Weed and Insect Communities in Wheat Crops with Different Management Practices

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ABSTRACT

Biotic adjustments to changes in crop management practices are reflected in the presence or absence of weed and insect populations. The pattern of response and the causes that drive them are important to reveal the main factors involved in molding the structure of an agroecosystem and its dynamics. In this study, weed and insect communities were characterized in wheat (*Triticum aestivum* L.) crops from the Rolling Pampas with different cropping histories. Surveys were performed in fields that were selected randomly from those located on highlands with typical Argiudol soils and cultivated with conventional tillage. Fields, weeds, and insects were classified with cluster analysis, and weed and insect associations were determined using agronomic variables with canonical correspondence analysis (CCA). The classification of the data resulted in six floristic groups and seven insect groups that characterized different weed and insect communities. Three weed and insect communities associated with the number of years with annual cropping after a pasture that lasted for several years, the duration of wheat crop cycle, and soybean as a preceding crop were identified.

Structural and functional changes in the ecosystems of the Rolling Pampas occurred during the 20th century (Ghersa and Martínez-Ghersa, 1991; Ghersa and León, 1999). For example, the landscape changed from grassland to an agricultural mosaic, and the natural factors that regulated the ecosystem composition and function lost their importance in relation to agricultural management factors. Wheat was one of the pioneer crops introduced to the region, and it had and will continue to have a significant economic and ecologic impact (Parodi, 1926; 1930; Hall et al., 1992).

Land use in this region has been intensified since 1970, after wheat–soybean [*Glycine max* (L.) Merr.] double cropping expanded throughout the region, increasing soil cultivation and generating a heterogeneous environment associated with the cropping histories of the fields (Michelena et al., 1989). This heterogeneity implies heterogeneity in resource distribution (Pastor et al., 1997), weed community structure (Ghersa and Martínez de Ghersa, 1991; Ghersa et al., 1996; Ghersa and León, 1999; de la Fuente et al., 1999; Suárez et al., 2001), and plant tissue chemistry and associated plant growth traits (Pastor et al., 1997; Gil et al., 2002).

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Changes promoted by land use in the abiotic (physical and chemical environment) and in the biotic (crop and weed) components of the agroecosystem can considerably influence other biotic components of the agroecosystem, e.g., insect numeric balance, population dynamics, and species diversity (Thies and Tscharntke, 1999; Norris and Kogan, 2000).

Taxonomically diverse plant habitats often provide microclimates, greater availability of food sources (prey, pollen, and nectar), alternative hosts, and shelter sites that encourage colonization and population buildup of natural enemies (Coll and Bottrell, 1995; Dicke, 1999). In wheat fields, for instance, predator abundance, species richness, and species diversity increased with an increase in vegetation diversity, the amounts of noncultivated land, and patchiness in the surrounding landscape (Elliott et al., 1999).

The characterization of the causes that drive changes in number of weeds and insects in agroecosystems has been recognized as a very important factor in acquiring knowledge on how to manage agronomic production (Harper, 1977; Cox and Atkins, 1979; Norris and Kogan, 2000). Besides, there is very little empirical information that may be useful to characterize the relationship between cropping history and structure of the biotic communities in the agroecosystems. This kind of information would be an important step toward the understanding of the causes and patterns of change in the structure of the biotic community in cropped lands. Therefore, our objective was to identify weed and insect communities in wheat crops with different cropping histories and to find relationships between management practices and the structure of these communities.

MATERIALS AND METHODS

Description of the Area

The Rolling Pampas is a subregion of the grassland of Río de la Plata in Argentina (between 34 and 36° S and 58 and 62° W) (Fig. 1). The climate is mild and humid with hot summers. Annual average rainfall is 950 mm, annual average temperature is 17°C, and the prevailing type of soil is Argiudol (Soriano et al., 1991; Hall et al., 1992). In those areas where the main activity is agriculture, there is a significant loss of the A horizon, with a marked reduction of organic matter, total N, and available P (Michelena et al., 1989).

Sampling Procedure

In 1996 and 1997, 29 surveys were performed in wheat fields cultivated with conventional tillage to identify weed and insect communities. Surveys were performed in late spring, between 15 November and 15 December, in both years, in similar

Abbreviations: CCA, canonical correspondence analysis.

