Times and methods of black oat management on corn plantability[1]

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ABSTRACT

The importance of maintaining straw on the soil surface is a subject widely discussed and proven in the literature. However, the effects of this straw on planting efficiency and quality still lack information. In this sense, both time and method of the black oat management influence the permanence of the straw on the soil and, thus, can interfere in the next crop's germination and plantability of the seed drill. This study aimed to evaluate methods and times of black oat management and their implications on the plantability and development of the corn crop in succession in two harvests. A randomized block design with twelve treatments was used, consisting of the combination of three methods of management (crushed, rolled, and desiccated) and four times of management (0, 10, 20, and 30 days before the corn sowing) of black oat straw, arranged in a 3 x 4 factorial scheme, with four replications. The black oat management carried out 30 days before the corn sowing provides the highest corn emergence rate. Management methods that promote greater fragmentation of straw tend to offer less mechanical impediment to seedling development and result in a greater initial and final plant population.

Keywords: emergence speed; sowing depth; plant stand; *Zea mays*.

INTRODUCTION

Corn is a crop that has a great diversity of use and can be used for animal and human feeding and in the high-tech industry, such as biodegradable films and packaging (Landim *et al.*, 2016). However, most of the corn produced is used for producing animal food, which corresponds to 70% of the world's demand (Jasper *et al.*, 2009).

Currently, Brazil is the third-largest producer of the cereal, with an average grain yield of 5,587 kg ha^{-1}, considered low, compared to that of the United States (10,550 kg ha^{-1}). The productive potential of a corn hybrid results from the sum of factors, such as weed control (Zagonel *et al.*, 2000), water distribution (Bergamaschi *et al.*, 2004), and plant population per area, with plants spaced equidistantly (Silva *et al.*, 2017) and more uniformly developed (Weirich Neto *et al.*, 2015). The management methods of winter cover crops often influence some of these factors (Passos *et al.*, 2019).

In Brazil, corn is grown mostly under the no-tillage system, and black oat is one of the crops most included in the winter rotation system due to the ease of seed acquisition, plant rusticity, speed of the biomass formation, adequate cycle, and mainly, the large amount of dry matter provided by the plant (Ziech *et al.*, 2015).

For summer crops sowing, the crop residues and cover crops grown in the winter season need to be managed first, which can be performed by chemical or mechanical methods. According to Aratani *et al.* (2006), mechanical straw management facilitates the sowing process. Nevertheless, it promotes increased machine traffic in the crop-field and, consequently, increases soil compaction risk, besides accelerating the straw decomposition and rising the operational cost.

Chemical management of crops has advantages such as efficiency, speed, and the soil's non-disturbance, allowing plant control in any season, including the rainy seasons, when mechanical management is not recom-

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mended. Regarding the disadvantages of the chemical control method, we can mention the need for specific equipment, cost for training operators, and greater risk of environmental contamination (Vargas *et al.*, 2006). However, chemical management is preferred due to controlling the cover crops and weeds present in the field, which reduce competition periods with maize crops (Büchi *et al.*, 2020).

According to the time between the winter crop management and the summer crop sowing moment, the physical traits of the straw range. In this respect, Copetti (2015) describes that on the day of management, the plants are still green, the fibers are flexible and have a high level of humidity; as the days pass, they become wilted, the fibers remain flexible for some time, and the moisture content tends to decline. At 30 days after management, the moisture content reaches the lowest values, and the fibers are brittle. This variation in the straw's physical traits can strongly influence the initial development of the successor crop and the sowing machine plantability.

Within this context, this study aimed to evaluate methods and times of black oat management and their implications on the plantability and development of the corn crop in succession in two harvests.

MATERIAL AND METHODS

The experiment was implemented during the 2017/2018 and 2018/2019 harvests, in the experimental area of the Federal University of Technology – Paraná, Pato Branco campus, located at 26°16'36" S and 52°41'20" W, in soil classified as Typic Hapludox (Soil Survey Staff, 2014), with a very clay texture. The climate is classified as humid subtropical of the Cfa-type (Alvares *et al.*, 2013). The data referring to the average temperature and rainfall throughout the experiment development are shown in Figure 1.

A randomized block design consisting of twelve treatments was used, arranged in a 3 x 4 factorial scheme, with four replications. The treatments consisted of combining three managements of black oat straw (crushed, rolled, and desiccated) and four management periods (0, 10, 20, and 30 days before the corn sowing). The area was divided into four randomized blocks, totaling forty-eight experimental units, each with an area of 74 m^2 (3.7 x 20 m), considering the central part of each experimental unit as the useful area for evaluations (21 m^2).

Black oat, cultivar Embrapa 139, was used as a cover crop with a density of 350 seeds m^{-2}, without fertilization on the sowing and topdressing.

The straw management was carried out using the following equipment: crushed straw, tractor plus the straw crusher (Jan/Triton® 1800), with a cutting width of 1.8 m; rolled straw, tractor plus the crimper-roller (Triton®), with 1.2 m working width; desiccated straw with a sprayer (Jacto®), with a 12 m long bar and 600 L tank. The herbicide Zapp QI (1.1 L ha^{-1}) was used, with 200 L ha^{-1} of spray volume.

