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Intercropping System for Protection the Potato Plant from Insect Infestation

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Abstract. The use of intercropping system provides an option for insect control for organic farmers that are limited in their chemical use. Additionally, intercropping systems can be attractive to conventional growers as a cost-effective insect control solution. A study was carried out for two seasons 2011-2012 and 2012-2013 to evaluate the effect of intercropping of potato (*Solanum tuberosum* L.) with onion (*Allium cepa* L.) on whitefly (*Bemicia tabasi* Gennadius) and aphids' *Myzus persicae* Sulz. and *Aphis gossypii* Glover infestation in potato fields. Results indicated that intercropping significantly reduced potato plant infestation with whitefly by 42.7, 51.3% while it was 62.69% reduction with aphids during the two successive winter seasons than when potato plants were cultivated alone. Therefore, intercropping could be recommended as a protection method of reducing pest population in the fields.

Key words: intercropping, whitefly, aphids, potato, onion, pest infestation.

Introduction

The use of chemical insecticides for the control of insect pests results to resistance of some pests to some conventional insecticides. Alternative methods of managing pests such as cultural control have to be employed to reduce pest infestation on crops. BIDOO *et al.* (2012) reported that onion was used as an intercrop to manage the pests of cabbage.

Intercropping is the planting of more than one crop in close proximity as part of the same farming system. The design of intercropping system can vary dramatically depending on the purpose of the intercrop for the farming operation. Intercropping produces the benefits of on-farm diversity, increased productivity, resource distribution balance, farm risk reduction, and weed and insect pest control. Intercropping systems for insect pest control includes the planting of a crop that has a repellent effect, an attractant effect, or a combination of both, on a target pest in close proximity to a crop that has the potential to be attacked by it (DEGRI *et al.*, 2014). Many spatial combinations are possible for intercropping, including mixed intercropping, in which different crops are planted in the same row or at alternating rows. Crop rotation means planting different crops on the same plot during different times of the year, and can include some of the benefits of intercropping, such as reducing insect pest populations, increasing beneficial insects, and weed suppression. In addition, non-crop plants such as weeds, cover crops, and habitat

plantings can be combined in space and time to influence numbers of pest and beneficial arthropods on the main crop (SMITH & LIBURD, 2015). Some plant combinations, for instance, with non-hosts reduce the spread of pests within crops (GAUTAN & KAUSHIK, 1980; WILLEY & GARVER, 1981; DEGRI *et al*., 2014). Non-host plants in such mixture may emit chemicals or odors that adversely affect the pests, thereby conferring some level of protection to the host plant (SING *et al*., 1986; REDDY, 2012). Studies indicate that crop diversification through intercropping, such as cereals with legumes, is effective in reducing insect pest damage (NWANZE, 1989). Also, the intercropping of groundnut with pearl millet (*Pennisetum glaucum* L.) increased the population of *Gonizous sp*., a parasitoid species that effectively manages leaf miner *Arachis hypogaea* L. population in groundnut (DHALIWAL & ARORA, 1966). Work by CHABI-OLAYE *et al*. (2005) found a considerably reduced amount of noctuid eggs laid by *Sesamia calamistis* Hampson and *Busseola fusca* Fuller due to lack of the host found by the ovipositing adult moths in maize intercropped with grain legumes or cassava than those in monocrop. The aim of the present experiment was to evaluate the effect of intercropping of potato plant with onion for protection the potato from insect infestation under field experiment.

Materials and Methods

Experiments were carried out at an experimental farm in Kalubia governorate, Egypt, during the successive two late winter seasons 2011-2012 and 2012-2013 in order to evaluate the effect of intercropping of onion, *Allium cepa* (L.), with potato plants *Solanum tuberosum* (variety Necola) on potato infestation with aphids and white fly which have been recorded as the major pests (MOAWAD, 1999, Ain Shams University, pers. comm.). Each plot contained 10 rows and was separated from other plots by uncultivated rows. Each row was cultivated with six potato tubers at distances of 25 cm (MICHEAL, 1995, Zagazig University – pers. comm.). Tubers were buried in soil at 10 cm depth. The planted area was kept free from any chemical insecticidal treatment. The transplanted onion was cultivated at the end of each potato row; which was surrounded from east and west by three onion transplants; while the north and south of potato rows were planted only by an onion row, contained 12 onion transplants. The check plots were cultivated by potato plants only and were separated from the experimental area by an unplanted plot (20 rows). The check and test plots were divided in an area of 300 m^2. Experiments were replicated three times for each of the two seasons. Sampling of potato (25 leaflets at 7 days intervals for three months duration from December, January and February) was carried out after 30 days of plantation for whitefly *Bemicia tabaci* and aphids *Myzus persica* and *Aphis gossypii* infestation. The collected samples were kept in paper bags in a refrigerator till examined by the use of a binocular microscope. They were separated, identified and counted. The data was statistically processed, using t-test.

