ISSN: 2694-166X
DOI: 10.33552/SJBLS.2020.01.000516
Scientific Journal of Biology & Life Sciences
Iris Publishers

Research Article

The Effect of Intercropping Cabbage-Cowpea on Insects Population, Diversity and Interactions

Isaac Gadzekpo[1], Beck Arebamen Akhiwu*[2] and Rubby Ama Nyarko[3]

[1]*Department of Biological Sciences, Youngstown State University, Ohio, USA*

[2]*Department of Plant Pathology, Nematology and Entomology, University of Idaho, Moscow, Idaho, USA.*

***Corresponding author:** Beck Akhiwu, Department of Plant Pathology, Nematology and Entomology, University of Idaho, Moscow, Idaho, USA.

Received Date: November 02, 2020

Published Date: December 16, 2020

Abstract

Knowing the right crop to intercrop is very important in successful pest management strategy. Our study used complete randomized block design (RCBD) with three replicates to investigate the effect of intercropping cabbage and cowpea on insects' population, diversity and Interactions. The insects found on our study were *Brassicae brevicoryne, Plutella xylostella, Hellula undalis, Zonocerus variegatus, Trichoplusia ni, Aphid craccivora, Empoasca spp, Megalurothrips sjostedti* and *Anoplocnemis curvipes*. Our study demonstrated that number of different insect pests attacked the cabbage and cowpea crops, at different stages of plant growth indicating that pest infestation of the two crops were growth stage specific. Our results suggest that intercropping cabbage and cowpea could promote the growth of natural enemies. Our study shows that intercropping cabbage and cowpea is very an effective pest management strategy against *B. brassicae* and *P. xylostella, A. craccivora* and *M. sjostedti.*

Keywords: Intercropping, Cowpea, Cabbage, Pest, Population, Growth

Introduction

Understanding the specific factors that drive insects' growth, population and preferences are vital to successful pest management. A multiple cropping practice that involves growing two or more crops simultaneously on the same field, has a common goal to produce a greater yield on a given piece of land by making use of resources or ecological processes that would otherwise not be utilized by a single crop [1]. Many studies have demonstrated that intercropping can be used to reduce insect pest population on crops [2]. [2] study found that Colombia beans grown as maize/bean polycultures had 26% fewer *Empoasca krameri* adults than monoculture beans. Population of *Diabrotica baltecata* were found to be 45% less in polycultures [3]. Risch et al. [3] study involving 198 kinds of insects demonstrated that intercropping reduced insect pest populations. Similar study involving intercropping of maize, cowpea and cotton has been demonstrated to encourage high population of beneficial insects in cotton farming system [4]. Cabbage worm (*Artogeia rapae L*) population has been reported to be greater in monoculture than intercropping [4]. reported that when onion and cabbage are intercropped, cabbage aphid and cabbage webworm populations are reduced. Intercropping have been suggested to favor natural enemies of attacking insect pest [5]. Intercropping cereal crops and molasses, *Melinis minutiflora* has been shown to reduce lepidopteran stem-borers and also increased larval parasitism of stem-borers by *Cotesia sesamiae* in cereal crops in Africa [6]. The volatile agents produced by *M. minutiflora* deterred female stem-borers and attracted foraging female *C. sesamiae*, which encouraged predation and parasitism [6].

However, knowing the right crops or plants to intercrop is very important in successful pest management strategy. Our study intercropped cabbage and cowpea. The main aim of our study was to assess the effectiveness of intercropping in the management of cabbage and cowpea pests, identify some common pests of cabbage and cowpea cultivated under mono-cropping and intercropping systems and determine the differences in mean density of cabbage

and cowpea pests under mono-cropping and intercropping systems. Our study is also aimed at reducing the use of inorganic chemicals in cabbage/cowpea production. Our hypotheses was that insect pest populations, diversity and activities would be more on intercropped system than monocropped system.

Materials and Methods

Study Crop

Cabbage (*Brassica oleracea*; var. capitata), is a leafy green or purple biennial plant, grown as an annual vegetable crop for its dense-leaved head [7]. As a member of the crucifer family, cabbage is closely related to other cole crops, such as broccoli, cauliflower, and Brussels sprouts (Guerena, 2006). It is grown worldwide both for domestic and commercial uses. It is a good source of vitamin A, B, C, E, and K; omega 3 fatty acids, folate, minerals such as sulfur, calcium, potassium, phosphorus, manganese, magnesium, as well as protein and dietary fiber. They are also rich in antioxidants that protect the body from damage by free radicals. It also contains lactic acid which helps digestion and is low in calories [8]. B. oleracea was developed in western and central Europe from wild species, B. oleracea var. oleracea found in the Mediterranean region [9]. They were one of the first of the cole crops that were domesticated approximately 2,000 years ago [10] mostly because of the important nutrients found in cabbage and its ability to thrive in various environmental conditions. The major cabbage pests include Diamondback Moth (*Plutella xylostella*), Webworm (*Hellula undalis*), Cabbage Aphid (*Brevicoryne spp.*), Grasshopper (*Zonocerus variegatus*), and the Cabbage Looper (*Trichoplusia ni*) among others [11].