The corn hybrid used was the Pioneer 30F53VYH, with LEPTRA biotechnology, with a longitudinal distribution of approximately five seeds per meter. The fertilizations on the sowing and topdressing were carried out considering the soil analysis and the grain yield estimate of 12 t ha^{-1}. In the fertilization on the sowing, 450 kg ha^{-1} of the granulated NPK formulation 08-20-15 was used. In the topdressing fertilization, 200 kg ha^{-1} of urea (45% of nitrogen) was applied. The crop treatments were carried out according to the corn production recommendations.

For the corn sowing, a no-till seeder-fertilizer drill (Vence Tudo®, SA 14600 model) was used, with a mechanical seed dosser (horizontal disc), five planting rows, spaced at 0.70 meters between rows, lagged double discs furrower with 356 mm (14") diameter. A New Holland® tractor, TL85E model, 4x2 FWA (front-wheel assist), with a maximum power of 57.4 kW (78 hp) at 2,400 RPM, with tire wheelset.

The black oat dry matter was analyzed on the day of corn sowing by collecting the vegetable cover mass inside an iron square of 0.50 m on the side and later drying the material in an oven at 60 °C until reach constant weight.

Three central lines of each experimental unit were used to determine the sowing depth; ten seedlings at the V3 growth stage per row were evaluated. The emerged seedlings were cut close to the soil, and with the aid of a spatula, the root with the seed was removed from the soil, measuring the distance between the seed and the stem region where the seedling was cut.

A profilometer was used to survey the mobilized soil profile, made from wood, with vertical rulers graduated in centimeters, arranged every two centimeters across the sowing row, and used in the three central sowing rows of each experimental unit.

The germination speed index and the emergence march were evaluated over 10 meters on the three central sowing rows of each experimental unit. Daily seedling counting was performed until the number of seedlings that emerged was constant, according to the methodology proposed by Maguire (1962).

The average spacing between plants was obtained by measuring the spacing between all plants of the central sowing rows in each experimental unit. The spacing was classified as normal, double, and flawed after the measures were taken, according to the methodology proposed by Kurachi *et al.* (1989).

The plant population was evaluated by the number of plants in each experimental unit's useful area at 30 days after sowing and at the harvest time. The plant height was assessed together with the plant population count, with ten plants being measured in each experimental unit.

The data obtained were submitted to analysis of variance. In the cases that significant difference ($p \leq 0.05$) was observed, the means from the management methods were compared by the Tukey test ($p \leq 0.05$). Whereas for the management time factor, a polynomial regression analysis was adopted, with the models being selected by the criterion of highest R^2 and the significance ($p \leq 0.05$) of the equation parameters, employing the statistical program Genes (Cruz, 2013).

The data were also submitted to a principal component analysis using the R statistical program (R Development Core Team, 2018). To minimize the scale's effects, the data underwent a transformation where the raw data were subtracted from the mean and divided by the standard deviation, generating standard scores (Zuber *et al.*, 2017).

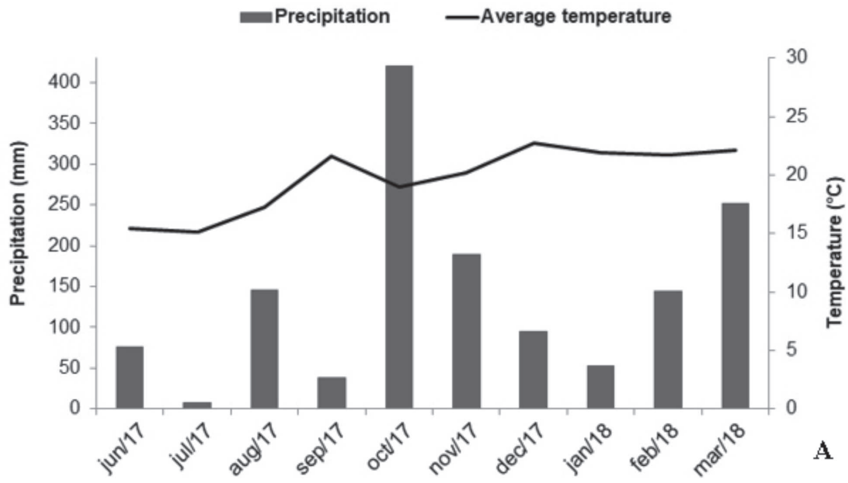
RESULTS AND DISCUSSION

The average dry matter of oats in the area was 4,508.38 kg ha^{-1} for the desiccated straw management, 4,140.56 kg ha^{-1} for the rolled straw management, and 3,477.93 kg ha^{-1} for the crushed straw management in the 2017/2018 harvest (Table 1). The desiccated straw management had a higher dry matter value because it remained erect longer and had less contact with the soil. In the case of management with crimper-roller, straw felled and cut into

Table 1: Average values of dry matter (DM), germination speed index (GSI), and initial plant population (IP) according to the methods of black oat management in the 2017/2018 harvest

Management	DM (kg ha^{-1})	GSI	IP (pl ha^{-1})
Desiccated	4,508.38 a	15.14 b	72,436 b
Rolled	4,140.56 ab	15.87 b	73,954 ab
Crushed	3,477.93 b	16.71 a	76,127 a

Means followed by different letters in the column differ from each other by the Tukey test at 5% probability.



