Effect of Intercropping on the Diversity of Insect Community in Brinjal

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Abstract

1. A study was conducted at Bangabandhu Sheikh Mujibur Rahman Agricultural University Gazipur, Bangladesh from October 2002 to May 2003 to determine the diversity index and equitability of insect community with four different intercrops in brinjal (*Solanum melongena*).
2. Results revealed that intercropping generally produced greater diversity index of insect community.
3. Richness of taxonomic categories was lower in intercropping systems compared to the combination of their component sole crops.
4. A combination of pitfall trapping and sweep netting methods for capturing the insects over the whole crop growth period revealed a highly significant positive relationship between richness (x) and diversity index (y), but a negative relationship between richness (x) and equitability (y).

Keywords: Intercropping, diversity, equitability, richness, insect, arthropod

Introduction

Intercropping (i.e. growing more than one crop simultaneously in the same area) is one way of increasing vegetational diversity. According to Van Emden (1965), intercropping or polyculture are ecologically complex because interspecific and intraspecific plant competition occurs simultaneously among herbivores, insect predators, and insect parasitoids. Population density of herbivorous insects is frequently found to be lower with the practice of intercropping (Risch, 1983). Two hypotheses have been proposed to explain this phenomenon: (1) the associational resistance or resource concentration hypothesis (Roots, 1973), which proposes that the specialist herbivores are generally less abundant in a vegetationally diverse habitat because their food sources are less concentrated and natural enemies are more abundant and (2) The natural enemies hypothesis (Russell, 1989) which states that

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diversity in plant species may provide important resources for natural enemies such as alternate prey, nectar and pollen or favorable breeding sites. Intercropping or polyculture generally produced a greater diversity index and higher equitability of arthropod/insect community (Uddin *et al.*, 2002). Agronomic practices, like the intercropping of crops with diverse growth habits, have proven to be very useful techniques in controlling a large number of crop pests (Dhaliwal & Dilwari, 1993; Hossain *et al.*, 1989; Prashad & Chand, 1989). However, little is known about the diversity of insect species in brinjal fields when co-habitating with different intercrops. Thus, the present study was undertaken with the specific objective of determining the diversity index and equitability of the insect community and the relationship between richness of taxonomic categories with the diversity index and equitability in brinjal grown with different intercrops.

Materials and Methods

Experimental design and Crop cultivation:

The experiment was laid out in a randomized complete block design with 3 (three) replications and 9 (nine) treatments. The unit plot size was 4 m x 3 m. The distance between plots and replications were 0.5 m and 1m, respectively. Combinations of brinjal (*Solanum melongena* cv. Uttara), coriander (*Coriandrum sativum* cv. BARI Dhania-1), onion (*Allium cepa* cv. local), garlic (*Allium sativum* cv. local) and chilli (*Capsicum frutescens* cv. Baromasi) constituted the treatments in the intercropping. The intercropping treatments were brinjal+onion, brinjal+garlic, brinjal+coriander and brinjaj+chilli. In addition to these, sole cropping of each component crop was also considered as treatments in the experimental design. The row to row distances for brinjal, onion, garlic, coriander and chilli were 1m, 30cm, 30cm, 30cm and 40cm, respectively and the plant to plant distances within a row of brinjal, onion, garlic, coriander and chilli were 60cm, 15cm, 15cm and 30cm, respectively. Coriander was sown in a row continuously. In the case of intercropping, seedlings of chilli, bulbs of onion and garlic and seeds of coriander were planted in an alternating row arrangement. The crops were grown and studied at the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University Gazipur, Bangladesh during October 2002 to May 2003. Standard agronomic and cultural practices like manuring and fertilization, gap filling, thinning, weeding, irrigation, mulching etc. were followed.

Data collection for the measurement of diversity index and equitability

The simplest measure of species diversity is to count the number of species present. The concept was extended to include order and family level. Capturing the insects was performed using two relative methods viz., pitfall trapping and sweep netting. Data were collected at early, mid and late stages of crop growth. Small sized plastic pots measuring 6 cm in diameter and 8 cm in depth were used as pitfall traps, each of which was filled with water with a few drops of detergent added. Three traps were placed in the soil in each of the plots at early, mid and late stages of crop growth to trap the insects. The rim of the pot was flush at ground level so as not to obstruct insect movement. After 48 hours of setting traps, insects were collected from each plot/treatment and kept separately. Cycles of sweeping, five times in total, were done at each plot by sweep netting at early, mid and late stages of crop growth. Samples collected from each plot were kept separately. On the basis of phenotypic similarity, trapped insects were then sorted and further identified into the family and order that they belong to with the help of identified specimens kept with the museum of the dept. of Entomology, BSMRAU and other standard taxonomic keys. Data were recorded against each treatment.

