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INSECT FAUNA OF CANOLA AND PHENOLOGY OF THE DIAMONDBACK MOTH, *PLUTELLA XYLOSTELLA* L. (LEPIDOPTERA PLUTELLIDAE) AS A KEY PEST

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Mahmoud M. F., Shebl M. - Insect fauna of canola and phenology of the diamondback moth, *Plutella xylostella* L. (Lepidoptera Plutellidae) as a key pest.

Canola or oilseed rape (*Brassica napus* L.) is one of the most important crops worldwide as a main source of edible vegetable oil. A field study of the insect fauna and the phenology of diamondback moth, *Plutella xylostella* L. in canola was conducted during the 2012/2013 and 2013/2014 growing seasons. The study was carried out at the Experimental farm, Faculty of Agriculture, Suez Canal University, Ismailia. A total of 31 insect species were recorded from the crop (13 pest species, 9 natural enemy species and 9 insect pollinators). Diamondback moth and cabbage aphid were the dominant pests, lady beetles and hoverflies were the most abundant natural enemies and honeybees were the dominant pollinators. The phenology, infestation rate and parasitism of *P. xylostella* were determined for the two growing seasons. In 2012/2013, the peak population (14.5 larvae or pupae/plant) was recorded in the eleventh week when temperatures ranged from 8.8 to 18.2 °C with relative humidity of 70%, while in the 2013/2014 season the peak population (8.3 larvae or pupae/plant) was recorded in the twelfth week when temperatures ranged from 8.2 to 20.0 °C with relative humidity of 70%. The infestation levels of *Plutella xylostella* ranged from 20 to 80% during the 2012/2013 season, while in the 2013/ 2014 season infestation levels ranged from 10 to 50%. Percent parasitism showed more at least two peaks in each growing seasons. Peaks were 44.5 and 31.2% in 2012/2013 season and 30.2, 32.6 and 25.9% in 2013/2014 season.

KEY WORDS: Canola, Insect fauna, *Plutella xylostella*, Phenology, Infestation rate, Parasitism.

INTRODUCTION

Canola (oilseed rape), *Brassica napus* L. (Brassicaceae), is now the third most important source of edible vegetable oil in the world. In Egypt, oil crops make up 1.8% of the total cultivated area of the country. Canola has the potential in Egypt to fill the local oil production gap. Moreover, it can be grown in the newly reclaimed lands as a winter crop (EL-HADIDI *et al.,* 2007; MEGAWER & MAHFOUZ, 2010; KANDIL & GAD, 2012). Growing canola still faces many challenges; one of them being heavy infestations by various insect pests, causing poor growth and low yield (DOSDALL & MASON, 2010). In Egypt, the most serious insect pests of canola are the cabbage aphid, *Brevicoryne brassicae* (L.) (Aphididae: Homoptera); thrips, *Thrips tabaci* (Lindeman) (Thripidae: Thysnaoptera); diamondback moth, *Plutella xylostella* (L.) (Plutellidae: Lepidoptera); whitefly, *Bemisia tabaci* (Gennadius) (Aleurodidae: Homoptera); leafminer, *Liriomyza* sp. (Agromyzidae: Diptera) and two-spotted spider mite, *Tetranychus urtica* Koch, (Teranychidae: Acari) (SAYED & TEILEP, 2013).

Among these *P. xylostella* is the most serious pest of canola globally (GATHU, 2013; LÖHR *et al.,* 2007). It occurs wherever crucifer crops are grown and is believed to be the most universally distributed of all Lepidoptera (GRZYWACZ *et al*., 2010; SYED *et al*., 2012), having established in almost every climatic zone of the world (MOSIANE *et al.,* 2003). *Plutella xylostella* larvae feed on the leaves of canola during the vegetative crop stage, on growing tips during the bolting stage, and on the flowers and pods during the reproductive growth stages causing poor pod filling and reduced yield (MOSIANE *et al*., 2003). As well, *P. xylostella* has been known to cause serious economic damage on cabbages locally, reaching up to 100% crop losses (MKIZE, 2003).

In Egypt, little is known about the insect fauna associated with canola and damage caused. Therefore, the purpose of this study was to: 1) survey the insect fauna of canola; 2) determine their status as pests, natural enemies or pollinators; and 3) study the seasonal phenology of *P. xylostella* populations throughout 2012/2013 and 2013/2014 seasons.

MATERIALS AND METHODS

STUDY SITE AND CANOLA CROP

This study was carried out at the Experimental farm, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt during the 2012/2013 and 2013/2014 growing seasons. The land used measuring about 0.315 ha was planted with the canola cultivar (Serw 4). On October, 22 in 1st and 2nd growing seasons, seeds of canola were sown at rate of 5-10 seeds/hill with 25 cm apart. After 18 days from sowing date, seedlings were thinned to one plant/hill to obtain 16 plants/m^2. Other agronomic practices adopted according to the recommended methods.

COLLECTION AND IDENTIFICATION THE INSECTS ASSOCIATED WITH CANOLA CROP

Plants were monitored weekly from germination until harvest for insects associated with canola (pests, natural

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enemies, and pollinators). A sweep net measuring 40 cm in diameter was used to collect insects from five selected sites (Suez Canal University new campus 30.26N 32.16E). At each site a sample consisting of 10 sweeps 180º arc was taken and the number of insect counted. The collected insects were killed in a cyanide jar and transferred to the laboratory. The large insects were pinned, labeled and placed in a collection box for taxonomic study. The smaller insects were mounted on microscope slides, labeled and preserved too in the box of slides. Insects were identified to species when possible through the use of published taxonomic keys and direct comparisons with authoritatively identified museum specimens housed at the Department of Plant Protection, Ismailia.