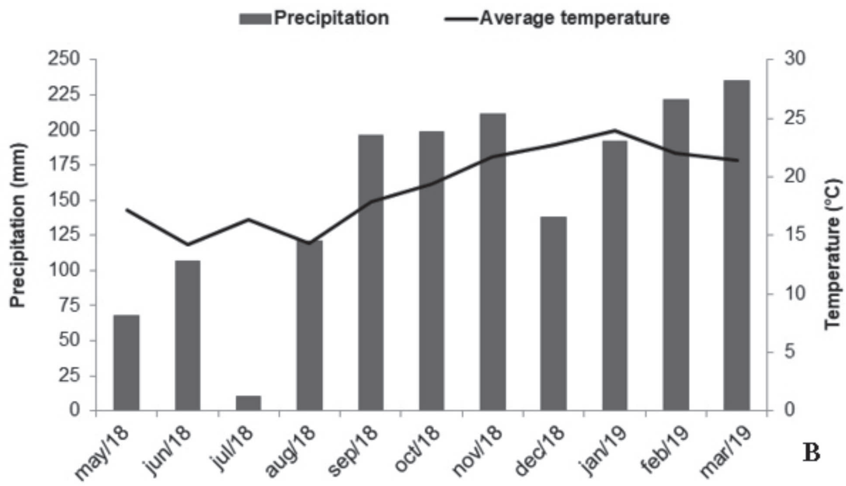


Figure 1: Precipitation (mm) and temperature (°C) in the 2017/2018 (A) and 2018/2019 (B) harvests. Source: Paraná Meteorological System (Simepar, 2020).

medium pieces allowed a higher decomposition rate and, consequently, less dry matter than desiccated management. In crushed straw management, the straw, broken up into small pieces, accelerated the decomposition process, which provided a lower dry matter value.

When the management times in the 2017/2018 harvest are compared, it can be verified that the black oat managed on the day of corn sowing showed the highest dry matter value (5,643.80 kg ha^{-1}) (Figure 2). A progressive daily decrease of 106.77 kg ha^{-1} of dry matter was observed after management, reaching 2.440 kg ha^{-1} of dry matter 30 days after management. Similar data were found by Kaefer *et al.* (2012), evaluating five times of black oats desiccation (0, 7, 14, 21, and 28 days) preceding the corn sowing. These authors reported higher dry matter yield of oat when management was close (7 days) or simultaneous (0 days) to corn sowing, obtaining dry matter values in each evaluated period of 1,870 and 2,220 kg ha^{-1}, respectively. In the 2018/2019 harvest, there were no significant differences between treatments, with an average value of 3,957.50 kg ha^{-1} of dry matter.

According to Nunes *et al.* (2006), about 6,000 kg ha^{-1} of DM is considered the minimum ideal amount for soil covering in the no-tillage system. Cruz *et al*. (2006) recommend the permanent maintenance of at least 2,000 kg ha^{-1} of dry matter for the implementation and efficient management of the no-tillage system; however, as security, they recommend adopting rotation systems that produce an average of 6,000 kg ha^{-1} or more of dry matter. If we consider the value of 6,000 kg ha^{-1} of DM as the ideal value, it is recommended that the management of oats be carried out close to the sowing date.

The sowing depth of corn was not significantly influenced by the methods and times of black oat management in both harvests, presenting an average value of 6.1 cm in the 2017/2018 harvest and 5.3 cm in the 2018/2019 harvest. This result is related to the type of disk furrower used, which facilitates the cutting of straw, providing that the machine does not show sowing problems.

The depth of seed deposition must be considered, as it can affect germination, being conditioned by temperature, soil type, and water content (Silva *et al.*, 2008). The deeper the seed deposition, the higher the energy consumption to complete the seedling emergence; however, if it is not deep enough, the seed will be more susceptible to water stress (Weirich Neto *et al.*, 2007).

No significant differences were found in the area of mobilized soil with an average of 55.15 cm² in the 2017/2018 harvest and 50.90 cm² in the 2018/2019 harvest, which suggests that this parameter would be more related to the type of furrow and soil than with the physical quality of the straw (green, withered, or dry). In general, the soil mobilization obtained in this experiment presents low values when compared with the other values found in the literature for the disc-type furrower mechanism, which vary from 39.39 cm² (Modolo *et al.*, 2019) to 87.40 cm² (Santos *et al.*, 2010), thus adapting to the assumption of low surface mobilization of the soil recommended by the no-tillage system.

Several studies demonstrate the difference in the mobilized soil area when comparing furrower mechanisms (Mion *et al.*, 2009; Modolo *et al.*, 2013), depths of furrower action (Cepik *et al.*, 2005; Cepik *et al.*,

