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Identifying the Major Insect Pollinators of *Allium cepa* Flowers in Selected Gardens of Kano State, Nigeria

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Abstract

A field experiment was conducted to assess the major insect pollinators of Allium. cepa seed plantations based on visitation frequency. The study was conducted in three selected gardens in Kano State, Nigeria. Ten umbels were randomly selected; for the observation of insects' composition and abundance visiting the flowers by counting and recording the identity of every insect seen on the flower for 15 minutes. The observations were done for one month at weekly interval, from mid March, 2020 to mid April, 2020. A total of twelve observations were made, four from each garden. The results of study shows that Yanbukar garden has the highest significant ($p<0.05$) number of insects visiting A.cepa flower while Anisoptera and Coccinellidae are not found there. The least significant ($p<0.05$) number of insects on the flowers were recorded on Darmanawa garden with Caelifera and Anisoptera absent. However, Diptera has the highest significant ($p<0.05$) number recorded among the other insects. This was followed by Apis which was also significantly high ($p<0.05$) as compared to other insects. The Poisson distribution fit of model also indicated that there many number Diptera and Apis in the observations than the model will predict. Therefore, Diptera have highest visitation frequencies as compared to Apis on A. cepa seed plantation and this is a crucial component in evaluating pollination activity of a pollinator.

Keywords: Insects, *A. cepa*, flower, gardens, Kano, Nigeria.

Introduction

Onion (*Allium cepa* Linn.) a cosmopolitan vegetable consume by humans is biannual in terms of seeds production and annual in terms of bulb (herbaceous) production[1]. Seeds plantations have been a major problem for breeders all over the globe due to existence of sticky pollen grains. Hand pollination is a significant means of transferring pollen grain in plant propagation but is burdensome[2]. Previous studies estimated 87% honey bees pollination, 10%, wind pollination and 3% other pollination agents in onion[3]. The plants belonging to genus *Allium* are known to produce umbelliferous inflorescence[4]. According to Kavitha and Reddy[1] *Allium* spp. flowers are morphologically designated as bowl shaped flowers with hidden nectarines which are generally found under part of the ovary. The flowers are produced on single hollow elongated scapes. Each plant produced an average of 6.72 scapes and each scapes supports an umbel comprises an average of 479 florets[1]. Depending on species type, time of planting, size and storage conditions of mother bulb, the number of florets per umbel can differ[5]. The prominent pollinators' fascinators in plants include odor, shape and the colour of flowers. Alongside these morphological characteristics, the other cause of disparity for special attraction among vegetables and fruit crops is the rich gift of nectar and pollen provided by some flowers[2]. Nectar produces by flowers influence the behavior of pollinators relative to their energy needed for activities[6]. The nonappearance of insect pollinators over the plantations of onion seed is a major challenge to farmer globally. With the exception of honey bee as natural pollinator, there is little or no literature recognizing the pollination activities of other insects visiting *A. cepa* and these insects might be unfounded as pests by the farmer. Therefore, this study is aimed at evaluating the most frequent insects visiting *A. cepa* seed plantation which is an important component in assessing pollination activity of pollinators.

Materials and methods

The field experiment was conducted in three selected gardens in Kano State, Nigeria, these include; Yanbukar garden in Wudil Local Government Area (GPS:11°47'43.830"N, 8°50'20.929"E), Darmanawa garden in Tarauni Local Government Area (GPS: 11°57'47.173"N, 8°32'44.709"E) and Dantsinke garden also in Tarauni Local Government Area (GPS:11°56'56.804"N, 8°32'44.376"E). Yanbukar garden is located very close to Wudil River and away from residential areas. Darmanawa garden is closed to a drainage system while Dantsinke garden is closed to a pond; both the two gardens were situated within residential areas.

The method of Herrera[7] was adopted with slight modifications. Ten umbels were randomly selected; insects' composition and abundance visiting the flowers were evaluated by counting and

recording the identity of every insect seen on the flower for 15 minutes. The observations were done for one month at weekly interval, from mid March, 2020 to mid April, 2020. Four observations were made from each garden, forming a total of twelve observations.

The data composed were put through two-ways analysis of variance (ANOVA) to determined the significant number of insects visited *A. cepa* flowers among the gardens and the significant insect visitor among the insect species. Where the ANOVA indicated significant difference Least Significant Difference (LSD) was used to separate the means. The data for individual insect visitor was subjected to Poisson distribution model to determine the rare and most frequent visitor. The ANOVA analysis was conducted with Sigma Stat statistical software (version 3.5) while the Poisson distribution probabilities were obtained with Statdisk statistical software (version 10.0.0).

Results and discussion

This study evaluates the major insect pollinator of *A. cepa* flowers from the diverse insects that visit the flower. Table-1 shows the mean distribution of insects visited the flowers of *A. cepa* from three gardens. Yanbukar garden has the highest significant ($p<0.05$) number of insects visiting *A. cepa* flower though Anisoptera and Coccinellidae were not present. This was followed by Dantsinke garden which was also significant ($p < 0.05$) and Coccinellidae were also not present. The least significant ($p<0.05$) number of insects on the flowers were recorded on Darmanawa garden with Caelifera and Anisoptera absent. However, Diptera has the highest significant ($p<0.05$) number recorded among the other insects. This was followed by Apis which was also significantly high ($p<0.05$) as compared to other insects.