Measurement of diversity index and equitability

To assess both the abundance pattern and the species richness, Simpson's diversity index was used (Simpson, 1949).

$$\text{Simpson's Index (D)} = \frac{1}{\sum_{i=1}^{s} P_i^{\,2}}$$

Where, Pi is the proportion of individuals for the ith insect family and S is the total numbers of insect families in the community (i.e., the richness).

Equitability was quantified by expressing Simpson's index, D as a proportion of the maximum possible value of D

$$\text{Equitability, E} = \frac{D}{D_{max}} = \frac{1}{\sum_{i=1}^{s} P_i^{\,2}} \times \frac{1}{S} \qquad [\text{As}D_{max} = S]$$

Insect pests and their natural enemies i.e. Predators and parasitoids, as well as other beneficial insects, like pollinators and spiders were taken into account.

Statistical analysis

Linear regression analysis was performed to explore the relationships between the number of taxonomic categories with diversity index and equitability.

Results and Discussion

1. Diversity index and equitability

Trends in diversity pattern of insects habitating intercropped fields under different crop combinations at early, mid and late stages of crop growth are shown in Table1.

Early crop stage

From Table 1, it is evident that richness among the treatments did not vary remarkably.

Table 1. Diversity and equitability of arthropod/insect community under different crop combinations at early, mid and late stages of crop growth

Crop combinations	Early stage			Mid stage			Late stage		
	Number of families	Diversity index (D)	Equitability (E)	Number of families	Diversity index (D)	Equitability (E)	Number of families	Diversity index (D)	Equitability (E)
Brinjal+Onion (*Solanum melongena & Allium cepa*)	10	2.66	0.27	15	7.31	0.49	6	4.03	0.67
Brinjal+garlic (*Solanum melongena & Allium sativum*)	11	3.44	0.31	13	5.99	0.46	9	6.21	0.69
Brinjal+Coriander (*Solanum melongena & Coriandrum* sativum)	11	3.53	0.32	16	8.49	0.53	5	4.26	0.85
Brinjal+Chilli (*Solanum melongena & Capsicum frutescens*)	9	3.37	0.37	15	7.70	0.51	7	4.26	0.61
Brinjal (*Solanum melongena*)	11	3.84	0.35	15	8.14	0.54	7	4.57	0.65
Onion (*Allium cepa*)	10	2.53	0.25	11	6.22	0.57	8	4.81	0.60
Garlic (*Allium sativum*)	8	2.86	0.36	11	6.78	0.62	8	5.57	0.70
Coriander (*Coriandrum sativum*)	11	3.82	0.35	13	7.77	0.60	8	5.24	0.65
Chilli (*Capsicum frutescens*)	9	2.63	0.29	9	5.98	0.66	8	4.38	0.55

Although the highest diversity index was observed among brinjal (3.84) and coriander (3.82) when grown as a sole crop, but overall a higher diversity index was apparent in intercrops. A large deviation of observed D from D max (number of families) and lower equitability might be due to the crops early growth stage where insect species were still not well established.

Mid crop growth stage

In the mid stage of crop growth, the highest equitability (0.66) was observed in sole chili crops although it also displayed the lowest diversity index (5.98) and richness (Table 1). Conversely, brinjal sole and brinjal + coriander showed a high richness and also had a higher diversity index of 8.14 and 8.49, respectively but with comparatively lower equitability. The results revealed a lower abundance of insect families in sole chilli; garlic and onion crops while a higher number of families were found among brinjal crops and in combinations with, chilli coriander and onion. In this stage, the value of diversity index and equitability increased from the early stage. The highest number of insect families found in brinjal +coriander crop systems contributed to it having the highest diversity index.

Late stage of crop growth

In the case of the late stage of crop growth, a higher diversity index was found primarily in all the sole crops (Table 1). However, a comparatively lower diversity index was observed in all the intercropped treatments except brinjal +garlic, which had the highest value (6.21) among all the treatments. The highest equitability was observed in brinjal + coriander (0.85) followed by garlic sole (0.70) and the lowest at (0.55) found in sole chili crops.