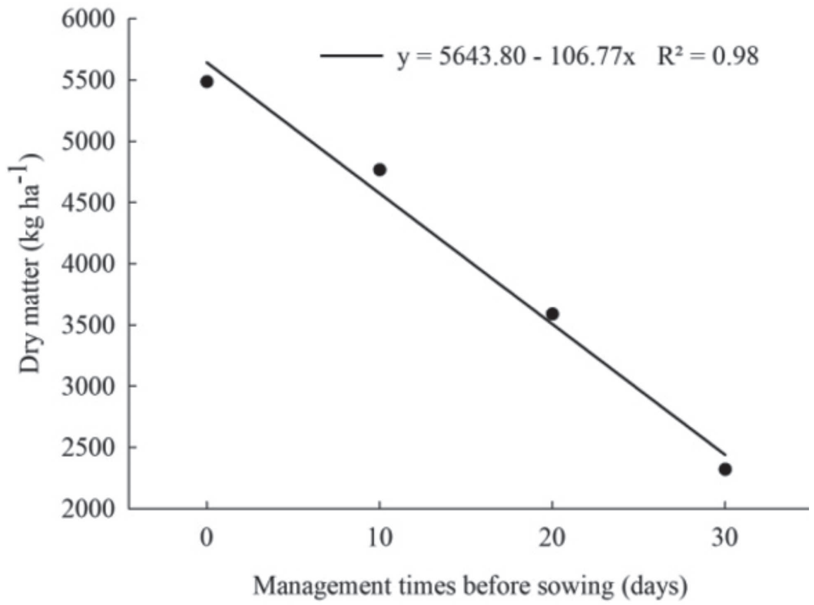


Figure 2: Dry matter of black oat straw according to the management times in the 2017/2018 harvest.

2010), and speed of sowing (Silveira *et al.*, 2011; Silveira *et al.*, 2013). However, few studies evaluate this parameter related to the straw.

Working with different levels of oat straw (0; 1; 2; 4 and 6 t ha^{-1}) and three furrower mechanisms (smooth disc, corrugated disc, and notched disc), Santos *et al.* (2010) observed an increase in the area of soil mobilized with the increase in the level of straw. This result is attributed to a higher soil moisture level at the experiment installation, which allowed a greater penetration of furrower mechanisms. In the present study, despite differences in the amount of straw for the management methods (Table 1) and management times (Figure 2) in the 2017/2018 harvest, the mobilized soil area did not show significant differences. This demonstrates that the amount of straw (up to 5,500 kg ha^{-1}) does not affect the mobilized soil area when sowing is carried out with a disc-type furrower.

The highest germination speed index in the 2017/2018 harvest was obtained with the crushed straw management (Table 1). This is due to the greater straw fragmentation that causes less physical impediment. Trogello *et al.* (2013) evaluated different managements of cover crop and operating speeds in the corn crop, and they obtained similar data. They observed that the mechanical managements that most fractioned the straw had better indexes. It provides better light penetration and higher temperature and humidity homogeneity in the area, creating a favorable microclimate to the crop emergence. The intact straw ends up inhibiting the light penetration into the mulch canopy, thus hampering the maize seedling emergence, which results in lower germination speed index (Campos *et al.*, 2020).

Contrary to what was observed in the 2017/2018 harvest concerning the GSI, the management methods did not show significant differences in the 2018/2019 harvest, with an average value of 22.14. The highest GSI obtained in the second harvest of the experiment is related to the better distribution of rain (Figure 1) (198 mm in October 2018), where we can see that in the previous harvest, there was a rain excess (420 mm in October 2017), harming the plant emergence.

The management times before sowing affected the germination speed index, presenting an increasing linear regression. The lowest index was recorded at 0 days; that is, the management and sowing were carried out simultaneously, and the highest index was found when the management was carried out 30 days before corn sowing (Figure 3). The management carried out on the day of sowing showed lower values due to the greater amount of straw on the soil, making it difficult for the seedling to emergence.

According to Weirich Neto *et al.* (2007), plants with different emergence speeds, besides suffering initial stress, may have their photosynthetic rate restricted due to shading or have pollination affected. Thus, the higher and the more homogeneous the GSI value among treatments, the quicker the seedlings emerge, and the less time it will be dependent on seed reserves.

The emergence march of corn seedlings was similar for the methods and times of black oat management in both harvests. The emergence started at seven days and stabilized at thirteen days after sowing. The average germination was 83% in the 2017/2018 harvest and 93% in the 2018/2019 harvest (Figure 4).

The highest germination percentage obtained in the 2018/2019 harvest is a consequence of the lower rainfall in October 2018 (198 mm). In the 2017/2018 harvest, there was an excess of precipitation in October 2017 (420 mm), causing stress on the seeds, reducing the germination percentage.

Evaluating different management methods of cover crops (crimper-roller, straw crusher, and herbicide), Cortez *et al.* (2009) found no differences in the number of days for seedling emergence, reporting that any management method can be chosen. This fact was also observed in our study, where any management method can be adopted, as it does not interfere with the number of days for emergence.

The management methods did not show significant differences in the spacing between plants, demonstrating the good ability of seed-drill to work under different oat straw conditions. Oat straw's management times significantly influenced the normal spacing in the 2017/2018 harvest and the flawed spacing in the 2018/2019 harvest, but no regression model fits the data.

The average spacing between plants did not show significant differences, with average values of 18.93 and 15.05 cm obtained in the 2017/2018 and 2018/2019 harvests. Similar results were obtained by Trogello *et al.* (2013) when evaluating four management methods for cover crops (disc harrow, straw shredder, crimper roller, and desiccated with herbicide); they stats that due to ideal soil and environmental conditions, sowing did not affect the average spacing between plants.

According to Silva *et al.* (2000), during the displacement of the seeds inside the conductive tube, vibrations occur caused by the machine's movement, changing the time of falling to the ground. Consequently, the uniformity of the spacing is affected. In the process of direct sowing, the longitudinal distribution of the seeds in an appropriate manner combined with the correct depth of deposition significantly contributes to obtaining a uniform plant stand (Almeida *et al.*, 2010).