The number of other insects recorded; Papilionoidea, Hymenoptera, Caelifera, Anisoptera and Coccinellidae did not differ significantly ($p > 0.05$).

Other Tables shows the fit of Poisson distribution model of the occurrence various insects recorded on *A. cepa* flowers. The total of two hundred and seventy-eight Diptera was recorded from twelve samplings. All the twelve samplings recorded 5 or more Diptera. There is an average of 5.000 number of Diptera per sampling with variance of 0.000 (Table-2).

The total of twenty-three Papilionoidea was from the twelve samplings conducted. In three samplings no any Papilionoidea was recorded, seven samplings have 1, 2 or 3 Papilionoidea and two (samplings have 4 or 5 Papilionoidea. An average of 1.917 Papilionoidea per sampling with variance of 2.627 was recorded (Table-3).

For *Apis*, a total of fifty-seven was recorded from the twelve samplings. From six samples carried out 2, 3 or 4 *Apis* was recorded while the remaining six samplings have 5 or more *Apis*. The average of 3.917 *Apis* per sampling and variance of 1.080 were recorded (Table-4).

The total observed for Hymenoptera was twenty from the samplings. Three samplings have on Hymenoptera record, eight samplings have 1, 3 or 4 Hymenoptera and one sampling has 5 or more Hymenoptera. An average of 1.500 Hymenoptera per sampling and variance of 2.091 were recorded (Table-5).

The total of three Caelifera was recorded from the samplings. Nine samplings have no Caelifera and the three samplings have 1 Caelifera. There is an average of 0.250 Caelifera per sampling with variance of 0.205 (Table-6).

Also Anisoptera have a total three with eleven samplings having no any Anisoptera and only one sampling having 3 Anisoptera. The average number per sampling is also 0.250 and the variance is 0.750 (Table-7).

Only one Coccinellidae was recorded from one sampling out of the twelve samplings. The average number per samplings is 0.083 and the variance is 0.000 (Table-8).

Table-1: Mean number of insects visited *A. cepa* flowers from three gardens in Kano State.

	Insects	Yanbukar	Gardens		Group mean±SE
			Darmanawa	Dantsinke	
Diptera	Diptera (Housefly)	27.000	20.000	22.500	23.167 ± 2.236^{a}
Lepidoptera	Papilionoidea (Butterfly)	3.500	0.750	1.500	1.917 ± 0.468^{c}
Hymenoptera	*Apis* (Honeybee)	7.250	4.500	2.500	4.750 ± 0.708^{b}
	Hymenoptera (Wasp)	3.250	0.750	1.000	1.667 ± 0.555^{c}
Orthoptera	Caelifera (Grasshopper)	0.500	0.000	0.250	0.250 ± 0.131^{c}
Odonata	Anisoptera (Dragonfly)	0.000	0.000	0.750	0.250 ± 0.250^{c}
Coleoptera	Coccinellidae (Lady bug)	0.000	0.250	0.000	0.083 ± 0.083^{c}
	Group mean±SE	5.929 ± 1.796^{a}	3.750 ± 1.392^{c}	4.071 ± 1.564^{b}	LSD = 2.574

LSD = 1.685. Means ± standard error with the same letter within column and row are not significantly different from each other (LSD $p > 0.05$).

Table-2: Fit of model for Diptera (Housefly) occurrence on *A.* I flower.

Number of insect per sampling	Frequency of sampling	Absolute expected frequency	Poisson probability (x)
0	0	0.08	0.0067
1	0	0.40	0.0337
2	0	1.01	0.0842
3	0	1.68	0.1404
4	0	2.12	0.1755
5+	12	2.12	0.1755
Total	12	12.0	
Mean = 0.083	S^2 = 0.000		

S^2 = variance.

Table-3: Fit of model for Papilionoidea (Butterfly) occurrence on *A. cepa* flower.

Number of insect per sampling	Frequency of sampling	Absolute expected frequency	Poisson probability (x)
0	3	1.77	0.1471
1	2	3.38	0.2819
2	3	3.24	0.2702
3	2	2.07	0.1727
4	1	0.99	0.0828
5+	1	0.38	0.0317
Total	12	11.8	
Mean = 1.917	S^2 = 2.627		

S^2 = variance.

Table-4: Fit of model for Apis (Honeybee) occurrence on *A. cepa* flower.

Number of insect per sampling	Frequency of sampling	Absolute expected frequency	Poisson probability (x)
0	0	0.24	0.0199
1	0	0.94	0.0780
2	2	1.83	0.1527
3	3	2.39	0.1993
4	1	2.34	0.1952
5+	6	1.84	0.1529
Total	12	9.58	
Mean = 3.917	S^2 = 1080		

S^2 = variance.