Cowpea (*Vigna unguiculata*) is one of the most important food and forage legumes in the semi-arid tropics that includes parts of Asia, Africa, Southern Europe, Southern United States, and Central and South America [12]. It is a major staple food crop in sub Saharan Africa, especially in the dry savanna regions of West Africa [13]. The seeds are a major source of plant proteins and vitamins for man, feed for animals, and also a source of cash income [14]. The name cowpea probably originated from the fact that the plant was an important source of hay for cows in the southeastern United States and in other parts of the world [15]. The nutritional profile of cowpea is similar to that of other pulses, with relatively low saturated fat and cholesterol content and a total protein content that is two to four times greater than cereals and tubers. It is also a rich source of thiamin, iron, magnesium, phosphorus, copper as well as dietary fiber, folate and manganese. It has one of the highest levels of any food of folic acid, a crucial B vitamin that helps prevent spinal tube defects in unborn children [16]. Cowpea pests are of two groups: pre-flowering pests and post-flowering pests [17]. Pre-flowering pests include Bean Aphid (*Aphis craccivora*), Leaf Hopper (*Empoasca spp.*), Foliage Beetle (*Ootheca mutabilis*) and post-flowering pests include Flower Thrips (*Megalurothrips sjostedti*), Blister Beetle (*Mylabris spp.*), Pod borer (*Maruca testulalis*), and Pod Sucking Bug (*Anoplocnemis curvipes*) among others [14,18].

Experimental Procedure

A randomized complete block design (RCBD) with three replications for 3 treatments; cabbage only, cowpea only as well as cabbage and cowpea intercropped were used. The study was carried out on the experimental plot situated behind the Green house of the Department of Theoretical and Applied Biology (TAB) of Kwame Nkrumah University of Science and Technology (KNUST), Kumasi-Ghana. The soil used was a well-drained sandy-loam. The plot was cleared by the slash-and-burn method using a cutlass, rake and a hoe. The total land area was 196 m^2 with three plots, each measuring 14m x 4m with spacing of 1m between plots. From each plot, 3 beds were made, making a total of 9 beds, each measuring 4m x 4m, 3 beds for each treatment. The spacing between each plant was 0.8m for cabbage and 0.8m for cowpea with cowpea planted in between the cabbage plants for the three intercropped beds. The beds were 1m apart. Cabbage seeds of the Oxylus variety and cowpea of the Obaatampa variety were used for propagation. The cabbage seeds were first planted in nursery beds before transplanted unto the 19 field beds from the nursery because they are small and the seedlings are very delicate. The nursery bed measured 2m x 1m. The broadcast method was used for nursing the seeds. The seeds were scattered over the beds, watered and covered with palm fronds. After three days, the seeds started germinating. The palm fronds were removed 7 days after germination to allow sunlight to reach the seedlings. A net fencing was placed around the bed to prevent insects and other animals from destroying the seedlings. The cabbage seedlings were transplanted three weeks after nursing to the field and the cowpea seeds were seeded directly on the field, three seeds in a hole. After germination, thinning was done to prevent overcrowding to two seedlings per hole. Each mono-cropped field had five rows and five columns each and the intercropped field had five rows and five columns of cabbage and four rows and four columns of cowpea.

Data Collection

The seedlings were observed for two weeks on the field beds before insects' data collection. The plants were critically observed weekly and records were taken. 10 plants were randomly sampled for insect pest from each bed. Insects were identified in the Entomology laboratory of the Department of Theoretical and Applied Biology. Salifu 1982 protocol was used in rating insects' population.

Data Analysis

The data obtained was analyzed statistically using the general linear model (GLM) procedure of SAS and excel. The number of each insect pest species and yield were the parameters analyzed. The results were expressed as mean (±) standard error. Where the difference was significant, the means were separated using the Tukey's studentised range. Significant difference was measured at $P \leq 0.05$.

Results

Cabbage and Cowpea pests identified. The common insect pests recorded on the cabbage and cowpea crops in the course of the cultivation season are shown in (Tables 1&2) respectively.

Cabbage Aphid (*Brevicoryne brassicae*)

B. brassicae was observed three weeks after transplanting and remained on the plant till harvest. *B. brassicae* mean density was largest on the mono cropped beds and least on the intercropped beds. There was a significant difference between the mean of *B. brassicae* on the mono cropped beds and the intercropped beds ($P < 0.05$). Cabbage aphid mean density on the intercropped beds was 2.71 while mean density on the mono cropped beds was 3.92 (Table 3; $P = 0.0038$).