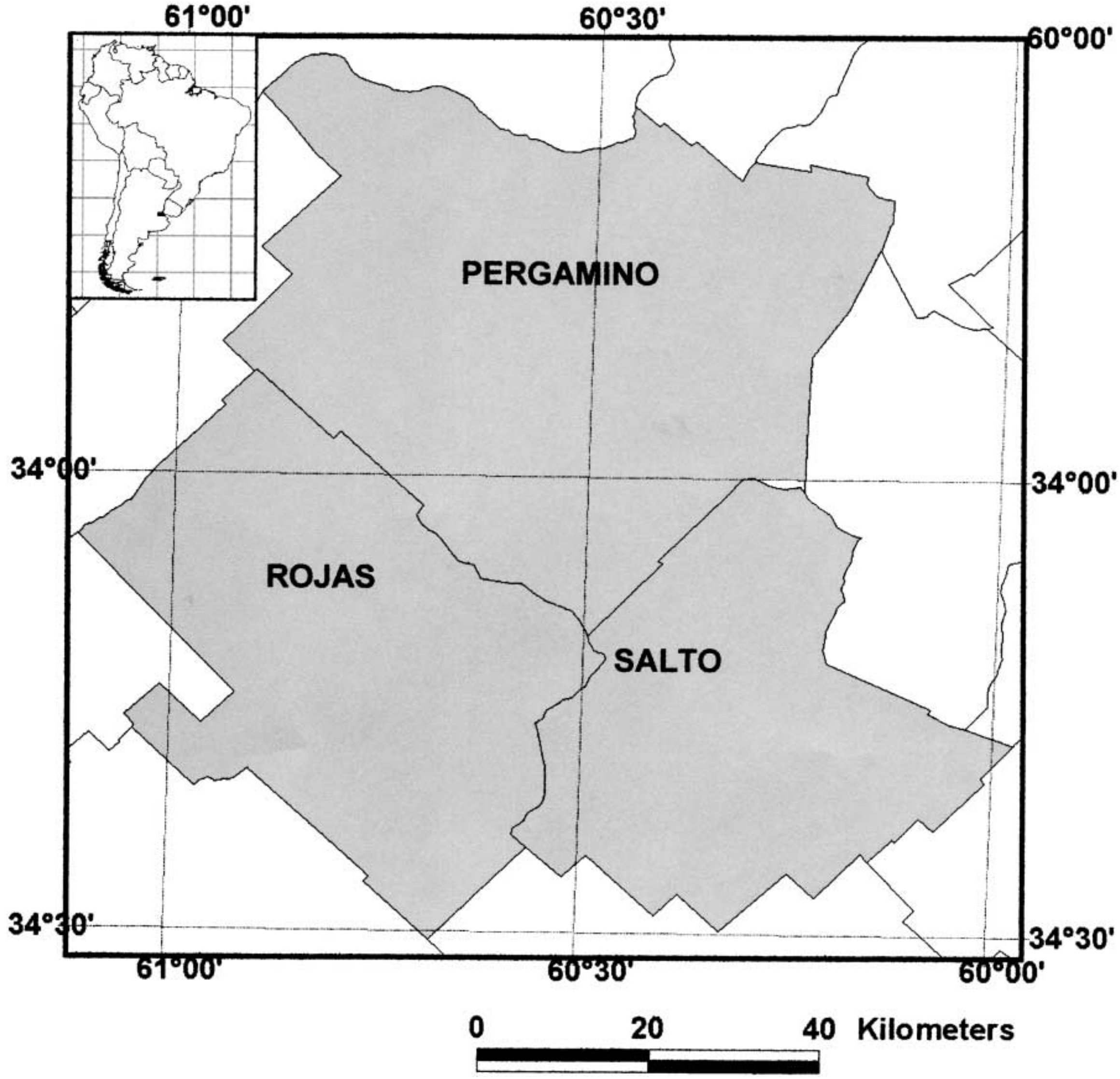

Fig. 1. Map of the area under study. The gray-shaded area indicate the departments (Rojas, Pergamino, and Salto) of the central Rolling Pampas included in the survey. The map in the inset shows the location of the area under study (black square) in South America.

environments located in the central area of the Rolling Pampas, covering a surface of approximately 5×10^4 ha. Fields were selected randomly on highlands of typical Argiudol soils (INTA, 1974). The sampling area of each survey included the whole central part of the field, with an average area of 70 ha, and borders were avoided. All weeds found in the sampling area were recorded. Most weeds in the surveyed crop fields were subordinated to the crop, presenting low cover abundance values and low height. Insects were captured with sweep net (Tonkyn, 1980). Fixed net sizes (30 cm diam.) and sweeping patterns were used (three points with four net sweepings in each one). The sampling was performed under similar climatic conditions at the same time between 1000 h and 1600 h each day. Once the crop cycle had finished, farmers provided information concerning the following agronomic variables: sowing dates, fertilization, weed and insect management, yields, previous crops, and rotation.

