Correlation between weeds and crops

Sirous Hassannejad*, Sorayya Navid

Department of Plant Eco-physiology, Faculty of Agriculture, University of Tabriz, East Azerbaijan, Iran

Key words: Canonical correspondence analysis, correlation, crops, density, weeds.

doi: http://dx.doi.org/10.12692/ijb/3.5.117-124 Article published on May 22, 2013

Abstract

In order to survey the effects of some crops (allelopathic and non allelopathic) on weed population, an experiment was done with sowing of seven different crops in 2012 at field research of University of Tabriz. Treatments were corn (Zea mays L.), sunflower (Helianthus annus L.), common beans (Phaseolus vulgaris L. var 1 and Phaseolus vulgaris L. var 2), castor bean (Ricinus communis L.), chicken pea (Cicer arietinum L.), and Lallemantia (Lallemantia iberica L.). Sampling of weed density in each plot was done in four times. Canonical correspondence analysis (CCA) showed that crop species can effect on weed species density. So that, the first two CCA axes explained 93.2, 82.5, 88.5, and 81.3 % of the variation in weed species density in sampling times 1, 2, 3, and 4, respectively. For example in the first sampling, the first axis of CCA represents a gradient of Cicer, Ricinus, Helianthus and the second axis represents a gradient of Ricinus, Cicer, Phaseolus 2, Phaseolus 1, and Lallemantia. So that, Lallemantia and Phaseolus 1, also Helianthus and Zea vectors with minimum angle, showed that these crops had maximum correlation each other, but Cicer and Zea vectors with maximum angle, showed they had minimum correlation together. Lamb's squarters (Chenopodium album L.) and prostrate knotweed (Polygonum aviculare L.) were dominant weed species observed in the beginning and ending of crops life cycle, respectively. In forth sampling, Ricinus plots were weed free, this is may be due to interference (competition and allelopathy) presented with Ricinus and weeds.

*Corresponding Author: Sirous Hassannejad sirous_hasannejad@yahoo.com
Introduction
Weeds are unwanted plants growing in the crop fields affecting them through competition for space, nutrients, sunlight, water and carbon dioxide. These unwanted plants can have a harmful effect on crop quality as well as quantity. Understanding the correlation between crops and weeds in agro ecosystems is very important. Presence, growth, and population density of weed species in each filed is strongly associated with agricultural practices. Investigations showed that a variety of factors can affect the existence of weed species (Dale et al. 1992; Salonen 1993; Andersson and Milberg 1998; Marshall et al. 2003). For example, the choice of crops, crop rotations, fertilizing, and weed management methods are the main factors that change weed community structure (Chancellor 1985; Froud-William 1987). Crop rotations can help to disrupt association between weeds and crops, due to disturb mimicry behavior of weeds with life history of the crops. Certain crops with allelopathic effects can suppress the growth of neighboring plants. Sunflower, fall rye, alfalfa, and barley are some allelopathic crops that suppress growth of certain weeds (Bertholdsson, 2005).

The effects of environmental factors on weed communities, such as species shifts can be done by multivariat analysis of weed communities (Kenkel et al. 2002). Multivariate analyses allow the researcher to simultaneously analyze multiple measurements on each object under investigation (Kenkel et al., 2002). Multivariate analyses like canonical correspondence analysis (CCA) can be applied to analyses of the occurrence and distribution of weed communities (Post 1988; Salonen 1993; Dieleman et al. 2000a, 2000b; Kenkel et al. 2002). CCA is a direct gradient analysis that is the most frequently used to describe weed communities as affected by environmental variables (Kenkel et al., 2002), also CCA is a data analysis method that represents correspondences between two or more sets of measurements. By using this method, researchers have survey the floristic composition and relative abundance of weeds, the influence of some management methods like crop rotation, tillage, herbicide usage and fertilizer application on dynamics of weed populations (Thomas 1991; Pysek and Leps 1991; Hume et al. 1991; Ball 1992; Thomas and Frick 1993; Derksen et al. 1993, 1995; O’Donovan et al. 1997; Barberi et al. 1997; Andersson and Milberg 1998; Legere and Samson 1999; Dieleman et al. 2000a; Leeson et al. 1999, 2000). Thus, the main objective of this study was to survey relationships between kinds of crops and weed population density with canonical correspondence analysis.