The double spacing showed average values of 10.2 and 24.4% in the 2017/2018 and 2018/2019 harvests, respectively. The flawed spacing showed average values of 9.2 and 4.1% in the 2017/2018 and 2018/2019 crops, respectively, while the normal spacing was 80.6% in the 2017/2018 harvest and 71.5% 2018/2019 harvest. According to the classification proposed by Tourino & Klingensteiner (1983), good performance in the sowing occurs when 75 to 90% of normal spacing is achieved, a fact observed in the 2017/2018 harvest. However, in the 2018/2019 harvest, the performance in the sowing is considered regular (50 to 75%).

Weirich Neto *et al.* (2012) evaluated the influence of mechanical management of oat straw with a roller preceding the corn crop's sowing. They observed that mechanical management significantly increased the flawed spacing and significantly reduced the acceptable spacing but did not change the multiple spacing. The authors claim that mechanical management may have altered germination due to the accumulated straw volume and allelopathy.

In the 2017/2018 harvest, the crushed straw management had a higher initial plant population, which did not differ statistically from the rolled straw management. In contrast, the lowest plant populations were observed in the desiccated straw management (Table 1). The best conditions for seedling emergence due to the greater fragmentation and homogeneous distribution of straw on the surface, provided by the crushed straw management, resulted in a larger plant population.

In the 2018/2019 harvest, the initial plant population did not show significant differences, with an average of 85,619 plants per hectare. The largest plant population observed in the 2018/2019 harvest compared to the 2017/2018 harvest is related to the better distribution of rainfall in all months over the corn crop cycle (Figure 1B). This provokes practically all the seeds deposited in the soil to germinate, thus providing a plant stand higher than expected. In contrast, in the 2017/2018 harvest, the rainfall distribution was more irregular (Figure 1A).

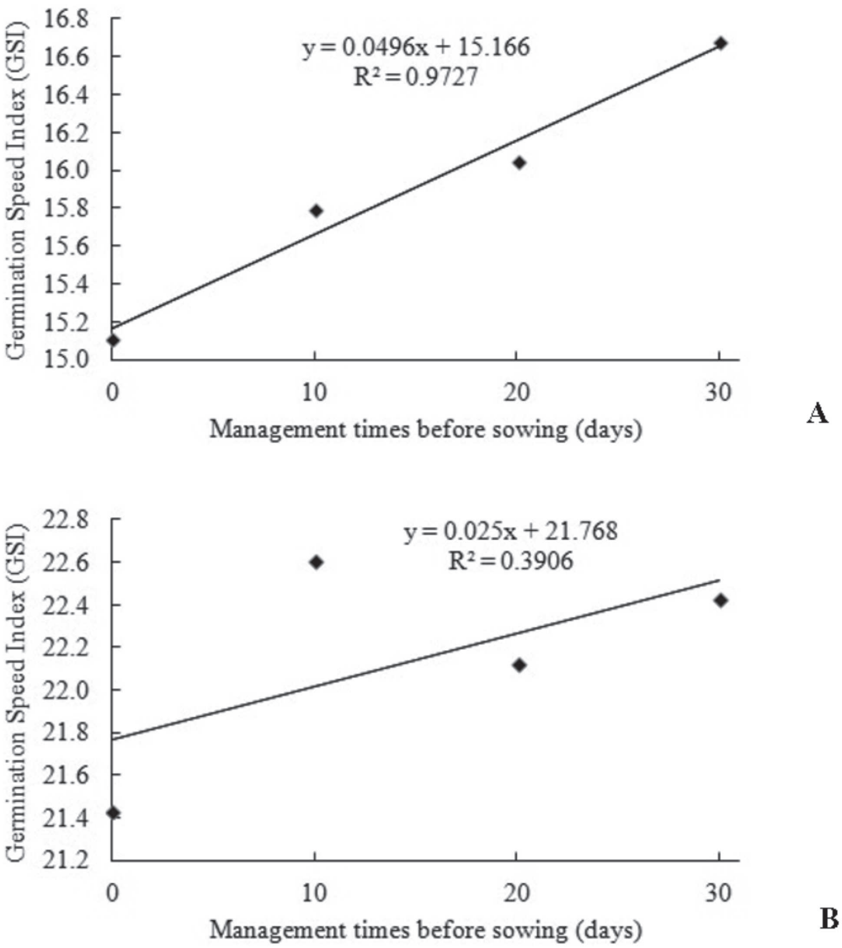


Figure 3: Germination speed index (GSI) of corn seedlings according to the management times of black oat in the 2017/2018 (A) and 2018/2019 (B) harvests.

Muraishi *et al.* (2005), evaluating the straw management methods (crushed and desiccated), Cortez *et al.* (2009) when managing cover plants with crimper-roller, straw shredder, and herbicide, Tabile *et al.* (2007) when evaluating three management systems (straw shredder, reaper, and desiccation), Trogello *et al.* (2013) using the desiccation with herbicide, disc harrow, crimper-roller, and straw shredder, and Weirich Neto *et al.* (2012) when evaluating the influence of mechanical management of oat straw with a roller before the corn crop sowing, did not observe differences in the plant population. Similar results to those were found in our experiment in the 2018/2019 harvest.

According to Vieira Junior *et al.* (2006), the plant population directly interferes with corn grain yield. Silva *et al.* (2006) state that the plant population is essential among the yield components since it directly interferes in the ears production per area and, consequently, the number of grains per area.