Data Analyses

Weed and insect data were analyzed in terms of species composition. Insect determination was done at order level in all cases and at superfamily, family, or species level when possible. The determination work at these last levels is usually time-consuming, if not impossible, due to lack of taxonomy expertise. Besides, sometimes detailed taxonomy does not improve the results in detail, despite the long time required for acquiring proper taxonomic knowledge (Paoletti and Bressan, 1996). The insect specimens that document our observations are available in our personal insect collection at the Faculty of Agronomy, University of Buenos Aires. The presence or absence of data corresponding to weeds or insects and fields were classified using a cluster analysis. A Sorenson coefficient (CC) version modified by Bray and Curtis (Magurran, 1988) was used for species and surveys as distance measure:

$$CC = 2W/(A + B)$$

where W is the number of species shared between fields and A and B are the total number of weeds or insects in each sample. Farthest neighbor (complete linkage) was used for weed or insects where the distance between two clusters is given by the maximum distance between any pair of numbers of both clusters. Group average linkage was used as similarity measure (van Tongeren, 1987) for fields. Classifications of weeds or insects and fields were combined in a table where groups of weeds or insects are shown in rows and communities are shown in columns. Constancy (proportion of fields in which a given species occurs in the survey) was calculated for every weed or insect in the community. Weeds or insects with constancy values <10% were eliminated from the analysis because species with lower constancy may be considered as more or less accidental occurrences (Mueller-Dombois and Ellenberg, 1974). Arthropod habits and food preferences were determined using anatomic characteristics and bibliography (Richards and Davies, 1984; Arroyo Varela and Viñuela Sandoval, 1991).

Weed and insect heterogeneity was related to the agronomic variables. The ordination of weeds and insects in fields, obtained from the reciprocal averaging, was constrained to the agronomic variables by multiple regressions with CCA (ter Braak, 1987). Canonical correspondence analysis constructs those linear combinations (axes) of environmental variables along which the distribution of the species is maximally separated. To determine association between data and agronomic variables, a biplot from CCA was prepared by overlaying a vector diagram. It was based on coefficients from the canonical functions describing each canonical axis. The direction of vectors indicates the association of fields with agronomic variables, and the length indicates the discriminating power of the association.

Crop grain yield and the number of years since the last pasture were analyzed with ANOVA, and differences among the means were tested with Tukey test.

RESULTS

Weed Community

The classification of 38 weed species with total constancy values ≥10% resulted in six floristic groups (Table 1). Two groups, I and III, presented high average total constancy (63 and 48%, respectively); another two groups, II and IV, presented intermediate average total constancy (33 and 26%, respectively); and finally, Groups IV, V, and VI presented a low average total constancy (16 and 13%). Groups I and III were common to all weed communities, whereas Groups II, IV, V, and VI characterized different weed communities.

The classification of 29 fields resulted in three weed communities: A, B, and C, with a species richness of 32, 32, and 34, respectively. Community A was charac-

Table 1. Constancy values of weed species of wheat in the central Rolling Pampas, Argentina, and units (groups and communities) resulting from the cluster analysis.

