49	18,00 dB	37,00 dA
2,4-D	806	34,50 cB	51,00 cA
Paraquat+diuron	400+200	6,75 eB	31,00 eA
Additional Witness	---	96,00 aA	94,00 aA
General Media	---	48,13	
CV (%)	---	4,70	

[1] Means followed by the same lowercase letter in the column and upper case in the row do not differ significantly from each other by the Tukey test ($p \leq 0.05$).

These results differ from those obtained by Kappes et al. (2009), where the application of diquat resulted in a lower percentage of normal soybean seedlings in the cold tests. Caierão and Acosta (2007) concluded that the use of glyphosate did not affect the germination of barley seeds.

In relation to the accelerated aging test (Table 7), all treatments presented higher results in the second application period with the additional control, followed by paraquat + diuron, diquat and glufosinate ammonium. Again, the second season of application stands out for presenting more developed plants and less sensitive to herbicide application.

According to the analyzed variables, it can be observed that, independent of the herbicides used in this study, the application season with the greatest results was the G4 season, that is, the stage at which the canola plants are entering physiological maturation and more near the end of their cycle.

Table 7. Accelerated aging test (%) in Hyola 50 hybrid canola seeds as a function of treatments and maturation times.

Treatments	Dose ($g\ ha^{-1}$ de i.e or e.a)	Application times	
		G3	G4
Control	---	9,00 gB[1]	22,75 eA
Ammonium Glufosinate	400	21,00 cB	41,00 bA
Paraquat	400	16,00 efB	30,00 dA
Glyphosate	1440	14,00 fB	33,00 dA
Diquat	400	23,00 bcB	42,00 bA
Saflufenacil	49	17,25 deB	36,75 cA
2,4-D	806	20,00 cdB	31,25 dA
Paraquat+diuron	400+200	25,00 bB	44,00 bA
Additional Witness	---	67,25 aB	81,00 aA
General Media	---	31,90	
CV (%)	---	4,11	

[1] Means followed by the same lowercase letter in the column and upper case in the row do not differ significantly from each other by the Tukey test ($p \leq 0.05$).

It is possible to apply maturing herbicides in the canola crop, and the most appropriate time corresponds to eight days before the normal harvest period (Silva et al. 2011). The same authors also report that the application in previous periods can cause losses in seed productivity, quality and its components, which was observed in parts of this study.

The best season for application of maturing herbicides in soybean cultivation is when the plants are with about 80-90% of the vegetables with brown staining and water content in the seeds of 45 to 60% (Lacerda et al. 2005). According to Santos et al. (2004), knowledge of the appropriate season for the application of herbicides aiming at the anticipation of the harvest, is of fundamental importance to obtain a maximum number of viable seeds, as well as to avoid that seed quality and productivity are affected.

Pre-harvest management techniques, such as herbicide maturation, may potentiate the amount of intact silica in the plant and thus favor considerable increases in seed productivity (Coimbra et al. 2004). However, depending on the way this practice is performed, as well as the period that the herbicide is applied, it can cause damages in the quality of the seeds, besides causing residues of the product in its composition. However, if the application is performed correctly, there may be greater uniformity of crop maturation, reduction of losses, and obtaining higher physiological quality seeds.

IV. CONCLUSION

Plants that remained in the field until the crop cycle (additional treatment) and did not receive herbicide application showed higher physiological quality seeds in all analyzed variables.

The applications carried out in the G3 season cause the greatest damage to the seeds, with more evident damage to the herbicides glyphosate and 2,4 - D.

The diquat, regardless of the season of application, presents significant results in relation to all variables analyzed and other treatments, as well as the herbicides paraquat + diuron and glufosinate ammonium.

There is the possibility of application of maturing herbicides in the canola and the most appropriate moment to its use is in the G4 season.

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