International Journal of Research in Agricultural Sciences
Volume 7, Issue 6, ISSN (Online): 2348 – 3997

Spatial Variability of *Cyperus rotundus* in Production Seedbeds of Onion and Sweet Potato

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Date of publication (dd/mm/yyyy): 23/11/2020

Abstract **– Vegetables cultivated in areas infested with *Cyperus* sp. suffer competition for water and nutrients, which requires an efficient intervention to do not reduce production. As the control of this weed represents a great challenge due to its multiple forms of propagation, the mapping of the level of infestation in the environment to be cultivated is a resource that facilitates decision making. Through the mapping of infestation zones, is possible to make recommendation maps for herbicide application and consequent reduce the production costs. The objective of this work was to analyze the spatial distribution of *Cyperus* sp. in onion and sweet potatoes seedbeds, with a grid of points every 2 and 3 meters, respectively. The removal of the plants from each quadrant was performed, including tubers and stolons. After that the material collected was washed and then dried in a kiln at 65 °c for 72 hours. The area was mapped taking the number of plants and dry mass of the aerial and root parts of *Cyperus* sp. at each quadrant on the seedbeds.**

Keywords **– Geostatistics, Kriging, Weeds, Special Distribution, Infestation.**

I. Introduction

Weeds have the ability to grow and reproduce spontaneously in all types of soil and environment. *Cyperus* sp. Is a herbaceous plant with a size between 15–50 cm belonging to the Cyperaceae family. It is a plant of difficult combat in the field, both in mechanical control, and herbicides. It has enormous multiplication capacity propagating by seeds, tillers, stolons and small tubers of high regenerative power (a single cut tuber can originate multiple plants). From these tubers comes the name *rotundus*, which of Latin means “round”. It can produce up to 40 tons of plant matter per hectare. For this, extract the equivalent of 815 kg ammonium sulfate, 320 kg potassium chloride and 200 kg of superphosphate per hectare (SILVA; PERES; LORETO, 2002).

Probably originally from India, today it is considered one of the most widely distributed plant species in the world, including tropical, subtropical and temperate climate countries. In Brazil, it occurs practically throughout the whole territorial extension. Its ability to survive in adverse conditions is enormous. Prolonged periods of drought or flooding of the terrain are supported (PASTRE, 2006).

The incidence of weeds in crops can cause losses in production and quality both by competition for water and nutrients and allelopathy, especially in critical periods (EMBRAPA, 2007). In areas of olericulture, weeds can cause greater stress in plants, because they are frequently exploited, with high fertilization, soil revolving, and large seed bank in the soil (PUJOL, 2016) thus favoring the development of weeds in the soil.

Onion and sweet potatoes are two oleraceouswidely grown in Brazil, and especially in its early stages they are very susceptible to competition for light, nutrients and have little water resistance. According to Soares and Gravena (2004), the damage caused by the influence of weeds can reach 94.5 % in onion crops.

The cost of herbicides corresponds to 60% of the consumption of pesticides (SNA, 2019). The farmer does not have the power to increase the price of his product, and most prices vary according to supply and demand. Therefore, the only way for the producers increase their profit is by reducing the cost of production and much has been done (BAIO, 2001).

Weeds have trends forming spatial patterns of agglomeration in spots (NORDMEYER et al., 1997; CLAY et al., 1999). With precision agriculture technology and the development of new equipment capable of performing localized herbicide applications, weed mapping becomes necessary and can lead to control only in the areas of occurrence (BALASTREIRE; BAIO, 2001). This management can reduce herbicide application and consequent reduction of production costs and lower application of pesticides in the environment.

The objective was to analyze the spatial distribution of *Cyperus* sp. in seedbeds with onion and sweet potato crops, with a grid of points every 2 and 3 meters, respectively.

II. Material and Methods

The experiment was developed in the municipality of Gurupi - TO, located at longitude 8700962, latitude 712378 and 287 m altitude, in 2019. According to the Koppen classification, the region's climate is Type Aw, with an average temperature of 26.4°C and an average annual rainfall of 1483 mm (CLIMATE, 2019).

The experiment was analyzed under initial post emergence conditions of *Cyperus* sp., in prepared beds with plumber, returned to 30 cm deep, and irrigated by drip. In the plantings of onion and sweet potato seedlings, the spaced used was of 10x25 cm and 50x50 cm, respectively, and the evaluation of infestation occurred at 25 days after the transplantation of the seedlings of onions and sweet potatoes, which removes the shading an root competition effect made by these main crops to *Cyperus* sp..

In both trials, the evaluation was made by removing plants of *Cyperus rotundus* by uprooting, since the presence of recently returned soil allowed the removal of seedlings, stolons, and tubers. For the determination of root and upper leaves dry weight, the collected plant material was packed and placed in a kiln with forced circulation at 65°C for 72 hours, until it reached constant weight, and then weighed in analytical scale.