It was observed that the first three principal components explained 84.22% of the data variance, with 58.56% in the first component, 15.26% in the second, and 10.40% in the third component (Figures 5A, 5B, and 5C).

Based on the principal components analysis, in the 2017/2018 harvest, it appears that the variables germination speed index (GSI), normal spacing (NS), initial plant population (IP), and final plant stand (FPS) were the who presented higher scores (Table 2) on the positive axis of the first principal component (PC1) (Figures 5A and 5B). On the other hand, the variables dry matter (DM), flawed spacing (FS), average spacing (AS), and seed deposition depth (SD) were those that had the highest scores on the negative axis of PC1 (Figures 5A and 5B). These sets of variables are positioned in opposite positions of PC1, showing an antagonistic behavior between them (Figure 5A). In other words, high levels of dry matter on the soil surface can negatively interfere in the initial development of the plant and, consequently, in the final stand, corroborating the results of Pedó *et al.* (2014).

It was possible to observe that the germination speed index (GSI) and initial plant population (IP) variables were highly correlated with each other (Figures 5A and 5B), demonstrating that the higher the GSI, the higher the IP. The highest GSI and largest plant population were observed in the crushed straw management (Table 1). Conversely, the sowing depth (SD) showed a high score in the negative portion of PC1, suggesting that the deposition of seeds in greater depth may provide a reduction in the germination speed index (GSI) and the initial plant population (IP) (Pedó *et al.*, 2014).

Regarding the second principal component (PC2), the variables with the highest scores were double spacing (DS) and the mobilized soil area (MSA) (Table 2), with DS showing positive scores and MSA showing negative

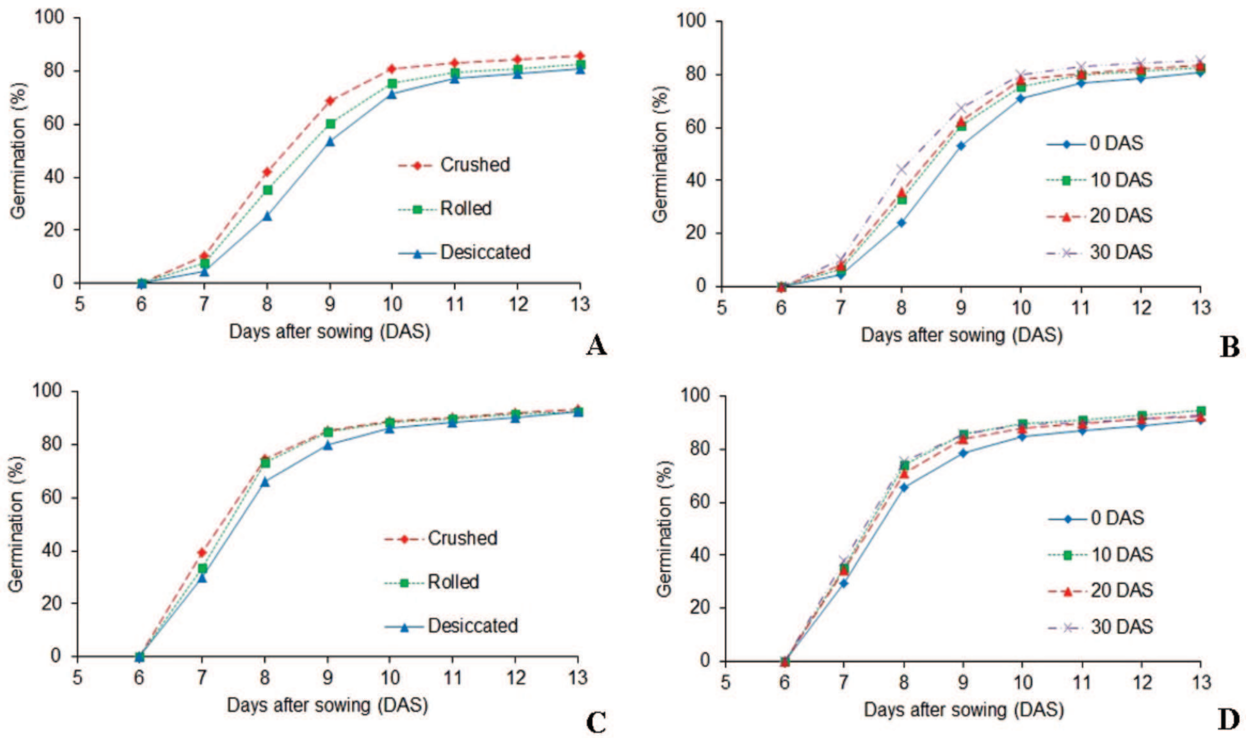


Figure 4: Corn seedling emergence according to the methods (A and C), and times (B and D) of black oat management in the 2017/2018 and 2018/2019 harvests, respectively.

scores. This polarization between the variables suggests that, under certain conditions, a larger area of mobilized soil can increase the DS, compromising the crop's homogeneity and causing losses (Pedó *et al.*, 2014).