Diamondback Moth (*Plutella xylostella*)

P. xylostella was observed five weeks after transplanting. There was also a significant difference in *P. xylostella* means between the intercropped and mono cropped beds ($P = 0.0214$). Mean density of *Plutella xylostella* on the mono cropped cabbage was 2.61 and 1.39 on the intercropped cabbage (Table 3).

Table 1: The insect pests of cabbage recorded at the experimental site.

Common Name	Scientific Name
Cabbage Aphid	*Brassicae brevicoryne.*
Diamondback Moth	*Plutella xylostella*
Cabbage Webworm	*Hellula undalis*
Grasshopper	*Zonocerus variegatus*
Cabbage Looper	*Trichoplusia ni*

Table 2: The insect pests of cowpea recorded at the experimental site.

Common Name	Scientific Name
Bean Aphid	*Aphis craccivora*
Leaf Hopper	*Empoasca spp.*
Flower Thrips	*Megalurothrips sjostedti*
Pod Sucking Bug	*Anoplocnemis curvipes*

Table 3: Mean Density of Insect Pests on Cabbage.

Treatment	*Brevicoryne sp.*	*Plutella xylostella*	*Trichoplusia ni*
Sole Cabbage	3.92 ± 0.28a	2.61 ± 0.44a	2.25 ± 0.48a
Intercrop	2.71 ± 0.29b	1.39 ± 0.24b	1.42 ± 0.43a
P	0.0038	0.0214	0.2108
F	9.29	5.82	1.66

Cabbage Looper (*Trichoplusia ni*)

T. ni was also observed seven weeks after transplanting with generally lower numbers on all the beds. The mean density of *Trichoplusia ni* however did not differ significantly on the mono cropped and intercropped beds (Table 3; $P = 0.2108$).

Bean Aphid (*Aphis craccivora*)

Aphis craccivora was observed three weeks after seeding just as observed in *B. brassicae*. There was a significant difference between the mono cropped and intercropped beds. Mean density on the mono cropped bed was slightly higher than on the intercropped bed with a mean density of 4.29 on the mono cropped and 3.71 on the intercropped beds (Table 4; $P = 0.0833$).

Flower Thrips (*Megalurothrips sjostedti*)

M. sjostedti was also observed six weeks after seeding with the onset of flowering. The mean density on the two beds differed significantly ($P = 0.0147$). The mean density of *M. sjostedti* on the monocrop was 1.40 and 0.53 on the intercropped beds (Table 4).

Table 4: Mean Density of Insect Pests on Cowpea.

Treatment	*Aphis craccivora*	*Megalurothrips sjostedti*	*Anoplocnemis curvipes*
Sole Cowpea	4.29 ± 0.22a	1.40 ± 0.29a	2.67 ± 0.49a
Intercrop	3.71 ± 0.24b	0.53 ± 0.17b	2.17 ± 0.54a
P	0.0833	0.0147	0.5113
F	3.13	6.76	0.46

Pod-sucking bug (*Anoplecnemis curvipes*)

A. curvipes was observed 9 weeks after seeding at the onset of pod formation in the cowpea. There was no significant difference between the mean A. curvipes numbers on the monocropped and intercropped beds. The highest mean density was recorded on the intercropped bed (Table 4).

Discussion

The findings of this study demonstrated that a number of different insect pests attacked the cabbage and cowpea crops. The pests were also observed at different stages of plant growth indicating that pest infestation of the two crops was growth stage specific. Consequently, the cabbage crops had poorly developed leaves right from the early stages. This finding is in agreement with study which suggest that aphid infestation leads to poor leaf development and eventual leaf death. There was no formation of heads by the cabbage crops, and thus yield could not be measured. There was also very low yield of cowpea in both cropping system, yield too low to be a measurable parameter. This suggests that this particular method of planting did not have significant effect on yield although mean density of cabbage aphids and diamondback moth differed significantly between the two cropping systems. Our results suggest that intercropping cabbage and cowpea could promote the growth of natural enemies [19]. Our result is in contrast with findings which suggest that intercropping is not reliable cropping system in controlling diamondback moth. Cabbage aphid density was observed to be relatively higher than diamondback moth infestation even though the diamondback moth is known to be the major pest of cabbage as reported [11] and [4]. The reduction in Bean aphid and thrips population is also supported by the work of. The low population of aphids and thrips in our study may be due to the micro-environmental effect of the cabbage which may distrupt the insects' visual search for the preferred crop. Our study found no significant reduction in cabbage looper infestation and pod-sucking bug infestation on the cowpea crops, which may indicate that intercropping system may only be effective for the control of some specific insect pests [20-22].

