English Version

Evaluation of plant components of maize on different times of Nitrogen application in succession to different cover crops

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Abstract

Maize (*Zea mays* L.), has been deployed in crops in no-tillage system, where its use has brought better results in production due to low revolving in the soil, thus reducing the risk of erosion, maintaining the natural and improved water retention. The experiment was planted in the area of commercial farming, characterized by an Rhodic Hapludox in the municipality of Capitao Leonidas Marques-PR, in the agricultural year 2008/2009. The objective of this study was to evaluate the development of corn, according to the different application periods of nitrogen, supplied as urea, in succession to four different cover crops, and oats (Avena strigosa), radish (Raphanus sativus) wheat (Triticum spp.) and natural spontaneous vegetation (fallow), along with different applications of N, arranged as follows (1 / 3 furrow + 2 / 3 with 8 leaves and 1 / 3 furrow + 1 / 3 to 4 leaves + 1 / 3 with 8 leaves). The experimental design was the randomized blocks, in which the plant height and ear insertion height, thickness of stem and ear and ear length were evaluated. The results show that the different times of application and the various cover crops did not differ significantly in their results.

Key Words: Plants of covering; no-tillage system; nutrients.

Introduction

The world production of maize (*Zea mays L.*) accounts for approximately 770 millions of tonnes annually (PARANÁ, 2008). In Brazil it is the most produced cereal, and it occupies an area of approximately 13 million hectares, with an average production of 42 millions of tonnes a year, which results in an average of 3.2 tonnes ha^{-1}. Among some factors to explain this low productivity, it must be emphasized the lack of consumption and the incorrect use and management of nitrogen (N), which is the most absorbed nutrient and the one that influences the most on the response in grain yield (SILVA et al. 2008).

In order to obtain good grain yield, the application of N is essential many times at high dosages, in a variety of forms, i.e., in the seeding, covering and when plants have a certain number of leaves (4 to 8), since soils in general do not fully supply the demand of N for the demanding maize crop (PÖTTKER e WIETHÖLTER, 2004). The dynamics of N on the soil-plant system are influenced by the type of fertilizer used, the system of cultivation, management and weather conditions (SILVA et al., 2006).

Thus, maize plants should be always well nourished with N, therefore it is necessary to estimate correctly the quantity it must provide to the soil. Some recommendations use criterions of the quantity of organic material available on the soil, and the expectation of production to determine the correct dosage (RAMBO et al., 2004).

The use of no-tillage system brings changes concerning the management of cultural waste on the soil. There is also the occurrence of changes in the nutrient availability to the plant coming from the soil, including with N, due to the increase on organic matter and conservation of the mulch, increasing the biological activity (PAULETTI and COSTA, 2000).

Therefore, no-tillage system may be seen as higher number of vegetal matter to the covering, which results in less risk of erosion, and the conservation of the chemical, physical and biological qualities of the soil (SILVA et al., 2006).

Basic requirements to the success of the implementation of this system are demanded, as crop rotation in the field, with the choice of species

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that leave good ground cover as some winter cereals, i.e. wheal, oak, radish and others, providing thus the seeding of the desired crop over the superficial residues of the other crop in the soil after the removal of the forages (SILVA et al., 2007).

Black oat (*Avena strigosa*) is the forage most used as cover crop in Brazil. However, it has been diagnosed a certain reduction on the nitrogen absorption in the beginning of the maize cycle, due to the relation carbon/nitrogen that black oat generates. Studies show that this occurrence is caused by a certain immobilization on the N disposed due to the large amount of carbon supplied by the black oat, which increases the microbial activity (CERETTA et al., 2002).

Another option to use as a ground cover is the napier *(Raphanus sativus)*, which has good nitrogen fixation, however with a good root system, has a great ability to recycle this nutrient of fairly deep soil layers. Its limiting factor on the nitrogen disposition is similar to the legume, i.e., it has low relation carbon/ nitrogen, which accelerates the matter decomposition (SILVA *et al.,* 2006).

This legume is developed in soils with medium fertility, and can promote covers of 70% of the soil in the first 60 days after the seeding. In addition to its use as covering, it can be used to feed dairy or beef cattle and in intercropping with oak, rye, peas, both for forage and green manure (OHLAND et al., 2004)

It can be observed that the ideal would be monitoring the development on the maize crop, defining thus, the potential of each species used in the intercropping on this agriculture yield system (SILVA et al., 2006).

Nowadays, agricultural systems that allow more additions than losses will have better performance in the cultivation. However, it can be noticed a certain concern of the producers related to the effects of soil compaction, caused by the system implanted, when we point the agricultural traffic and machinery as the major cause of real concern for farmers (CONTE et al., 2008). These problems may be controlled by reduction on the machinery traffic in determined areas, or even the use of lighter machinery and wheels with larger contact area.