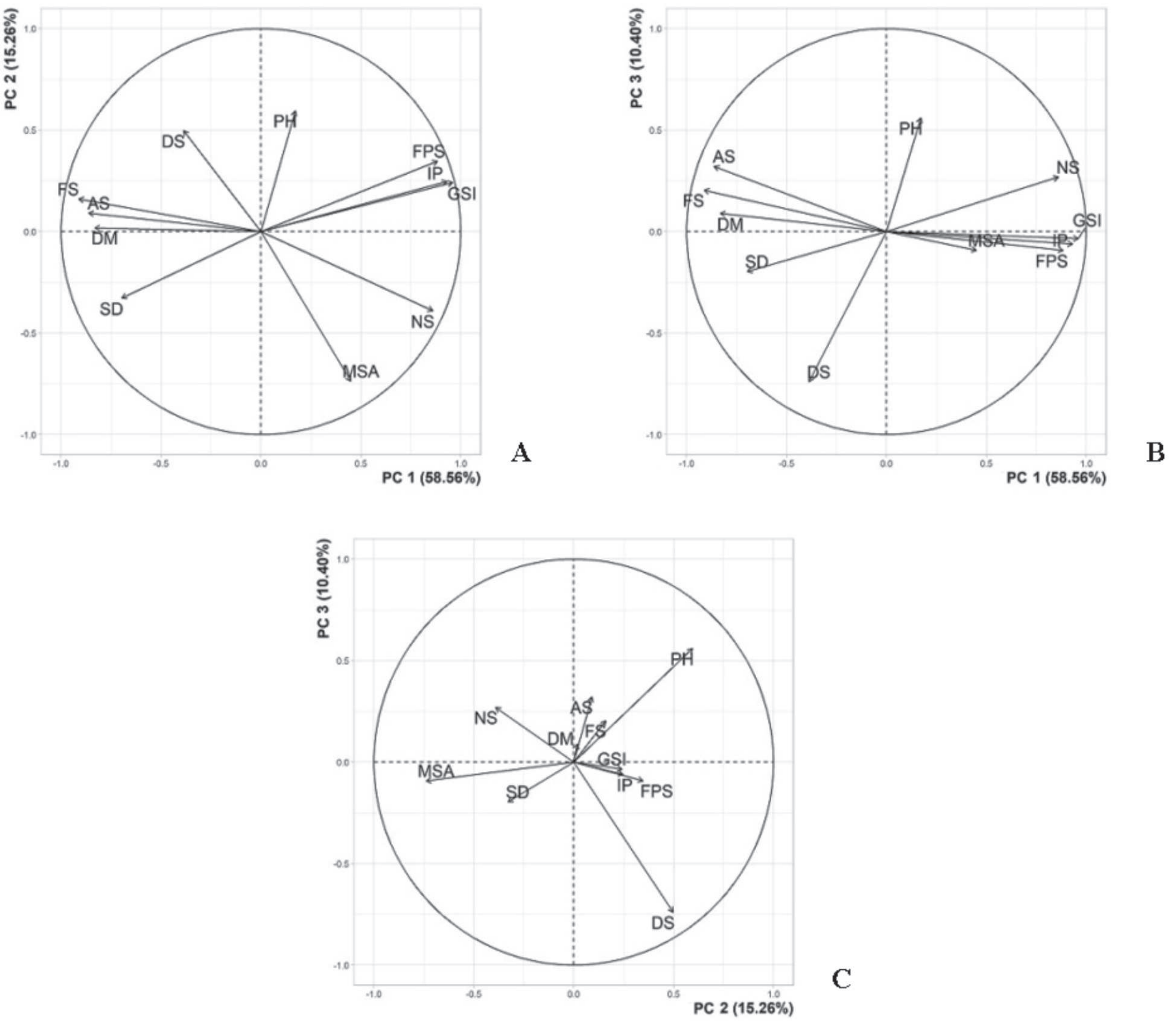
The variables that contributed the most to the third component were average spacing (AS), normal spacing (NS), flawed spacing (FS) (positively), and double spacing (DS) (negatively) (Figures 5B and 5C; Table 2). This correlation between normal and flawed spacing is not clear in the data analysis.

From the principal components analysis of the 2018/2019 crop, it could be noticed that the first three components explained 71.98% of the data variation, with the first, second, and third principal component responsible for 35.64%, 22.11%, and 14, 23% of the variation, respectively (Figures 6A, 6B and 6C).

Variables such as germination speed index (GSI), sowing depth (SD), and initial plant population (IP) were those that had the highest scores on the positive axis from the first component (Table 2). On the other hand, variables such as the average spacing (AS) and mobilized soil area (MSA) had the highest scores on the negative axis from the first component (Table 2).

It was also possible to observe that the germination speed index (GSI) and initial plant population (IP) variables were highly correlated with each other (Figures 6A and 6B), demonstrating that the higher the germination speed index, the numerous the initial population of plants, data observed in the first year of the experiment (Figures 5A and 5B).

Concerning the PC2, the variables that stood out the most were the sowing depth (SD) and the flawed spacing



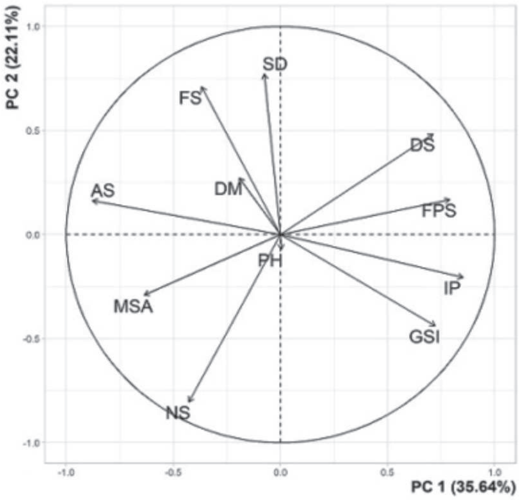
DM: dry matter; SD: sowing depth; MSA: mobilized soil area; GSI: germination speed index; DS: double spacing; NS: normal spacing; FS: flawed spacing; AS: average spacing; IP: initial plant population; FPS: final plant stand; PH: plant height. PC1 = first principal component; PC2 = second principal component; PC3 = third principal component.

