BROADLEAVED WEED SPECIES ASSOCIATION IN RICE FIELDS

Fábio Schreiber[1]; Germani Concenço[2]; André Andres[2]; Samara Emerim Concenço[3]; Ivana Santos Moisinho[4]; Jeferson F. Prates[4]; Mariane Camponogara Coradini[4]; Matheus Bastos Martins[4]; Andressa Pitol[5]

Keywords: chi-square; lowlands; rotation.

INTRODUCTION

The relationship between weed species and crops in arable fields is explored by several authors in terms of competitive aspects and crop yield losses (FRANCO et al., 2017). However, only recently the interactions within the weed community in these same arable fields are gaining importance in the weed science (SANTOS et al., 2017).

Weed species association are known to occur to a certain degree, aiming to increase survival rates. In arable fields that follow the same weed management season after season (i.e. same herbicide, soil tillage, crop species), the associations among weed species are expected to be valid at a higher degree, since species that are not adapted to these conditions tend to be eliminated (GUREVITCH et al., 2009).

In rice fields, an overall comprehension regarding weed associations is almost completely ignored, but its importance lies on two aspects: (1) weed species that build up a positive association will answer better to stresses (PATERNO et al., 2016), such as herbicide applications and flooding; and (2) the understanding of these associations would make possible to elaborate management strategies, whether they are chemical or cultural (water management), that would control a wider range of weed species which occur simultaneously in lowland rice. Moreover, this information would also be relevant for crops that succeed rice in the rotation scheme (soybean, sorghum).

The understanding of these two aspects would provide weed researchers with information about the species that are most prone to survive, reproduce and increase its frequency into rice fields. In rice fields, there is an increasing concern with broadleaved weeds because several species are becoming resistant to herbicides (ANDRES et al., 2013). In addition, when considering a crop rotation scheme, weed species that not infest rice, but are able to survive under flooding, will infest the crop grown in succession.

We aimed with the present study to characterize the association among broadleaved weed species in lowland areas, as a tool to understand weed occurrence and subsidize long term management programs for areas where rice is rotated with other crops.

MATERIAL AND METHODS

After a sequence of summer crops in an area of 1.5 ha which included flooded rice and sorghum (sorghum-2010 / rice-2011 / sorghum-2012 / rice-2013 / fallow-2014), in March 2015, the area was subsoiled and received the application of limestone. Immediately, superficial drains were made in order to aid in the drainage of excess water from rainfall. Ryegrass (*Lolium multiflorum*) was planted in April 2015, leaving an area without succession

[1] Engenheiro Agrônomo, Dr., bolsista de pós-doutorado da área de Manejo Sustentável de Plantas Espontâneas, Embrapa Clima Temperado, Pelotas-RS.

[2] Engenheiro Agrônomo, Dr., Pesquisador, Embrapa Clima Temperado, Rodovia BR 392, km 78, 9º Distrito - Monte Bonito, Pelotas, RS, Brazil. CEP. 96010-971, email: germani.concenco@embrapa.br.

[3] Agronomist, Federal Technical Institute of Santa Catarina, Campus Santa Rosa do Sul, Santa Rosa do Sul, SC, Brazil.

[4] Estudante de Agronomia, Universidade Federal de Pelotas, estagiário da área de Manejo Sustentável de Plantas Espontâneas, Embrapa Clima Temperado, Pelotas-RS.

[5] Engenheiro Agrônomo, mestrando na área de fitossanidade FAEM/IUFPel, Pelotas-RS.

of crops after ryegrass cultivation. In 2016 a herbicide application with ACCase-inhibitor was carried out in order to eliminate the grass weeds, and in April of the same yea,r the present study was implanted.