Most of the works produced until now present wide range on the utilization of N by the plant. In a general way, it is defined an average of 65% of N present on the grains and approximately 35% on the other plant parts (SILVA et al., 2006).

The N cycle is affected when there is no soil disturbance, since factors as immobilization, mineralization, leaching and volatilization are changed (CABEZAS et al., 2000).

There is an important question referent to the recommendation of the use of N, in the case of different edaphoclimatic conditions, different rates of straw accumulation and time variation in the adoption of the no-tillage system. This happens since each factor presents different difficulty levels on the moment of the need of nitrogen recovery. (FIGUEIREDO et al., 2005; CABEZAS et al., 2004).

The period of nitrogenous fertilizer has a wide range concerning the N utilization on maize; however, there are no exact definitions of what would be the best period. Some experiments show that the application of nitrogen on no-tillage system is advantageous when performed in pre-seeding, while others are advantageous when applied in high dosages on the planting with nutrient supply during the cycle, provided as cover (SILVA et al., 2006).

One of the main problems of the current system of the Nitrogen fertilizer recommendation is that the determination of the dosages is made before the planting, without a later monitoring over the emergence. This happens since weather and soil variations, together with factor of leashing, volatilization, nitrification and mineralization can undergo wide ranges, and, consequently, influence the plant development. With this, it may happen an underestimation or overestimation of the dosages, which reflects in a first moment on yield loss by the farmer or, in a second, in unnecessary spend in the moment of fertilization (RAMBO et al.,2004).

The application in high dosages in only one period, weather it is on pre-seeding or seeding, may result in the accumulation of $N\text{-}NO^-_3$ on soil on the initial stages of maize development, due to its low demand. By contrast, on the usual N application period in cover (4 to 8 leaves) the demand for nitrogen increases (PÖTTKER e WIETHÖLTER, 2004).

The same authors report that the application of N in different plant development stages has as objective the supply of the nutrient especially to the initial stages, to reduce the effects of immobilization by the soil microorganisms when they decompose cultural residues (PÖTTKER e WIETHÖLTER, 2004). Different methods are used on the application of nitrogen; the most used are the incorporation in the row and broadcast. When urea is the N source used, it must be performed a soil disturbance, mixing the fertilizer when there is no rain during the first appliance days, to avoid, thus, the formation of ammonia and its release in the atmosphere.

With the no-tillage system, the content of the organic matter and N on the soil are higher, especially with the production of legumes. Thus it can be verified the possibility of applying on the chosen fodder part of the N to be used on the maize cover in succession (MAI et al., 2003).

With this in mind, it aimed to identify the components of the maize plant, as plant height, ear length, thickness of stalk and ear and ear insertion, applied on four different vegetal cover and two different period of nitrogen application.

Material and Methods

The experiment was conducted on a privet property, which belongs to the farmer Ivone Marco Primo in the municipality of Capitão Leônidas Marques (PR), with a total area of 95 hectares, in which 3080 m² were occupied by experimental area. The property is located at approximately 370 meters of altitude, in an area without irrigation and with a soil Rhodic Hapludox in no-tillage area.

Before the implantation of the experiment, soil samples were collected from each parcel in crops from 0 to 20 cm of depth, in order to evaluate the fertility.

The experimental design used was randomized block with split-plot. The setting of the experiment consisted in the division of five blocks. Inside each block it was randomized divided the experiment plots, which constituted of 7x14 meters. To facilitate the identification of covers and applications, it was left a carrier 1 meter wide between the blocks. The plant population was 60,000 plants ha^{-1} and spacing of 90 cm between rows. The fertilization was performed according to data obtained with the soil analysis.

Each plot was composed by a different species of vegetal soil cover (oak, radish, wheal and fallow) with an application of two N doses in form of urea in different periods, in pre-seeding with a planter and on the covers performed manually with the aid of a feeder. The dosage utilized was 80 kg ha^{-1} of N, distributed as follows: 1/3 furrow + 2/3 with 8 leaves and 1/3 furrow + 1/3 with 4 leaves + 1/3 with 8 leaves, it was applied 150 g of urea by plot line.

The maize hybrid used was Agroeste 1570, a simple hybrid with early cycle, of medium to high size, high technology. It was planted 5 to 6 seeds per meter.

To analyze all variables, it was used a flexible metric measure, which allowed to evaluate more accurately contours, i.e. the thickness of stem and ear. Considering the variable plant height, the process of measure initiated on the stem base, ranging to its apex. To the variable insertion of stem the process initiated on the base of the stalk and went to the peduncle. And the variable ear length was measured in a rectilinear shape without any interval or interruption. It was considered three replications for each plot, and the analysis was executed at the end of the crop cycle, when it was ready to be harvested. The static analysis was performed by the software Sisvar and Tukey at 5%.

Results and discussion

Table 1 presents the summary of the variance analysis to the F values to plant height, ear length, stem and ear thickness of the maize crop, submitted to different soil cover and periods of N application.