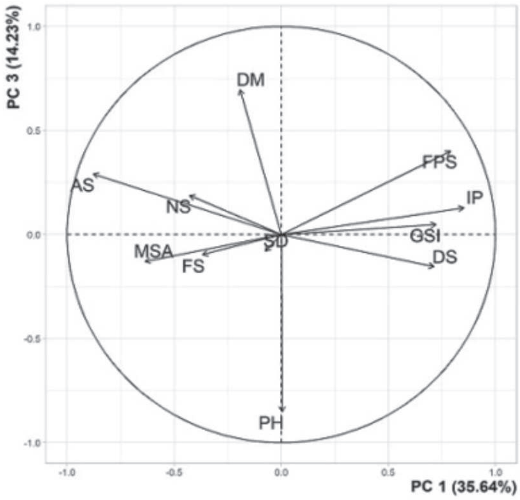
Figure 5: Dispersion of variables by principal component analysis in the 2017/2018 harvest (A, B, and C).

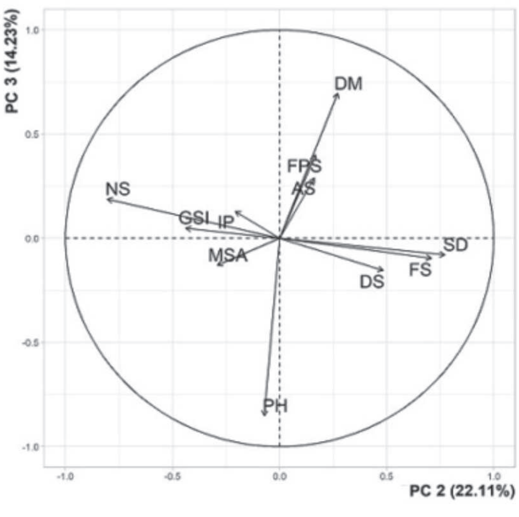
Table 2: Eigenvectors of the variables analyzed in the 2017/2018 and 2018/2019 harvests. PC1 = first principal component; PC2 = second principal component; PC3 = third principal component

Variables	2017/2018 harvest			2018/2019 harvest		
	PC1	PC2	PC3	PC1	PC2	PC3
DM	-0.832	0.018	0.089	-0.193	0.272	0.696
SD	-0.696	-0.328	-0.196	-0.075	0.771	-0.079
MSA	0.450	-0.737	-0.093	-0.636	-0.291	-0.129
GSI	0.960	0.242	-0.035	0.723	-0.439	0.047
DS	-0.387	0.498	-0.739	0.713	0.483	-0.155
NS	0.860	-0.390	0.269	-0.428	-0.805	0.188
FS	-0.913	0.160	0.204	-0.368	0.709	-0.096
AS	-0.862	0.090	0.320	-0.878	0.163	0.291
IP	0.931	0.247	-0.061	0.852	-0.206	0.128
FPS	0.884	0.346	-0.092	0.791	0.167	0.400
PH	0.172	0.594	0.559	0.004	-0.072	-0.851

DM: dry matter; SD: sowing depth; MSA: mobilized soil area; GSI: germination speed index; DS: double spacing; NS: normal spacing; FS: flawed spacing; AS: average spacing; IP: initial plant population; FPS: final plant stand; PH: plant height. PC1 = first principal component; PC2 = second principal component; PC3 = third principal component.







DM: dry matter; SD: sowing depth; MSA: mobilized soil area; GSI: germination speed index; DS: double spacing; NS: normal spacing; FS: flawed spacing; AS: average spacing; IP: initial plant population; FPS: final plant stand; PH: plant height. PC1 = first principal component; PC2 = second principal component; PC3 = third principal component.

Figure 6: Dispersion of variables by principal component analysis in the 2018/2019 harvest (A, B, and C).

(FS) (Table 2), with a high correlation between them, which suggests that the deeper the seed is deposited, the higher the number of flawed spacings. The variable, normal spacing (NS), showed high scores on the negative axis of PC2 (Table 2), showing the importance of a correct adjustment in the seed deposition for more homogeneous sowing.

Regarding PC3, the variables that stood out the most were dry matter (DM), mobilized soil area (MSA), and double spacing (DS) (Figure 6). Despite the polarization in these variables' results, the data do not allow making reliable inferences about them.

It is important to highlight that, in the 2018/2019 harvest, there was a great dispersion among the variables considering the principal component analysis, where the variables that slightly stood out suffered a compensatory effect from the other variables, with no significant differences between treatments.

CONCLUSIONS

The management of black oat plants carried out 30 days before corn sowing provides the highest corn emergence speed.

The methods and times of black oat management do not affect the depth of seed deposition, the mobilized soil area, and corn plants' distribution uniformity.

Management methods that improve plant fragmentation offer fewer impediments to seedling development and promote greater initial and final plant populations.

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