Field survey was carried out in May 2016, on 100 quadrats with 0.5 m side (0.25 m^2) that were randomly sampled into the experimental area described above. For each sampling, all plant species rooted into the quadrat were identified and recorded. Plant species which were not known at the time of the evaluation were taken to the lab for posterior identification by a plant taxonomist. Plant species occurring into each quadrat were listed and compared in pairs, being the data organized in 2 x 2 contingency tables, as follows (CHAPMAN, 1976):

Species "y" \ Species "x"	+	-	
+	*a*	*b*	*a+b*
-	*c*	*d*	*c+d*
	a+c	*b+d*	*n*

where:

X^2 = chi-square estimation with Yates' correction;
a = number of quadrats containing both species;
b = number of quadrats containing only species "y";
c = number of quadrats containing only species "x";
d = number of quadrats containing both species;
n = total number of quadrats in the contingency table.

The association between plant species was estimated by the chi-square test, both at 1% and 0.1% of significance, simply represented by the formula (Chapman, 1976):

$$X^2 = \frac{n\,[(|ad - bc|) - 0.5\,n\,]^2}{(a+b)(c+d)(a+c)(b+d)}$$

All formulas and procedures for areas sampling, community description and species clustering, followed recommendations by Chapman (1976) for synecological analyses.

RESULTS AND DISCUSSION

The contingency matrix (Figure 1) indicated possibility of association between several pairs of broadleaved lowland weed species; at 1% significance, 51 associations were reported, out of 300 possible associations (17% association possibility); at 0.1% significance, 4.7% of association possibility was reported (14 out of 300). The species which did not associate to any other (1% significance) were *Eclipta alba*, *Raphanus raphanistrum*, *Sagina chilensis* and *Solidago chilensis*. These species should be further studied for allelopathic effects, among other factors.

On the other hand, the most sociable species were *Emilia sonchifolia* and *Plantago tomentosa*, that even at 0.1% significance were able to associate to other six species (Figure 2). The X^2 test, when significant, does not necessarily indicate that the presence of one of these species causes the occurrence of its associates (HERBEN et al., 2016). However, it reports that the positively associated weed species occur together more often than would be expected by chance.

Among the factors which could favor these positive associations are: (1) similar demand for environmental resources (GUREVITCH et al., 2009); (2) frequently imposed selection pressure which causes survival of a given group of independent plants; and (3) interdependence between species, where a factor connected to a given weed species increases the survival or occurrence of other (HERBEN et al., 2016).

1% significance (above diagonal) / 0.1% significance (below diagonal)

		1 Bidens pilosa	2 Centella asiatica	3 Chrysanthemum myconis	4 Conyza bonariensis	5 Conyza canadensis	6 Eclipta alba	7 Emilia sonchifolia	8 Facelis retusa	9 Gamochaeta coarctata	10 Gamochaeta simplicicaulis	11 Gnaphalium pensylvanicum	12 Gnaphalium purpurium	13 Gnaphalium spicatum	14 Plantago tomentosa	15 Pluchea sagitallis	16 Polygonum persicaria	17 Raphanus raphanistum	18 Sagina chilensis	19 Silene gallica	20 Solanum americanum	21 Solidago chilensis	22 Soliva pterosperma	23 Trifolium resupinatum	24 Triodanis perfoliata	25 Veronica peregrina
1	Bidens pilosa		+																							
2	Centella asiatica					+		+							+									+		+
3	Chrysanthemum myconis																+									
4	Conyza bonariensis					+		+				+			+	+				+			+			
5	Conyza canadensis							+				+			+											+
6	Eclipta alba																									
7	Emilia sonchifolia					+			+	+		+	+	+	+	+									+	+
8	Facelis retusa							+				+	+	+	+		+									+
9	Gamochaeta coarctata										+					+	+									
10	Gamochaeta simplicicaulis																									
11	Gnaphalium pensylvanicum							+					+		+	+	+								+	
12	Gnaphalium purpurium													+	+	+	+				+					
13	Gnaphalium spicatum														+	+										
14	Plantago tomentosa					+		+	+			+				+									+	+
15	Pluchea sagitallis							+							+											
16	Polygonum persicaria								+																	
17	Raphanus raphanistum																									
18	Sagina chilensis																									
19	Silene gallica																									
20	Solanum americanum																									
21	Solidago chilensis																									
22	Soliva pterosperma					+																				
23	Trifolium resupinatum			+																						
24	Triodanis perfoliata							+							+											
25	Veronica peregrina																									

Figure 1. Complete chi-square contingency matrix for a pool of 100 samples, showing the relationships between pairs of broad-leaved weed species, at 1% and 0.1% significance levels. The species association tree for *E. sonchifolia* and *P. tomentosa* are highlighted at the 0.1% significance side of the table.