Conclusion

In conclusion, our study shows that intercropping cabbage and cowpea is very an effective pest management strategy against *B. brassicae* and *P. xylostella*, *A. craccivora* and *M. sjostedti*.

Acknowledgements

None.

Conflict of Interest

No conflict of interest.

References

1. Lithourgidis AS, Dordas CA, Damalas CA, Vlachostergios DN (2011) "Annual intercrops: an alternative pathway for sustainable agriculture" (PDF). Australian Journal of Crop Science 5(4): 396-410.
2. Altieri MA, Francis CA, Van Schoonhoven A (1978) A reviews of Insect Prevalence in Maize (Zea Mays L.) and Bean (Phaseolus vulgaris L.) Polycultural systems Field Crop Research 1: 33-49.
3. Risch SJ (1983) Intercropping as cultural pest control: Prospects and limitations. Environmental Management 7(1): 9-14.
4. Mochiah MB, Baidoo PK, Obeng A, Owusu Akyaw M (2011) Oleracea Tomato as an Intercropped Plant on the Pests and Natural Enemies of the Pests of Cabbage Brassicae. International Journal of Plant, Animal and Environmental Sciences 1: 233-241.
5. Trenbath RB (1993) Intercropping for the management of pests and diseases. Field Crop Research 34(3-4): 381-405.
6. Khan ZR, Ampong Nyarko K, Chiliswa P, Hassanali A, Kimani S, et al. (1997) Intercropping increases parasitism of pests. Nature (388): 631-632.
7. Jha R, Nayak N (2014) Comparative study on shelf life of Lactuca sativa and Brassica oleracea var. capitata inside open room environment, normal water and polythene bag. International Journal of Research (IJR) 1: 1309-1314.
8. Forte K (2012) The Health Journal: Cabbage and potatoes. UMKC'S Independent Student Newspaper.
9. Nieuwhof M (1969) Cole Crops: Botany, Cultivation and Utilization. London: Leonard Hill.
10. Bewick TA (1994) Cabbage: Uses and Production. Horticultural Sciences Department, Florida Cooperative Extension Service. Institute of Food and Agricultural Sciences, University of Florida Pp. 1-3.
11. Badii KB, Adarkwah C, Nboyine JA (2013) Insecticide Use in Cabbage Pest Management in Tamale Metropolis of Ghana. Greener Journal of Agricultural Sciences 3: 403-411.
12. Timko MP, Singh BB (2008) Cowpea, a Multifunctional Legume. In P.H. Moore, & R.Ming, Genomics of Tropical Crop Plants. Springer (pp. 227-228).
13. Dugje IY, Omoigui LO, Ekeleme F, Kamara AY, Ajeigbe H (2009) Farmers' Guide to Cowpea Production in West Africa. Ibadan, Nigeria: International Institute of Tropical Agriculture (IITA).
14. Gianessi L (2013) IPM Proves Most Effective in Controlling Insect Pests of Cowpea in Africa: International Pesticide Benefits Case Study. Crop Protection Research Institute, Washington, DC.
15. Timko MP, Ehlers JD, Roberts PA (2007) Cowpea. In C. Kole, Genome Mapping and Molecular Breeding in Plants Springer-Verlag, Berlin Heidelberg (3: 49).
16. Carvalho AF, Mateus De Sousa N, Farias DF (2012) Nutritional ranking of 30 Brazilian genotypes of cowpea including determination of Antioxidant capacity and Vitamins. Journal of Food Composiyion and Analysis 26(1-2): 81-88.
17. Ajeigbe HA, Adamu RS, Singh B (2012) Yield performance of cowpea as influenced by insecticide types and their combinations in the dry savannas of Nigeria. African Journal of Agricultural Research 7(44): 5930-5938.
18. Egbo EO (2011) Management of major field insect pests and yield of cowpea (Vignaunguiculata (L) walp) under calendar and monitored application of synthetic chemicals in Asaba, southern Nigeria. American Journal of Scientific and Industrial Reasearch 2(4): 592-602.
19. Risch SJ, Andow DA, Altieri MA (1983) Agro ecosystem diversity and pest control: Data, tentative conclusions and new research directions. Environmental Entomology 12: 625-629.
20. Baidoo PK, Adam JI (2012) The effects of extracts of Lantana camara (L) and Azadirachtaindica (A. juss) on the population dynamics of Plutellaxylostella, Brevicorynebrassicae and Hellulaundalis on cabbage. Sustainable Agriculture Research 1: 229-234.
21. Baidoo PK, Mochiah MB, Apusiga K (2012) Onion as a Pest Control Intercrop in Organic Cabbage (Brassica oleracea) Production System in Ghana. Sustainable Agriculture Research 1: 36-41.
22. Salifu AB (1982) Biology of Cowpea flower thrips and host plant resistance. Msc. Thesis, University of Ghana.