Group	Species	Constancy of communities			
		A	B	C	Total†
		%			
I	Spurred anoda [*Anoda cristata* (L.) Schlecht]	67	100	100	86
	Lambsquarters (*Chenopodium album* L.)	92	75	88	86
	Large crabgrass [*Digitaria sanguinalis* (L.) Scop.]	50	75	88	68
	Johnsongrass [*Sorghum halepensis* (L.) Pers.]	67	38	88	64
	Fierce thornapple (*Datura ferox* L.)	50	63	88	64
	Buckwheat (*Polygonum convolvulus* L.)	33	63	88	57
	Chickweed [*Stellaria media* (L.) Vill.]	58	63	50	57
	Woodsorrel (*Oxalis chrysantha* Prog.)	42	50	75	54
	Plumeless thistle (*Carduus acanthoides* L.)	42	38	75	50
	Barnyardgrass [*Echinochloa crusgalli* (L.) Beav.]	58	38	38	46
II	Wild marigold (*Tagetes minuta* L.)	50	63	38	50
	Persian speedwell (*Veronica persica* Poir.)	33	88	13	43
	Oat (*Avena fatua* L.)	42	38	13	32
	Soybean [*Glycine max* (L.) Merr.]	25	75		32
	Smallflower galinsoga (*Galinsoga parviflora* Cav.)	25	38		21
	Spurge (*Euphorbia lasciocarpa* Klotzsch)	25	25	13	21
III	Bull thistle [*Cirsium vulgare* (Savi) Terone]	58	38	88	61
	Swinecress [*Coronopus didymus* (L.) Smith.]	50	25	50	43
	Knotweed (*Polygonum aviculare* L.)	50	13	50	39
IV	Annual ryegrass (*Lolium multiflorum* Lam.)	17	38	63	36
	Bowlesia (*Bowlesia incana* Ruiz et Pav.)		50	50	29
	Dandelion (*Taraxacum officinale* Weber in Wiggers)	17	38	38	29
	Annual sow thistle (*Sonchus oleraceus* L.)	8	38	25	21
	Dichondra [*Dichondra microcalyx* (Hallier) Fabris.]		25	25	14
V	Celery [*Apium leptophyllum* (Pers.) F. Muell.]	8	25	50	25
	Bitter gourd (*Cucurbita andreana* Naud.)	17		38	18
	Clover (*Trifolium repens* L.)	17		38	18
	Ammi [*Ammi visnaga* (L.) Lam.]			50	14
	Beggarticks (*Bidens subalternans* de Candolle)			50	14
	Purslane (*Portulaca oleracea* L.)	8	13	25	14
	Pimpernel (*Anagallis arvensis* L.)		13	25	11
	Mustard (*Brassica rapa* L.)		13	25	11
VI	Alligatorweed [*Alternantera philoxeroides* (M.) Griseb.]	42		13	21
	Cocklebur (*Xanthium cavanillesii* Schouw)	17	13	13	14
	Wormwood (*Artemisia annua* L.)	17	13		11
	Rescuegrass (*Bromus catharticus* Vahl)	8	13	13	11
	Curly dock (*Rumex crispus* L.)	25			11
	Chamomile (*Anthemis cotula* L.)	8	13	13	11
	Species richness and number of surveys				
	Richness	32	32	34	38
	Number of surveys	12	8	9	29

† Constancy of weeds in all the fields of the survey.

terized mainly by Groups I, II, III, and VI; Community B was characterized mainly by Groups I, II, III, IV, and VI; and Community C was characterized mainly by Groups I, III, IV, V, and VI (Table 1).

Insect Community

The classification of 63 insect species with constancy values ≥10% resulted in seven insect groups (Table 2):

Table 2. Constancy values and function, herbivorous (h) and beneficial (b), of wheat insect species in the central Rolling Pampas, Argentina, according to the identified weed communities.