Table-5: Fit of model for Hymenoptera (Wasp) occurrence on *A. cepa* flower.

Number of insect per sampling	Frequency of sampling	Absolute expected frequency	Poisson probability (x)
0	3	2.68	0.2231
1	4	4.02	0.3347
2	3	3.01	0.2510
3	1	1.51	0.1255
4	0	0.57	0.0471
5+	1	0.17	0.0141
Total	12	12.0	
Mean = 1.500	S^2 = 2.091		

S^2 = variance.

Table-6: Fit of model for Caelifera (Grasshopper) occurrence on *A. cepa* flower.

Number of insect per sampling	Frequency of sampling	Absolute expected frequency	Poisson probability (x)
0	9	9.36	0.7788
1	3	2.34	0.1947
2	0	0.29	0.0243
3	0	0.02	0.0020
4	0	0.00	0.0001
5+	0	0.00	0.0000
Total	12	12.0	
Mean = 0.250	$S^2 = 0.205$		

S^2 = variance.

Table-7: Fit of model for Anisoptera (Dragonfly) occurrence on *A. cepa* flower.

Number of insect per sampling	Frequency of sampling	Absolute expected frequency	Poisson probability(x)
0	11	9.36	0.7788
1	0	2.34	0.1947
2	0	0.29	0.0243
3	1	0.02	0.0020
4	0	0.00	0.0001
5+	0	0.00	0.0000
Total	12	12.0	
Mean = 0.250	$S^2 = 0.750$		

S^2 = variance.

Table-8: Fit of model for Coccinellidae (Lady bug) occurrence on *A. cepa* flower.

Number of insect per sampling	Frequency of sampling	Absolute expected frequency	Poisson probability(x)
0	11	11.05	0.9204
1	1	0.92	0.0764
2	0	0.04	0.0032
3	0	0.00	0.0001
4	0	0.00	0.0000
5+	0	0.00	0.0000
Total	12	12.0	
Mean = 0.083	$S^2 = 0.000$		

S^2 = variance.

Discussion: The flowers of *A. cepa* have bowl shape, in the study the plantation harbor among others visitors, Diptera Lepidoptera, Hymenoptera and Coleoptera. This is in agreement with the findings of Roubik[8] who stated that flowers with bowl shape are visited and pollinated by fly, beetle, unspecialized bee and Lepidoptera. Devi *et al*.[2] listed insect visitors/pollinators of onion umbels at Haris to include: Hymenoptera (Wasp), Diptera, Lepidoptera, *Apis*, and Coleoptera (*Coccinella* sp.) and Sajjad *et al*.[9] reported who that insect fauna belonging to Diptera, Hymenoptera and Lepidoptera visit and pollinate the onion field.

The highest significant ($p<0.05$) number of insects visiting *A. cepa* flowers in Yanbukar garden in Wudil could be attributed to the location of the garden which might be closer to the pollinators' nest and less of disturbance by human activities.

The highest significant ($p < 0.05$) number of Diptera as the most frequent visitor was recorded in the study. This is similar to the work of Shafqat and Masood[10] reported eight true flies of Diptera and two Hymenopteran bees as pollinators of *A. cepa*. Also Saeed *et al.*[11] stated twelve true fly species and our bee species comprised the pollinators' community on onion plantation. In contrast to this Kanitha and Rami Reddy[1] reported that among the different insect family that pollinate onion, family Apidae including honeybee were major pollinators, Devi *et al*.[2] recorded four Apis species as major foragers on onion and Banik[3] estimated that honey bees were 87% in onion

pollination and other pollinator were 3%. These differences could be associated to ecological variations in the area where the studies are conducted which might result into conditions such as habitat suitability for nesting by the Apis, as Dipterans needs no nest and also there may be variation both locally and regionally in the composition of pollinator communities.

The fit of Poisson distribution model in the study shows the inappropriate fit of Diptera and Apis with the probabilities of obtaining 5 or more insects of 1755 samplings in 10,000 samplings and 1529 in 10,000 samplings respectively. These high probabilities indicated the abundance of the insect on *A. cepa* plantation with Diptera recording the highest abundance when compared to Apis.

Other insects visitors recorded in study fit the model appropriately with Lepidoptera having the probability of 317 in 10,000 samplings for obtaining 5or more insects, Hymenoptera (Wasp) 141 in 10,000 samplings for obtaining 5or more insects while Orthoptera, Odonata and Coleoptera have 0 probabilities in 10,000 samplings for obtaining 5 or more insects. This shows that the rare and randomly visitation of these insects on *A. cepa* flowers.

Conclusion

Dipterans were found to be the most frequent visitors of *A. cepa* flowers in both gardens, other frequent visitors were *Apis*, Lepidoptera and Hymenoptera (Wasp). Therefore, these insects are considered to be the major pollinators of *A. cepa* flowers. The presence of Dipterans particularly and other insects on the plantation should not be considered as unpleasant which call for insecticide application.

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