The semivariogram adjustment was performed by the software GS + (ROBERTSON, 1998) that tests semivariograms of the spherical, exponential, linear and Gaussian type, being the initial selection of the model performed by the software through the smallest square sum of the residue, and higher R^2 of the equation.

In order to obtain reliable results by estimation with the Kriging method, the criteria for validation of the semivariogram models were used (VSM) according to Azevedo (2004) the semivariogram that presented R^2 equal to or greater than 0.5. After determining the choice of the interpolation method, surface maps were generated using the software Surfer 8 (GOLDEN SOFTWARE, 2008).

For analysis of the degree of dependence, a change in the classification of Cambardella et al. (1994), subtracting a unit from the division $C_0/(C_0-C_1)$, multiplying this result by 100, is now carried out according to the following equation: $RNE = \{1 - [C_0/(C_0-C_1)]\} * 100$

Expressing the value in percentage, being considered weak spatial dependence semivariograms that result in percentage values less than 25%, moderate between 25 and 75% and strong for values higher than 75%.

III. Results and Discussion

The results of descriptive statistics are presented in Table 1 in which it is observed that the production of *Cyperus* sp. in seedbeds with potatoes and onions. The area under study in which the level of infestation was quantified in relation to cultivars apparently had a productivity with a tendency to a higher expression of competition in the areas of lower vegetation cover of crops, which presented a high variability, demonstrated by high coefficient of varation (CV), and the difference between the amount of potato crop infestants reached a value greater than 4 times the onion crop.

The dry weight of shoot of *Cyperus rotundus* in potato (DWSP) and onion (DWSO) presented CV of 540 and 148% due to their high variability in their production in the areas, noting that their highest value was 4,185.76 and 37.19 g and the smallest was zero, a value that was attributed to the points where the weed was not present.

Table 1. Descriptive analysis of the production of *Cyperus* sp., number of plants in sweet potatoes (NPP), number of plants in onion (NOP), Dry weight of shoot in sweet potatoes (DWSP), dry weight of shoot in onion (DWSO), dry weight of root in sweet potatoes (DWRP), dry weight of root in onion (DWRO).

Attributes	X	Md	S	Value			Coefficient			(SW)
				Min.	Max.		CV%	C_a	C_K	
NPP	121.97	8	309.71	0	1462		254	3.28	10.95	0.402
NOP	70.53	31.5	87.77	0	260		124	1.18	-0.154	0.281
DWSP (g)	128.82	0.893	696.38	0	4185.76		540	5.97	35.79	0.466
DWSO (g)	7.08	2.42	10.54	0	37.19		148	1.81	2.46	0.268
DWRP (g)	31.29	2.05	106.51	0	628.28		340	5.35	30.23	0,387
DWRO (g)	12.36	2.97	21.35	0	90.19		172	2.34	5.33	0.281

X, average; Md, median; S, standard deviation; CV, coefficient of variation; C_a, asymmetry coefficient; C_K, kurtosis coefficient; SW, frequency distribution.

The characteristic of root dry weight in sweet potatoes (DWSP) and onion (DWSO) presented CV of 340 and 172 %, and its greatest value was 628,28 e 90,17 g and the smallest was zero, where were the points where the invasive plant was not present. Adopting the criteria for classification of the coefficient of variation (CV) proposed by Gomes (2000) that it considers as low (< 10%); middle (10%< CV >20%); high (20%< CV >30%) and very high (CV >30%), the values were considered too high for all characteristics.

The high variability of experiment considering CV, asymmetry, and kutosis in an experiment with spatial distribution of weeds was also found by Chiba et al. (2010). High values are justified by the analysis of data from counting the number of weeds. This result was expected, as there were places that did not present *Cyperus* sp., and others with a high number of them, as can be observed in the maximum and minimum values (Table 1).

Analyzing Table 2 that presents the adjustments of the semivariograms, it is noted that the model that best adjusted for the characteristics NPP, DWSP, DWRP, and DWRO was the spherical, with a range of 6.94, 6.51, 6.90 and 7.66 m, respectively. And for NOP and DWSO, the model that adjusted the most was gaussian, with a range of 7.41 and 6.65, and all features had a strong degree of spatial dependence, meeting the parameters established for the use of Kriging.

Table 2. Parameters of semivariograms adjusted for the production of *Cyperus* sp., number of plants in sweet potato (NPP), number of plants in onion (NOP), dry weight of shoot in sweet potatoes (DWSP), dry weight of shoot in onion (DWSO), dry weight of root in sweet potatoes (DWRP), dry weight of root in onion (DWRO).