Material and methods
Experimental site and procedure
This study was conducted in 2012 at the field research of Tabriz University, Iran (38°01’ North latitude, 46°25’ East longitude, with altitude 1676 meters). The soil type was loam with 42.4% sand, 38% silt, 19.6% clay, 0.17% organic matter, PH 7.4 and Ec 0.93 ds/m. In order to determine the effects of different crops on weed species presence and their density, and understating relationship between crops planted in each plots and their weeds, an experiment was carried on the basis complete randomized block design with four replications. Corn (Zea mays L.), sunflower (Helianthus annus L.), common beans (Phaseolus vulgaris L. var 1 and Phaseolus vulgaris L. var 2), castor bean (Ricinus communis L.), chicken pea (Cicer arientinum L.), and Lallemantia (Lallemantia iberica L.) were planted as crop species. Seeds of these crops were sown in the same time, same distance (30 cm × 30 cm) and in the plots with same size (3 m × 4 m).

Measuring of treatments and Statistical analysis
Sampling of weeds was done within the quadrats 0.5 m × 0.5 m in each plot. Weed species in each quadrat were identified, counted, and recorded for subsequent data entry and analysis. After weed species density were determined in each plots, we arranged the samples into first matrix where weed species are represented by columns and plots by rows. Also, in second matrix, crop species are
represented by columns and plots by rows. Data on weed species density and crops presence or absent in all plots were analyzed through with ordination methods like canonical correspondence analysis (CCA), also weeds and crops distribution and their correlation displayed in ordination diagrams. These ordination methods were done for weed species that were nearly observed in all replication of each treatment. For CCA, CANOCO software (Version 4.5) was used. The association between weed species composition and some main environmental factors were examined with CCA by other researches (Ter Braak, 1986, 1987). Ordination plots were produced for both sampling quadrats and weed species associated with crop species.

**Results and discussion**

The results of CCA clearly demonstrated the correlation between crops and weed species. CCA showed that crops can effect on weed species density. So that, the first two CCA axes explained 93.2, 82.5, 88.5, and 81.3 % of the variation in weed species density in sampling times 1, 2, 3, and 4, respectively (Table 1).

**Table 1.** Eigenvalues of the first two CCA axes that explained of the variation in weed species distribution affected by crop species. All four eigenvalues reported in this table are canonical and correspond to axes that are constrained by crop and weed species.

<table>
<thead>
<tr>
<th>Axes</th>
<th>First sampling</th>
<th>Second sampling</th>
<th>Third sampling</th>
<th>Fourth sampling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Eigenvalues</td>
<td>0.078</td>
<td>0.025</td>
<td>0.09</td>
<td>0.024</td>
</tr>
<tr>
<td>Species-environment correlations</td>
<td>0.977</td>
<td>0.917</td>
<td>0.935</td>
<td>0.877</td>
</tr>
<tr>
<td>Cumulative percentage variance of species data</td>
<td>56.7</td>
<td>74.6</td>
<td>69.5</td>
<td>62.8</td>
</tr>
<tr>
<td>Cumulative percentage variance of species-environment relation</td>
<td>70.8</td>
<td>93.2</td>
<td>65.1</td>
<td>82.5</td>
</tr>
</tbody>
</table>

**Table 2.** Weighted correlation matrix (weight= sample total) between crop species with CCA axes output by CANOCO (Version 4.5)