2. Relationship between the number of families with diversity index and equitability

A positive relationship was found between the number of families and diversity index in all crop growth stages (Table 2.) Assessment of the whole crop period revealed a highly significant positive

Table 2. Relationship between the number of families (x) and diversity index (y) at different crop growth stages

Crop growth stages	Relationship between	Relationship	Significance of the regression equation
Early stage	No. of insect families (x) and diversity index (y)	Y= 0.28+0.29x ; r= 0.62	NS
Mid stage	〃	Y= 2.86+0.33x ; r= 0.82	P<.01
Late stage	〃	Y= 1.50+0.45x ; r= 0.77	P<.01
Whole crop period	〃	Y= 0.96+0.40x ; r= 0.64	P<.001

NS= Not significant

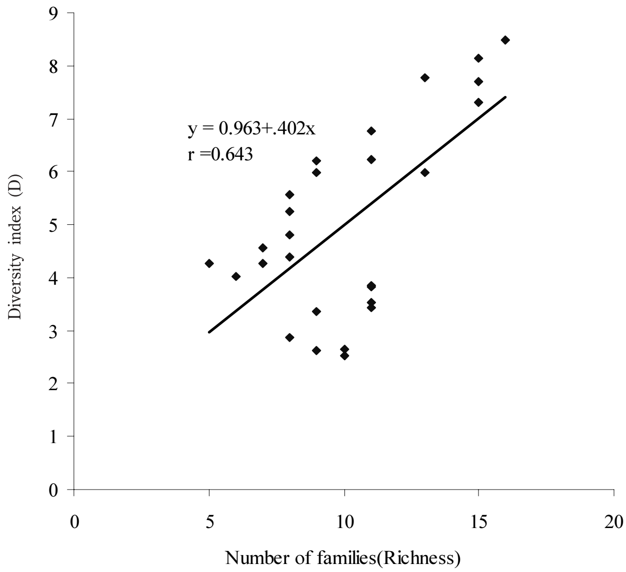

Fig. 1. Relationship between the number of families and diversity index of arthropod/insect community in sole brinjal and intercrop combinations

Table 3. Relationship between the number of families (x) and equitability (y) at different crop growth stages

Crop growth stages	Relationship between	relationship	Significance of the regression equation
Early stage	No. of insect families (x) and equitability (y)	Y= 0.37−0.005x ; r= −0.13	NS
Mid stage	〃	Y= 0.82−0.02x ; r= −0.74	P<0.01
Late stage	〃	Y= 0.95−0.04x ; r= −0.57	NS
Whole crop period	〃	Y= 0.69−0.02x ; r= −0.32	NS

NS= Not significant

relationship (r = 0.64) between richness and diversity indices (Fig. 1). It is clearly evident that diversity index of insect/arthropod communities is influenced by the number of insect families (i.e. species richness) in diversified agro ecosystems. On the contrary, a negative relationship was observed between the numbers of families with equitability in all the crop growth stages (Table 3). However, the results during the mid stage of crop growth revealed a significant relationship (r= −0.74) between richness and equitability.

The value of diversity index depends on both the species richness and the evenness (equitability) at which individuals are distributed among the species. For a given richness, 'D' increases with equitability and for a given equitability 'D' increases with richness (Begon *et al*., 1990). In the present study, when diversity was assessed by relative method, sole brinjal and coriander generally showed a higher diversity index in all the growth stages among crops, although the brinjal + coriander system showed a comparatively lower diversity index in early and late stages of growth when compared to sole brinjal and coriander. The results indicated that the pest insects were less abundant in intercropped fields and greater numbers belong to the different families of natural enemies and beneficial co-habitants. This result is in conformity with Roots (1973) hypothesis. He proposed that specialized herbivores are generally less abundant in vegetationally diverse habitats because their food sources are less concentrated and natural enemies are more abundant. Whittaker (1972) and May (1975) showed that the relationship between species number (S): abundance of individuals (N) has two features: (1) species richness- the total number of species present in the area (ST) and (2) equitability or evenness - the pattern of distribution of the individuals between the species. They also claimed that in the equitability of the species the abundance relationship will be a reflection of the underlying distribution. May (1975) also reported that diversity index is strongly influenced by species richness.

In the present study, however, all the intercrop combinations showed a much lower number of insect families compared to combinations of that in their respective sole crops during all crop growth stages.

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