Group	Order	Family or superfamily	Species	Function	Constancy of communities A	B	C	Total†
					%			
I	Diptera	Muscidae	Species di011	b	100	100	100	100
	Coleoptera	Coccinellidae	Eriopis connexa	b	88	100	100	95
	Coleoptera		Species co001		100	100	57	92
	Hymenoptera	Eulophidae	Species hy022	b/h	100	100	80	92
	Hemiptera	Cicadellidae	Species he037	h	100	100	80	92
	Hemiptera	Aphididae	Species he018	h	100	100	60	83
	Diptera	Sarcophagidae	Species di019	b	88	67	86	81
	Coleoptera	Chrysomelidae	Cicloceraia sp	h	88	83	71	81
	Hemiptera		Species he010		75	67	80	75
	Hymenoptera		Species hy024		100	67	40	67
	Diptera		Species di013		75	67	40	58
	Hemiptera	Nabidae	Species he089	b	63	50	29	48
	Hemiptera	Pentatomidae	Species he055	h	50	50	43	48
	Hemiptera		Species he016		25	33	20	25
	Hemiptera		Species he017		25	33	20	25
	Orthoptera	Tettigoniidae	Neoconocephalus argentinus	b	25	33	14	24
	Hemiptera	Lygaeidae	Species he025	h	13	17	14	14
	Coleoptera	Chrysomelidae	Caeporis stigmula	h	13	17	14	14
	Coleoptera	Chrysomelidae	Diabrotica speciosa	h	13	17	14	14
II	Diptera		Species di021		100	67	20	58
	Hemiptera		Species he042		50	67		33
	Hymenoptera	S. Cynipoidea	Species hy027	b/h	50	33		25
	Coleoptera		Species co004		25	33		17
	Hymenoptera	Mymaridae	Species hy038	b	25	33		17
	Coleoptera		Species co077		25	33		17
	Neuroptera	Chrysopidae	Chrysopa lanata-lanata	b	25	17		14
	Coleoptera	Chrysomelidae	Species co138	h	13	17		10
	Diptera	Syrphidae	Species di024	b	13	17		10
III	Diptera	Tipulidae	Species di050		25	100	80	67
	Colembolo		Species cl064	h	25	100	80	67
	Diptera	Muscidae	Species di070		25	67	60	50
	Hymenoptera	Braconidae	Species hy029	b	25	67	40	42
	Diptera	Dolichopodidae	Condylostylus sp	b	13	50	43	33
	Coleoptera		Species co062			67	40	33
	Hymenoptera	Formicidae	Species hy063	h		67	40	33
	Hymenoptera		Species hy153			33	60	33
	Diptera	Muscidae	Species di122	b		50	29	24
	Hymenoptera	S. Ceraphronoidea	Species hy067			33	20	17
	Hymenoptera	Eurytomidae	Bruchophagus sp	h		33	20	17
	Hemiptera	Reduviidae	Species he045	b		33	14	14
	Hymenoptera	Formicidae	Species hy109	h		17	29	14
	Coleoptera	Coccinellidae	Species co049	b		17	14	10
	Hemiptera	Cydnidae	Species he130	b		17	14	10
	Macrolepidotera	Arctiidae	Species le139	h		17	14	10
	Hemiptera	Lygaeidae	Species he063	h		17	14	10
	Diptera	Tephritidae	Species di069	h		17	14	10
IV	Hemiptera	Cicadellidae	Species he011	h	75	33	60	58
	Hymenoptera	Ichneumonidae	Species hy054	b	75	17	57	52
	Diptera		Species di052		50		20	25
	Coleoptera		Species co005		25		20	17
	Coleoptera		Species co008		25		20	17
	Hymenoptera		Species hy039		25		20	17
	Coleoptera	Meloidae	Epicauta sp	h	13		14	10
V	Diptera		Species di051		50			17
	Hymenoptera	Formicidae	Species hy028	h	50			17
	Coleoptera	Melyridae	Astylus atromaculatus	h	25			10
VI	Hymenoptera	S. Ceraphronoidea	Species hy025	b	25	100	20	42
	Hemiptera	Aphididae	Species he034	h		67		17
	Macrolepidoptera	Geometridae	Species le106	b		33		10
VII	Orthoptera	Acrididae	Species or015	h	13	17	57	29
	Hemiptera	Lygaeidae	Geocoris sp	b	13	17	43	24
	Coleoptera		Species co057				40	17
	Hymenoptera	Braconidae	Species hy094	b			29	10
		Species richness and number of herbivorous and beneficials						
	Richness				47	53	50	63
	Herbivorous				14	18	17	21
	Beneficials				13	18	15	19

† Constancy of insects in all fields of the survey.

one group, Group I, with a high average total constancy (59%); four groups, II, III, IV, and VI, with an intermediate average total constancy (22, 27, 28, and 23%, respectively); and two groups, V and VII, with a low average total constancy (14 and 20%, respectively). Group I was common to all insect communities, whereas Groups II, III, IV, V, VI, and VII characterized different insect communities.

The classification of fields resulted in three insect communities (Table 2): A, B, and C, with a species richness of 47, 53, and 50 respectively. Community A was characterized mainly by Groups I, II, IV, and V; Community B was characterized mainly by Groups I, II, III, and VI; and Community C was characterized mainly by Groups I, III, IV, and VII.

The habits and food preferences were established in only 42 cases (63%) out of a total of 63 insects. In Group I, for instance, species such as *Cicloceraia* sp., *Caeporis stigmula*, and *Diabrotica speciosa* are herbivorous while others, such as *Eriopis connexa* and *Noconocephalus argentinus*, can be classified as beneficial insects as they are predators of the herbivorous ones. No differences among communities were detected in the proportion of herbivorous and beneficial insects.