<table>
<thead>
<tr>
<th></th>
<th>First Sampling</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>axes 1</td>
<td>axes 2</td>
<td>axes 1</td>
<td>axes 2</td>
<td>axes 1</td>
</tr>
<tr>
<td>Cic.</td>
<td>0.9251</td>
<td>0.293</td>
<td>-0.5357</td>
<td>0.4786</td>
<td>-0.548</td>
</tr>
<tr>
<td>Lal.</td>
<td>-0.1056</td>
<td>-0.239</td>
<td>0.3371</td>
<td>0.0667</td>
<td>0.1262</td>
</tr>
<tr>
<td>Rci.</td>
<td>-0.4100</td>
<td>0.6494</td>
<td>0.3704</td>
<td>-0.0586</td>
<td>0.5091</td>
</tr>
<tr>
<td>Zea.</td>
<td>-0.1845</td>
<td>0.0829</td>
<td>0.1879</td>
<td>-0.1024</td>
<td>0.3135</td>
</tr>
<tr>
<td>Hel.</td>
<td>-0.2157</td>
<td>0.1259</td>
<td>0.3773</td>
<td>0.5143</td>
<td>0.4030</td>
</tr>
<tr>
<td>Pha.ch</td>
<td>0.0201</td>
<td>-0.5896</td>
<td>-0.5685</td>
<td>-0.2060</td>
<td>-0.4891</td>
</tr>
<tr>
<td>Pha.</td>
<td>-0.0917</td>
<td>-0.2667</td>
<td>0.0768</td>
<td>-0.5799</td>
<td>0.0921</td>
</tr>
</tbody>
</table>

In the first sampling time (two weeks after crops emergence), six weed species were observed in plots (Fig. 1 & 2). CCA axis 1 was positively correlated with Cicer and negatively correlated with Ricinus and Helianthus (Table 2 and Fig. 1). CCA axis 2 was positively correlated with Ricinus and Cicer and negatively correlated with Phaseolus 2, Phaseolus 1, and Lallemantia (Table 2 and Fig. 1). The first axis represents a gradient of Cicer, Ricinus, Helianthus and the second axis represents a gradient of
Ricinus, Cicer, Phaseolus 2, Phaseolus 1, and Lallemantia (Table 2 and Fig. 1). The closeness of weed species to a particular vector (crops vector) indicates that these weed species are likely to occur more often with increases this vector or weed species density increases when this crop is present. On the other hand, weed species are far from the particular vector (crops vector), by present this crops were decreased (Fig. 1). Crops with minimum and maximum angle between their vectors, have maximum and minimum correlation each other in weed species observed in their plots (Fig. 1). For example, Lallemantia and Phaseolus, also Helianthus and Zea vectors with minimum angle, showed they had maximum correlation each other. Cicer and Zea vectors with maximum angle each other, showed they had minimum correlation together (Fig. 1). Bindweed (Convolvulus arvensis L.) as a weed specie that preferring Cicer is located at the right side of the CCA diagram, this weed had maximum correlation with Cicer (Fig. 1). While green foxtail (Setaria viridis (L.) P. Beauv.) with maximum density was observed in Helianthus and Zea plots. Lamb’s quarters (Chenopodium album L.), red root amaranth (Ammaranthus retroflexus L.), and prostrate knotweed (Polygonum aviculare L.) are weeds that found in all crop plots, so that these weed species had highest correlation with all crops planted in this experiment (Fig. 1). Cheopodium had highest density in all plots (Fig. 2). This subject indicated that our field research is intensely infested by Cheopodium, and this is due to soil’s type our research filed. Setaria as only crass weed observed in plots, used from free spaces in Ricinus plots and was dominant in this plot in the first sampling time (Fig. 2). Because this crop was very weaker in positioning compare with Setaria in Tabriz climate. Surveys showed that in the first sampling time (two weeks after crops emergence), crops such as Cicer, Phaseolus 2, and Ricinus are weaker than others (Fig. 1). On the other hands, Helianthus and Zea are crops that have minimum weed density in the first sampling time, because these crops are powerful in beginning of their life cycle (Fig. 1). Observations showed that emerence of these two crops were sooner than other crops.