Attributes	Model	Nugget (C_0)	Sill (C_0-C)	Range (m)	R^2	SQR	RNE (%)	Space Dependency Class
NPP	Spherical	$1,20.10^3$	$7,16.10^4$	6,94	0,78	$9,09.10^7$	98,3	Strong
NOP	Gaussian	$1,0.10^1$	$9,15.10^3$	7,41	0,90	$6,70.10^6$	99,9	Strong
DWSP (g)	Spherical	$1,30.10^3$	$3,45.10^5$	6,51	0,87	$8,42.10^8$	96,2	Strong
DWSO (g)	Gaussian	$1,0.10^{-1}$	$1,36.10^2$	6,65	0,91	$8,06.10^2$	99,9	Strong
DWRP (g)	Spherical	$3,40.10^2$	$7,97.10^3$	6,90	0,89	$4,32.10^5$	95,7	Strong
DWRO (g)	Spherical	1,00	$5,49.10^2$	7,66	0,89	$1,30.10^4$	99,8	Strong

SQR, sum of squares waste; RNE, degree of spatial dependence.

All models with spatial dependence on NPP, NOP, DWSP, DWSO, DWRP e DWRO, presented R^2 of the semivariogram higher than 0.7, in addition to a degree of spatial dependence above 95% for all characteristics evaluated.

It can be observed in Table 2, that the number of *Cyperus* sp. in sweet potato and onion seedbeds presented strong spatial dependence, which allows localized herbicides application (SCHAFFRATH et al., 2007). The identification of the herbicide management zone leads to economic benefits and less impact on the environment.

The total number of *Cyperus* sp. plants was used for map modeling and their spatial distribution can be observed in Figure1.

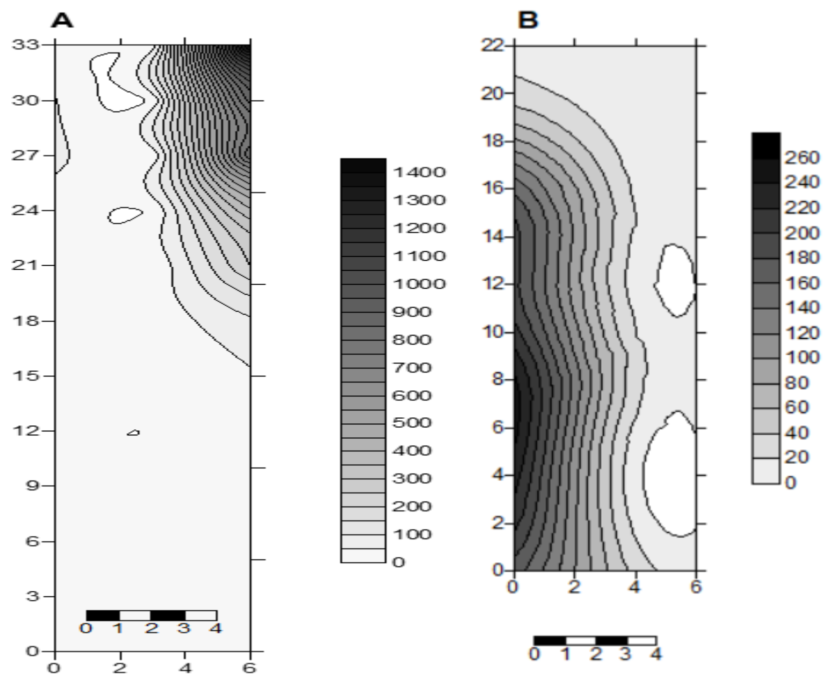

Fig. 1. Distribution map of *Cyperus* sp. on sweet potato beds (A) and onion (B).

In Figure 1, in the contour map of isolines formed from semivariogram models it was possible to observe the staining distribution of weeds, which was also observed by Nordmeyer et al., 1997, Clay et al., 1999, Schaffrath et al. (2007) e Chiba et al. (2010).

Weed mapping through the use of geostatistical methods offers the potential for localized management strategies. In the occurrence sites of weed in stains, managements such as mechanical control, implantation of suppressive crops and localized herbicide application can be adopted (SCHAFFRATH et al., 2007).

Chiba et al. (2010), observed spatial distribution defined for both broadleaf weeds and narrow leaves, which allows the use of geostatistics. This mapping with aggregate type occurrence structure favors the localized application of herbicides (SCHAFFRATH et al., 2007).

Baio (2001), found that localized herbicide application generated savings of 31.6% when compared to application in total area. The application of variable rate of herbicides, through the mapping by kriging, in the sunflower crop under direct sowing allowed savings of the order of 81% (JURADO-EXPOSITO et al., 2005).

IV. Conclusion

It was possible to observe strong spatial dependence for the distribution of *Cyperus* sp. in onion and sweet potato seedbeds. The range for the observed characteristics ranged from 6 to 7 meters. The use of geostatistical methods has the potential for weed mapping, formation of herbicide application recommendation zones and consequently localized management strategies. These actions lead to reduced production costs with herbicides and less environmental impact on agriculture.

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International Journal of Research in Agricultural Sciences
Volume 7, Issue 6, ISSN (Online): 2348 – 3997

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