Relationship between Weed–Insect Communities and Management Practices

The data concerning management practices revealed some differences among communities (Table 3). Years since the last pasture and yield for the long-crop-cycle wheat cultivars were significantly different among communities. When relationships between the structure of weed–insect communities and management information were studied, Community A presented low species richness (32 weed species and 47 insect species) and the presence of Insect Group V. As to the management practices, fields that characterized this community had a high number of years since the last pasture (19 yr), low yields (3.2 Mg ha^{-1} for long crop cycle and 3.0 Mg ha^{-1} for short crop cycle), and a high proportion of fields cultivated with short-crop-cycle cultivars, having soybean as preceding crop. Community B presented low weed species richness (32 species), the highest insect species richness (53 species), and the presence of Insect Group VI. This result coincided with those fields with an intermediate number of years since the last pasture (13 yr), high crop yields (4.3 Mg ha^{-1} for long crop cycle and 3.6 Mg ha^{-1} for short crop cycle), and a high proportion of fields cultivated with short-crop-cycle cultivars, treated with insecticides and having corn (*Zea mays* L.), soybean, and wheat–soybean as preceding crops. Finally, Community C presented high weed species richness (34 species), intermediate insect species richness (50 species), and the presence of Weed Group V and Insect Group VII. This data coincided with fields with the lowest number of years since the last pasture (3 yr), low crop yields (3.0 Mg ha^{-1} for long crop cycle and 3.0 Mg ha^{-1} for short crop cycle), a balanced proportion of fields cultivated with short- and long-crop-cycle cultivars, having corn and soybean as preceding crops.

The CCA provided results with regard to the most important factors among the measured variables affecting the occurrence of weeds and insects, which explain 53.9% of the total variance in weed–insect data. The three communities were ordered in relation to the three main axes. Eigenvalues were high, considering that variation was restricted to measured variables. The agronomic variables affected weeds and insects. The intraset correlation of management variables with the first three axes from CCA showed that Axis 1 (eigenvalue = 0.49) was related to years since the last pasture and to crop cycle, Axis 2 (eigenvalue = 0.41) was related to crop cycle and soybean as preceding crop, and Axis 3 (eigenvalue = 0.27) was associated mainly with crop cycle (Table 4 and Fig. 2). Weed Group V is placed to the right of the CCA diagram, coinciding with a low number of agricultural cycles.

Table 3. Summary of crop management information obtained from the farmers for each community.

Variables	Communities A	Communities B	Communities C	Mean	P
Years since last pasture	19a†	13b	3c	12	0.01
Yield		Mg ha^{-1}			
Long-crop-cycle cultivars	3.2	4.3	3.0	3.5	ns‡
Short-crop-cycle cultivars	3.0a	3.6b	3.0c	3.2	0.01
		Fields, %			
Crop cycle					
Long-crop-cycle cultivars	36	11	45	30	
Short-crop-cycle cultivars	64	89	55	69	
Fertilizer use					
P	82	78	82	80	
N	82	89	82	84	
Weed control					
Chemical	82	89	91	87.3	
Without control	18	11	9	12.6	
Insect control					
Chemical	22	50	20	30.7	
Without control	78	50	80	69.3	
Preceding crop					
Corn	9	44	45	32.6	
Soybean	64	22	45	43.6	
Wheat/soybean	9	22	9	13.3	
Sunflower	9	–	–	3	

† Means followed by different letter differ at 0.05.
‡ Not significant.

DISCUSSION

Taking into account management factors, the main agronomic variables related to weed and insect distributions were the number of years since the last pasture was plowed, crop cycle, and preceding crop. As the number of years with annual cropping since the last

Table 4. Intraset correlation of management variables with the first three axes from canonical correspondence analysis.

Variables	Correlations Axis 1	Correlations Axis 2	Correlations Axis 3
Years since last pasture	0.415	0.017	0.282
Yield	−0.189	−0.158	0.217
Crop cycle	−0.421	0.568	−0.729
Fertilizer	−0.285	0.209	−0.003
Weed chemical control	0.003	−0.061	−0.317
Insect chemical control	0.364	0.064	0.242
Preceding crop			
Corn	0.404	−0.088	0.032
Soybean	−0.133	0.523	−0.385
Wheat/soybean	−0.207	−0.494	0.205