It can be verified, by the Table 1, that there was no significant difference at 5% of probability of mistake by the Tukey test for all variables, which are plant height, ear length, stem and ear thickness and ear insertion.

It can be seen that, although there is no significance to the general differences in all the analysis, the variation coefficient (CV) to all variables, plant height, ear length, ear thickness and ear insertion shows low data dispersion (according to the Table), either to the factor cover or to the factor

Table 1. Summary of the variance analysis to the values of F to plant height, ear lenght, stem and ear thickness of the maize crop, submitted to different soil cover and periods of N application.

Variation causes	F values				
	AP	CE	EP	EE	IE
Cover	1.39 ns	1.48 ns	1.71 ns	2.10 ns	1.67 ns
Period	0.429 ns	0.081 ns	0.00 ns	0.65 ns	0.32 ns
C x E	0.242 ns	0.068 ns	0.53 ns	0.23 ns	0.187 ns
CV1	4.40	8.11	11.11	4.45	4.44
CV2	5.21	9.45	9.82	5.85	4.21
MG	199.52	23.45	8.05	16.65	119.10

*AP: plant height; CE: ear lenght; EP: stem thickness; EE: ear thickness; IE: ear insertion. C x E: cover x application period; MG: overall average. CV 1 = variance coefficient concerning the cover; CV 2 = variance coefficient concerning periods; ns = not significant at 5% of probability; *: significant at 5% of probability.*

application period. By contrast, the variable stem thickness presented medium data dispersion, with the CV equivalent to 11.11.

In Table 2, it can be observed that all the evaluated parameters do not show significant differences in all their data concerning different soil covers. However, it may be emphasized that the average values obtained by the vegetal cover of wheat, i.e. 203.20; 24.50; 8.50; 16.80 and 121.90, representing its parameters respectively, presented a little higher potential of contribution to the maize development, noting that, even the obtaining of higher values in all variables does not mean to say that the final result expected by the crop is higher.

This way, considering that the variables analyzed that showed the highest averages are those which will present highest or best final results expected to the crop, the Wheat and Oak covers stood out. It is worth noting that the latter is the most used in Brazil (Ceretta et al., 2002).

Thus, one can agree with the idea concludes by Lourente et al. (2007) about the use of these crops as vegetal cover, since they provide a larger number of organic residues and lower decomposition rates, which enables higher soil protection and better nutrient cycling.

The experiment might be favored due to the fact that the hybrid used is of high technology, and that the dosage demanded by the crop was applied. Some factors evaluated might have suffered influence by the short period of draught in the end of the cycle, which may interfere on the final results, as the development equilibrium of the physical aspects of the studied plants that contributes on the absence of significance.

To the different application periods, the experiment did not show significant differences as it is presented in Table 3. It can only be seen small differences in each evaluated variable regarding the N application periods established by the maximum difference of 2.15 cm to plant height, therefore, the application period did not interfere on this factors.

Table 2. Average values of plant height, ear length, thickness of stalk and ear and ear insertion to different soil covers (cm).

Parameter	Cover				Overall average
	Wheat	Radish	Oak	Fallow	
Plant height	203.20 a	198.90 a	200.60 a	195.40 a	199.52
Ear length	24.50 a	22.80 a	23.30 a	23.20 a	23.45
Thickness of stalk	8.50 a	7.70 a	8.20 a	7.80 a	8.05
Thickness of ear	16.80 a	16.40 a	17.10 a	16.40 a	16.67
Ear insertion	121.90 a	117.20 a	119.70 a	117.60 a	119.10

Averages followed by the same lowercase letter do not differ by the Tukey test at 5% of significance.

Table 3. Average values of plant height, ear length, thickness of stalk and ear and ear insertion to different periods of application of N (cm).

Period of application	Plant height	Ear length	Thickness of stalk	Thickness of ear	Ear insertion
1/3 furrow + 2/3 8 leaves	198.45 a	23.35 a	8.05 a	16.55 a	118.65 a
1/3 furrow + 1/3 4 leaves + 1/3 8 leaves	200.60 a	23.55 a	8.05 a	16.80 a	119.55 a

Averages followed by the same lowercase letter in the line do not differ by the Tukey test at 5% of significance.

Thus, the present work agrees with the results obtained by Silva et al. (2006), who cite that the period of application of nitrogen fertilizers varies widely on the maize usage, however without exact definitions of which would be the best usage. It must still be emphasized that some experiments indicate that the application of N on a no-tillage system is advantageous when performed in pre-sowing period, while others show advantages when applying high dosages on the sowing and proving during the cycle as cover.

Conclusions

It was not observed significant differences to the different periods of nitrogen application on the maize crop.

To the covers, even without presenting significant differences, wheat (*Triticum spp.*) was the cover with contributed the most to the crop development in all the evaluated variables.

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