Ricinus, Cicer, Phaseolus 2, Phaseolus 1, and Lallemantia (Table 2 and Fig. 1). The closeness of weed species to a particular vector (crops vector) indicates that these weed species are likely to occur more often with increases this vector or weed species density increases when this crop is present. On the other hand, weed species are far from the particular vector (crops vector), by present this crops were decreased (Fig. 1). Crops with minimum and maximum angle between their vectors, have maximum and minimum correlation each other in weed species observed in their plots (Fig. 1). For example, Lallemantia and Phaseolus, also Helianthus and Zea vectors with minimum angle, showed they had maximum correlation each other. Cicer and Zea vectors with maximum angle each other, showed they had minimum correlation together (Fig. 1). Bindweed (Convolvulus arvensis L.) as a weed specie that preferring Cicer is located at the right side of the CCA diagram, this weed had maximum correlation with Cicer (Fig. 1). While green foxtail (Setaria viridis (L.) P. Beauv.) with maximum density was observed in Helianthus and Zea plots. Lamb’s quarters (Chenopodium album L.), red root amaranth (Ammaranthus retroflexus L.), and prostrate knotweed (Polygonum aviculare L.) are weeds that found in all crop plots, so that these weed species had highest correlation with all crops planted in this experiment (Fig. 1). Cheopodium had highest density in all plots (Fig. 2). This subject indicated that our field research is intensely infested by Cheopodium, and this is due to soil’s type our research filed. Setaria as only crass weed observed in plots, used from free spaces in Ricinus plots and was dominant in this plot in the first sampling time (Fig. 2). Because this crop was very weaker in positioning compare with Setaria in Tabriz climate. Surveys showed that in the first sampling time (two weeks after crops emergence), crops such as Cicer, Phaseolus 2, and Ricinus are weaker than others (Fig. 1). On the other hands, Helianthus and Zea are crops that have minimum weed density in the first sampling time, because these crops are powerful in beginning of their life cycle (Fig. 1). Observations showed that emerence of these two crops were sooner than other crops.

![Image](Fig. 1. Biplot from the first two canonical variates describing the relationship of weed species and crops in the first sampling time (two weeks after crops emergence).)

**Fig. 1.** Biplot from the first two canonical variates describing the relationship of weed species and crops in the first sampling time (two weeks after crops emergence).

![Image](Fig. 2. Weed species observed in each crop plots and their density in the first sampling time (two weeks after crops emergence).)

**Fig. 2.** Weed species observed in each crop plots and their density in the first sampling time. Che (Chenopodium album L.), Set. (Seraria viridis (L.), P. Beauv.), Pol. (Polygonum aviculare L.), Ama.ret (Ammaranthus retroflexus L.), Con. (Convolvulus arvensis L.), and Mal. (Malva neglecta Wallr.).

In the second sampling time (four weeks after crops emergence), seven weed species were observed in all plots (Fig. 3 & 4). CCA axis 1 was positively correlated with Helianthus, Ricinus., and Lallemantia and negatively correlated with Phaseolus 2 and Cicer (Table 2 and Fig. 3). CCA axis 2 was positively correlated with Helianthus and Cicer, and negatively correlated with Phaseolus 1(Table 2 and Fig. 3). Weed species density were reduced in this time compare with first sampling,
but Chenopodium had highest density in all plots (Fig. 4). Malva had highest correlation with Phaseolus 2, also prostrate amaranth (Ammaranthus blitoides S. Watson) and Polygonum observed with highest density in Phaseolus 2 plots (Fig. 3 & 4).