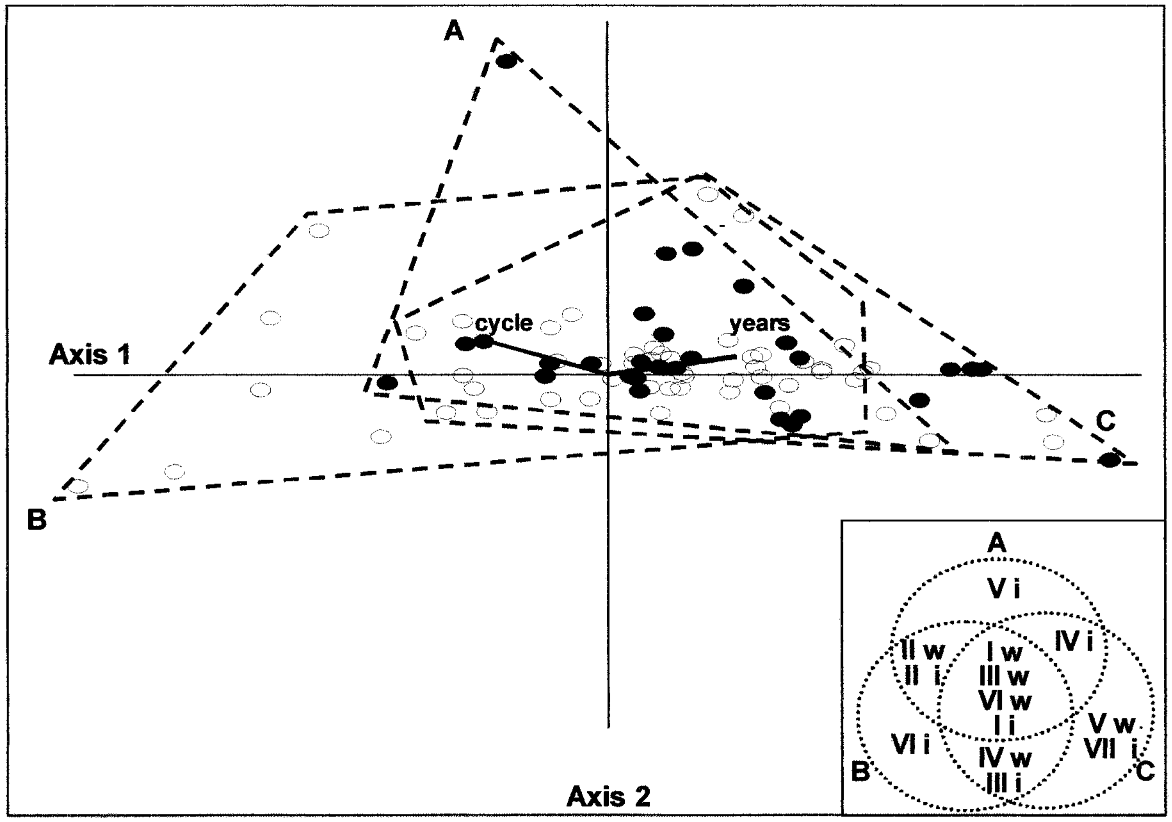

Fig. 2. Ordination diagram of weeds (filled circles) and insects (open circles) in the two principal axes of canonical correspondence analysis (CCA). Communities A, B, and C are enclosed by dashed lines. Vectors represent crop cycle (cycle) and years since last pasture (years). The diagram in the inset shows the weed (w) and insect (i) groups included in each community.

pasture increases, the physical and chemical soil environment is impoverished by effects of soil erosion and compaction as well as by crop nutrient exploitation (Michelena et al., 1989). Community A had the lowest diversity of weeds and was present in the fields with the longest period of cropping with annual species. On the other hand, when the number of years since the last pasture was low, Weed Group V was present (Community C, Table 1). Therefore, wheat weed communities might be related to soil environmental conditions. This relationship has been previously described for summer crops and soil condition, which in turn, was also related to crop yields (León and Suero, 1962; de la Fuente et al., 1999; Suárez et al., 2001). In this study, Communities A and C were not associated with a particular wheat yield level. This difference between winter and summer crops may be explained by the following: (i) Soil degradation is masked by a better water balance during winter as the water demand is reduced by lower temperatures (Hall et al., 1992), and a better water supply may compensate for soil degradation caused by cropping (Arce-Díaz et al., 1993); (ii) the proportion of fields cultivated with short and long crop cycles was different among communities, and yield potential is related to crop cycle; and (iii) the lower number of annual crops in fields with Community C might reflect poor environmental conditions that farmers try to reverse by rotating with pastures.