Results and Discussion

Results on the effect of intercropping potato with onion *(Allium cepa* L.*)* on the population density of immature stages (eggs, nymphs and pupae) of the whitefly, *B. tabaci* and aphids, *M. persicae* and *A. gossypii*, in the two seasons of winter plantations are given in Tables 1 and 2.

Effect on the whitefly infestation

The data presented in Tables 1 and 2 indicated that the lowest number of immature stages of the whitefly was observed on potato leaves intercropped with onion plant. Thus, during the two seasons, the mean number of immature stages of the whitefly/25 leaflets were 59.02 and 51.7 during the first and the second winter seasons, compared with 154.95 and 168.3 immature stages of the whitefly/25 leaflets for the control (sole potato), respectively. Reduction in percent of whitefly infestation reached 62% and 69% in the first and the second winter seasons, respectively.

Statistical analysis (t-test) revealed that there was highly significant differences (p<0.01) between the population density of

the whitefly on potato leaves intercropped with onion and that on potato leaves cultivated alone in the two seasons of the study.

Table 1. Effect of intercropping potato with onion on the population density of the whitefly (*B. tabaci*) in the first winter season (2011-2012).

Inspection dates		Mean number of immature stages of *B. tabaci* /25 leaflets±SE.	
		Potato : onion	Sole potato
Dec.	10	11.3±0.11	20.7±0.08
	17	21.3±0.01	46.7±0.12
	24	61.0±0.14	130.6±0.15
	31	98.7±0.51	395.1±1.04
Jan.	7	146.0±0.22	386.0±1.11
	14	142.3±0.31	302.0±0.46
	21	94.3±0.25	281.3±0.33
	28	81.7±0.07	193.0±0.17
Feb.	4	44.7±0.13	62.4±0.22
	11	6.9±0.03	41.7±0.12
	18	0.0±0.00	0.0±0.00
	25	0.0±0.00	0.0±0.00
Total		708.2	1859.9
General mean		59.02*± 0.32	154.95 ±0.05

Table 2. Effect of intercropping potato with onion on the population density of the whitefly *(B. tabaci*), in the second winter season (2012-2013)

Inspection dates		Mean number of immature stages of *B. tabaci* /25 leaflets	
		Potato: onion	Sole potato
Dec	15	3.6±0.08	15.7±0.12
	22	7.3±0.14	67.7±1.03
	29	73.7±0.20	326.3±0.12
Jan.	5	151.7±0.22	459.0±1.06
	12	159.0±0.12	451.7±0.08
	19	110.0±0.20	253.7±0.11
	26	59.70.12	233.0±0.05
Feb.	1	33.3± 0.14	143.7±0.21
	8	21.7±0.04	55.3±0.04
	15	0.0±0.00	13.7± 0.12
	22	0.0±0.00	0.0±0.00
Mar.	1	0.0±0.00	0.0±0.00
Total		620.0	2019.8
General mean		51.7* ±0.01	168.3±0.12

Effect on aphids. Infestation

Results are presented in Tables 3 and 4, they cleared that the infestation was much lower in case of potato plants intercropped with onion than in case of potato plants cultivated alone. Thus, the rate of infestation of potato plants cultivated with onion was 64.5 and 81.2 aphids/25 leaflets, compared with 112.6 and 166.8 aphids/251eaflets for the potato crop alone, with reduction in percent of aphids infestation reached 42.7% and 51.4% in the two seasons' respectively. The difference was statistically highly significant (p<0.01).