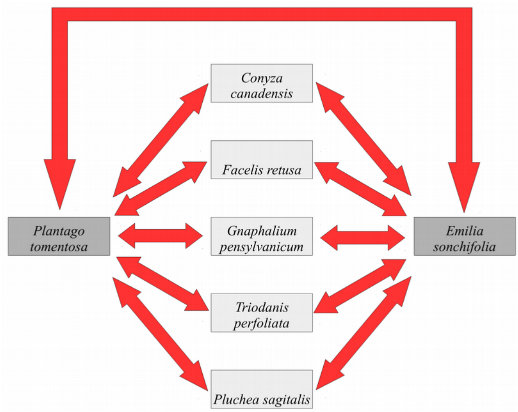

Figure 2. Schematic association between *P. tomentosa* and *E. sonchifolia* with their associated weed species.

For (1), areas which are too large are most prone to lack of homogeneity all along its extension; thus, clusters of species which present similar nutrient or moisture demand, as example, tend to naturally occur together with no direct relationships among the species into the cluster (GUREVITCH et al., 2009). The same is observed for small areas which are too inhomogeneous. For (2), a frequently imposed selection pressure, as the repetitive application of a given herbicide or frequent soil tillage with the same equipment at the same soil depth, would naturally select plant species less susceptible to that stress; thus, an ecologically unrelated and independent group of plant species could often occur together while no dependence among species is established. For (3), a root exudate from a given species could promote seed germination of positively associated weed species; the same would be observed in the case where one of the species attracts pollinators which will also pollinate its associates (GUREVITCH et al., 2009).

Our study supply evidence that there are associations among lowland broadleaved weed species aiming survival. In general, the plant association technique seems to be appropriate for studies in weed science. The X^2-based test was able to indicate those weed species which were not associated to their neighbors.

The knowledge about plant species associations in lowland areas, in rice or crops in rotation, would allow management strategies to give preference for those herbicides which are efficient on most species into the cluster, in despite of those which would control only the dominant weed species. This will help reducing the long-term weed selection in rice fields, by means of reducing the number of resistant weed biotypes to herbicides, and contribute to the sustainability of herbicide applications in rice and other crops in rotation.

CONCLUSION

There are associations among lowland broadleaved weed species aiming survival. Preference should be given for herbicides which are efficient on most species into the same cluster, in despite of those which would control only the dominant weed species.

REFERENCES

ANDRES, A.; THEISEN, G.; CONCENÇO, G.; GALON, L. Weed resistance to herbicides in rice field in Southern Brazil. In: PRICE, A. J.; KELTON, J. A. (Ed.). **Herbicides**: current research and case studies in use. Rijeka: InTech, 2013. p. 3-25.

CHAPMAN, S.B. (Ed.). **Methods in plant ecology**. Oxford: Blackwell, 1976.

FRANCO J.J. et al. Relative competitiveness of goosegrass biotypes and soybean crops. **Caatinga,** Mossoró, v. 30, n. 1, p. 271-277, 2017.

GUREVITCH, J.; SCHEINER, S.M.; FOX, G.A. (Eds.). **Ecologia vegetal**. Porto Alegre: Artmed, 2009.

HERBEN, T. et al. Reproduction by seed and clonality in plants: correlated syndromes or independent strategies? **Journal of Ecology,** v. 104, n. 6, p. 1696-1706, 2016.

PATERNO, G. B. et al. Species-specific facilitation, ontogenetic shifts and consequences for plant community succession. **Journal of Vegetation Science**, v. 27, n. 3, p. 606-615, 2016.

SANTOS, R. N. V. et al. Phytosociology and weed interference in okra under organic cropping system. **African Journal of Agricultural Research**, v. 12, n. 2, p. 251-259, 2017.