Soybean as preceding crop could also be related to the impoverishment of soil variables caused by the number of years with annual crops. In fields where Community A is present, farmers introduce more soybean than corn in the rotation because soybean yield is less affected by low N availability in the soil than the yield of other summer crops such as corn (Liebhardt et al., 1989; Karlen et al., 1994).

Although Weed Community B was not the richest in species, it was associated with the highest richness in insect species. This community was also associated with high wheat yields in short-cycle varieties. Food quality and quantity have been recognized to control insect richness (Howe and Westley, 1988a). Thus, it is possible that variations in wheat yield may have caused changes in the insect community. Another possibility related to crop cycle is the phenological synchrony in pest–crop interactions (Metcalf, 1999). Other factors related to the weeds or management that may have promoted high richness cannot be disregarded. Fields with Community B presented high temporal crop diversity (corn, soybean, and wheat–soybean), and it is recognized that crop rotations can increase wildlife populations (Karlen et al., 1994). Ecologists have recognized that peaks of diversity occur at intermediate levels of biological production. This is so because low habitat fertility reduces diversity through nutrient stress and also because high fertility removes the limitations imposed by nutrient stress, thus resulting in simplified communities as the outcome of competitive exclusion (Schluter and Ricklefs, 1993). Therefore, taking this into consideration, it can be speculated that Weed Community B was structured by a soil environmental condition that was intermediate between that in Community A and the one for Community C.

The presence or absence of some groups may be related to the abiotic and biotic environment (Howe and Westley, 1988b). Soil conditions affected weed composition, and they could also have affected weed and crop biomass. The absence of Insect Groups II, V, and VI in Community C and Insect Group III in Community A may be related to the presence of Weed Groups V and VI in Communities C and A, respectively. Many weeds of these groups produce volatile oil compounds that may either act as repellent or attract some insects (Salto et al., 1993), e.g., wild celery [*Apium leptophyllum* (Pers.) F. Muell. ex Benth.], toothpick ammi [*Ammi visnaga* (L.) Lam.], and beggarticks (*Bidens subalternans* de Candolle) from Group V and absinth wormwood (*Artemisia annua* L.) and mayweed chamomile (*Anthemis cotula* L.) from Group VI.

Besides, several interactions among weeds, arthropod pests, and their natural enemies have been reported. Species such as common lambsquarters (*Chenopodium album* L.), spurred anoda [*Anoda cristata* (L.) Schltdl.], and curly dock (*Rumex crispus* L.) are sources of recolonization for herbivores (aphids) in winter crops while prostrate knotweed (*Polygonum aviculare* L.) maintains numerous beneficial insects, including *Geocoris* sp., which migrates to the crop to feed on herbivores (Norris and Kogan, 2000).

Chemical control was very effective on weed and insect abundance, weed cover was always less than 1%, the crop dominated the canopy, and there was no significant crop damage caused by herbivorous insects. It is interesting to note that although weed and insect control is cited as one of the factors explaining their distribution (Norris and Kogan, 2000), our results showed that herbicide and insecticide use had a lower impact on weed and insect distribution than other agronomic variables. Moreover, fields where Community B was present had the highest insect richness and the highest proportion of fields with insect control (Table 3).

The present weed flora and insect fauna are dominated by a few species (species from Groups I and III for weeds and Group I for insects). This community structure is very common in arable lands (Clements et al., 1994), and the species in these dominating groups frequently cause serious problems for winter crop production in this area (Hall et al., 1992; Froud-Williams, 1999).

In agreement with Lawton and Brown (1993) and Lawton (1994), we observed that food web functional structure was maintained regardless of differences among communities in species composition. It can be argued that the number of species in which we were able to describe functional structure was not enough, but because the data of insect functions was obtained randomly, our data can be accepted as supporting this hypothesis. However, we guess the insect functions that we were able to determine were those of the most investigated insects.

Major changes in the agroecosystem of the Rolling Pampas caused by land use history are reflected in the weed and insect communities in wheat. Three communities were distinguished that may be associated with the number of years with annual cropping after a pasture that lasted for several years, the duration of wheat crop cycle, and soybean as a preceding crop.

A wide range of biotic and abiotic factors have been shown to impact the structure of communities. The evaluation of the importance of agroecosystem management in crop–weed–insect community has been hampered because of the difficulties inherent in most experimental designs using naturally occurring situations. This approach provides a useful methodology to address this kind of study and is a first step to understand how agroecosystems are structured by management decisions.

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