![Fig. 3. Biplot from the first two canonical variates describing the relationship between weeds and crops, in the second sampling time (one month after crops emergence).](image)

![Fig. 4. Weed species observed in each crop plots and their density in the second sampling time (one month after crops emergence).](image)

In the third sampling time (six weeks after crops emergence), eight weed species were observed in all plots (Fig. 5 & 6). CCA axis 1 was positively correlated with Ricinus, Helianthus, and Zea and negatively correlated with Cicer and Phaseolus 2 (Table 2 and Fig. 5). CCA axis 2 was positively correlated with Lallemantia and negatively correlated with Phaseolus 2, Ricinus, and Helianthus (Table 2 and Fig. 5). Weed species density were reduced in this time compare with first and second sampling. Polygonum, Ammaranthus retroflexus and Setaria like Chenopodium were dominant weeds in all treatments, without any antattention to kind of crops (Fig. 6). Ammaranthus blitoides and Malva not founded in Ricinus, and Helianthus plots, so these weeds are located in opposite of Ricinus, and Helianthus vectors (Fig. 5 & 6). Russian thistle (Salsola kali L.) and bindweed (Convolvulus arvensis L.) were founded in Phaseolus 2 and Cicer plots, so that these weed species were located between Phaseolus 2 and Cicer vectors (Fig. 5 & 6). Ricinus and Helianthus are crops that had highest correlation with weed species observed in their plots, because these crops vectors had minimum angle together (Fig. 5).

![Fig. 5. Biplot from the first two canonical variates describing the relationship between weeds and crops, in the third sampling time (six weeks after crops emergence).](image)

In the fourth sampling time (10 weeks after crops emergence), eight weed species were observed in all plots (Fig. 7 & 8). CCA axis 1 was positively correlated with Helianthus and Zea, and negatively correlated with Cicer and Phaseolus 2 (Table 2 and Fig. 7). CCA axis 2 was positively correlated with
Helianthus, Cicer and Phaseolus 2, but this axis negatively correlated with Lallemantia, Zea, and Phaseolus 1 (Table 2 and Fig. 7). In this sampling, Ricinus plots were weed free, so that in CCA biplot, Ricinus vector was not observed (Fig. 7 & 8). In Helianthus plots only Set. and Chenopodium were found. Polygonum was dominant weed species in Phaseolus 2, Phaseolus 1, Cicer and Lallemantia plots, while this weed was not found in Ricinus, Zea and Helianthus plots, therefore this weed was located between Phaseolus 2, Phaseolus 1, Cicer and Lallemantia vectors in CCA biplot (Fig. 7 & 8). Malva as like as Polygonum was not observed in Ricinus, Zea and Helianthus plots (Fig. 7 & 8).

**Conclusion**

In this research we found that weed species presence in each plot can duo to kind of crops planted in plots. Although presence or absent of each weed in each plot can duo to weed seed bank. Result of this survey showed that some weeds with extensivly ecological need can growth in different niches and microclimates under and between crop rows. Chancellor (1985) and Froud-William (1987) in their researches showed that selecting of crops can change weed population structure. Also, results showed that some weed species such as Chenopodium is aggressively occupied plots in beginning of crop life cycle, while it’s density will reduced by increasing crop canopy and presence of other weed species. Weeds often mimic the life history of the crops, so crop rotations can help to disturb correlation between crop and weeds. Some crops can interference with weeds by competition and allelopathy. In this experiment, we found that Helianthus and Zea can compete with weeds and suppress their growth, because fast germination and emergence. On the other hands, investigations showed that these two crops have allelopathic effects on weeds (Patrick and Koch, 1958; Guenzi
Allelopathic effects of shoot and root extracts on the seed germination and early seedling growth have been frequently reported (Tanveer et al., 2008). Perception the response of weeds to allelopathic plants in weed control methods is very important, because we have a complex agro-ecosystems that allelopathy plays an important role in their (Hassannejad et al., 2013 a, b). Understanding harmful or useful interactions between crop-weed communities plays an important role in integrated weed managements (IWM) systems.

References


Derksen DA, Thomas GP, Lafond GP, Loeppky HA, Swanton CJ. 1993. Impact of agronomic practices on weed community diversity within conservation-tillage systems. Weed Science 41, 409–417. URL:

http://dx.doi.org/10.1111/j.1365-3180.2004.00442.x


Hassannejad S, Porheidar Ghafarbi S, Lotfi R. 2013. Allelopathic effects of wheat and barley on emergence and seedling growth of some weed