The aforementioned results clearly showed that intercropping potato with onion plant exhibited considerable protection against the whitefly, but relative-

ly less protection against aphids. The effect may be attributed mostly to the odor of the non-host crop (onion). The obtained result agrees with those obtained by TAVAIENEN & ROOT (1974) and LAL (1991) who found that intercropping potato with onion and other crops exhibited a best protection of potato crop from the potato tuber moth *Phthorimaea operculilla* attack more than sole potato culture. It also agrees with POTTIS & GUNADI (1991) who found that intercropping potato crop with *Allium cepa* or *A. sativum* caused reduction in the population of *Myzus persicae, Aphis gossypii* and *Emposca* spp. LAWANI (1982) and KHAN *et al*. (1997) stated that intercropping has been reported to reduce insect pest populations due to colonization deterrence in crop field with increased plant diversity that creates unsuitable or unfavorable environment to some pest species.

Table 3. Effect of intercropping of potato with onion on the population density of aphids in first winter season (2011-2012).

Inspection dates		Mean number of aphids /25 leaflets.	
		Potato: onion	Sole potato
Dec.	10	0.0± 0.00	0.0 ±0.00
	17	0.0±0.00	28.6±1.12
	24	21.3±0.03	40.3± 0.11
	31	22.7± 0.12	57.0± 0.02
Jan.	7	32.0±0.19	110.3±1.17
	14	71.7±0.22	129.7±1.06
	21	90.3± 0.10	123.0±0.22
	28	90.3± 0.04	212.0±0.16
Feb.	4	173.7±1.01	253.0± 0.12
	11	168.7± 0.14	186.7±0.23
	18	59.0± 0.11	144.7±1.13
	25	44.3±0.02	66.0 ±0.12
Total		774.0	1351.3
General mean		64.5 *±0.20	112.6 ±0.32

Table 4. Effect of intercropping potato with onion on the population density of aphids in the second winter season (2012-2013).

Inspection dates		Mean number of aphids/25 leaflets.	
		Potato: onion	Sole potato
Dec.	15	0.0 ±0.00	0.0 ±0.00
	22	0.0±0.00	6.7±0.02
	29	2.7±1.02	26.7±0.14
Jan.	5	36.3±0.04	40.8 ±0.18
	12	44.0±0.12	63.3 ±0.22
	19	83.7±0.11	148.3± 0.36
	26	200.0±1.19	490.3±1.15
Feb.	1	313.7±1.32	416.0 ±0.16
	8	101.3±0.17	318.7±1.04
	15	112.6±0.52	285.0 ±1.06
	22	48.0± 0.33	131.3 ±0.44
Mar.	1	32.3±0.04	74.7 ±0.12
Total		974.6	2001.8
General mean		81.2* ±0.02	166.8 ±0.17

DHALIWAL & ARORA (1996) found increased number of parasitoid and predators in pearl millet under intercropping (UVA, 1985; AJAYI, 1990; KHAN *et al*., 1997). Up to 30% crop pest reductions due to natural enemy effect have been observed by BALIDDAWA (1985) in intercropping system. WSZELAKI (2014) reported that the use of intercropping can provide benefits to a management system, including decrease insect pest pressure, reduced need for external inputs, increases in biodiversity, enhanced production and lower economic risk. Separation susceptible plants with non-host species provides a physical barrier to insect pest movement, limiting spread and decreasing likelihood of damage to susceptible varieties. For example, separating planting of solanaceous crops, such as tomatoes and potatoes, that are susceptible to Colorado potato beetle, with a non-host crop, such as corn, can reduce the movement of Colorado potato beetle from one solanaceous crop to another. The additions of multiple species enhance biodiversity and encourage beneficial insect population. Resulting beneficial interactions between plants can confuse insects, lowering insect reducing the need for external inputs. Inclusion of multiple crops utilizing different environmental niches increases the productivity per unit of land, allowing for financial diversification, as well as a reduced financial risk in the event of crop failure. BAIDOO *et al*. (2012) mentioned that onion was used in an intercrops as a non-host crop to manage the pests of cabbage. SMITH & LIBURD (2015) stated that when an herbivore encounters a plant it cannot feed on, it must expend additional time and energy searching for an acceptable plant. This reduces the time and energy of the insect for crop damage or deposit offspring, and in some instances it encourages the insect to migrate from the area. Insects rely on visual, olfactory, and tactile cues to find host plants. The presence of non-host plant can interfere with an insect' s ability to detect host plant by physically masking the presence of the host plant or by producing volatiles that confuse the insect. In this sense, diverse habitat can reduce the appearance of host plants to pests.

Conclusions

The present research recommends that combination of potato as a major crop and onion plants as a cover crop during cultivation is an assistant factor to protect the potato plant from injury of the whitefly and aphids which are among harmful pests for the potato cultivations in the field.

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