Phenology of *Plutella xylostella*, infestation rate and parasitism

Four weeks after planting (22 October 2012/2013 and 2013/2014) and once the canola seedlings were established, the larvae, pupae and parasitoid cocoons were monitored every week. At weekly intervals 10 canola plants were randomly selected and scouted, and the number of *P. xylostella* larvae, pupae and parasitoid cocoons were recorded from each plant and samples of each were transferred into glass vials, placed into a bag and brought to the laboratory. In the laboratory, *P. xylostella* larvae were placed singly in Petri dishes and provided with fresh pieces of canola leaf. The lid of the Petri dish was secured with rubber bands so that the larvae could not escape. The canola leaves were replaced every second day until *P. xylostella* pupae or parasitoid cocoons formed. The parasitoids that emerged were identified. The larvae that escaped or died, and pupae and parasitoid cocoons that failed to emerge were excluded from the calculation of parasitism. Dead larvae and pupae of *P. xylostella* in each sample were dissected under a binocular stereomicroscope to determine if they were parasitized or died from other reason. Percent of parasitism of diamondback moth by parasitoids was calculated using the formula (number of parasitoids adults)/ (number of diamondback moth + parasitoids that emerged) × 100.

Meteorological conditions

The meteorological data (maximum temperature, minimum temperature and relative humidity) were provided by the Center for Meteorological and Weather Research Applied to Agriculture – Ismailia throughout the growing seasons of canola crop (Fig. I).

Statistical analysis

Simple correlation values were computed to evaluate the relation between the population of *P. xylostella* and climate factors (mean max. and min. temp. and mean % RH). Also, numbers of individuals collected were subjected to an analysis of variance (ANOVA) with the honestly significant difference value calculated as Tukey's statistic at $P \leq 0.05$ (SAS Institute 2004).

RESULTS AND DISCUSSION

Thirty one species of insects were recorded from the study site. Among these, 9 were seedling pests (Table 1), 5 were flower and pod (Table 2), 9 were natural enemies (Table 3) and 9 were insect pollinators (Table 4).

With the exception of *P. xylostella*, lepidopterous caterpillars occurred only during the vegetative stage (Fig. II), while aphids were dominant and destructive to the flowering and podding of the crop (Fig. III). *Brevicoryne brassica* L. is known to be the most abundant species of Aphididae on canola crop during the flowering and podding stage (Aslam *et al*., 2007; Sayed & Teilep, 2013). The coleopterans, especially of the families Nititulidae and Scarabaeidae feed on the flowers, pollen and nectar and contributes to the pollination of the crop. Loss of pod sites albeit sometimes severe, rarely reduces winter oilseed rape yields (Jellis, 2003). Although many coleopterans are pests, some play an important role as predators in crops, such as the Coccinellidae. These findings agreed with (Bunting *et al.,* 1995; Mosiane *et al*., 2003). Among the 9 species of beneficial insects (Fig. IV), Ichneumonidae and Braconidae dominated the parasitoides population while Coccinellidae and Syrphidae were the most abundant predators. *C. undecimpunctata* L. was the most dominant species of natural enemies, followed by *S. corollae* in the two growing seasons of canola crop. The honey bee, *Apis mellifera* L. was the most abundant species of pollinators present during both growing seasons, followed by the colletid bee *C. lacunatus* (Fig. V). Parasitic and predacious Hymenoptera play an important role in controlling insect pests of canola (Sayed & Teilep, 2013). Moreover, bees are important for pollination process and yield production of many crops (Mahmoud, 2012).

The infestation rate of *P. xylostella* was higher in 2012/2013 than 2013/2014 on all sample dates (Fig. VI). The infestation gradually increased in both growing seasons until the first week of February when 80% of plants were infested in the 2012/2013 season and the last week of December in 2013/2014 when 40% of plants were infested. After reaching the peak, the infestation rate then gradually decreased during the first growing season until the last sampling date (20%), while during the second growing season a second peak (50%) occurred on the last week of January and then decreased until the last week of February and increasing again to 20% on the last sampling date (Fig. VII).

Percentage of parasitism of *P. xylostella* was higher in 2012/2013 than 2013/2014 season on most sampling dates, except from 17/01/2014 to 07/02/2014 (Fig. VIII). The parasitism during 2012/2013 showed two peaks, the first one (44.5%) in the mid-January followed by a decreased to 17.7% by the first week of February. The second peak was in the third week of February (31.2%). In 2013/2014 parasitism gradually increased to a first peak of 30.2% by the mid of January, followed by a second peak of 32.6% the last week of January and third peak of 25.9% by mid-February. Overall parasitism in our study is in agreement with other studies which found that the parasitism of *P. xylostella* ranged from 10 to 80% (Navatha & Murthy, 2006; Gathu, 2013; Popape *et al*., 2014).

Correlation coefficients between temperature, relative humidity and total mean number of larvae and pupae of *P. xylostell*a/plant showed that during the 2012/2013 growing season there were no significant relationships, although minimum temperature showed a moderate negative correlation (r= - 0.316). Relative humidity showed a weak positive correlation (r= 0.287) In 2013/2014, there were strong positive and significant correlations found between maximum temperature, minimum temperature and the population of *P. xylostell*a (r= 0.451 and 0.421, respectively), and a weak positive but insignificant correlation (r= 0.217) between relative humidity and *P. xylostella* populations.

In conclusion, the insect fauna in canola in Egypt

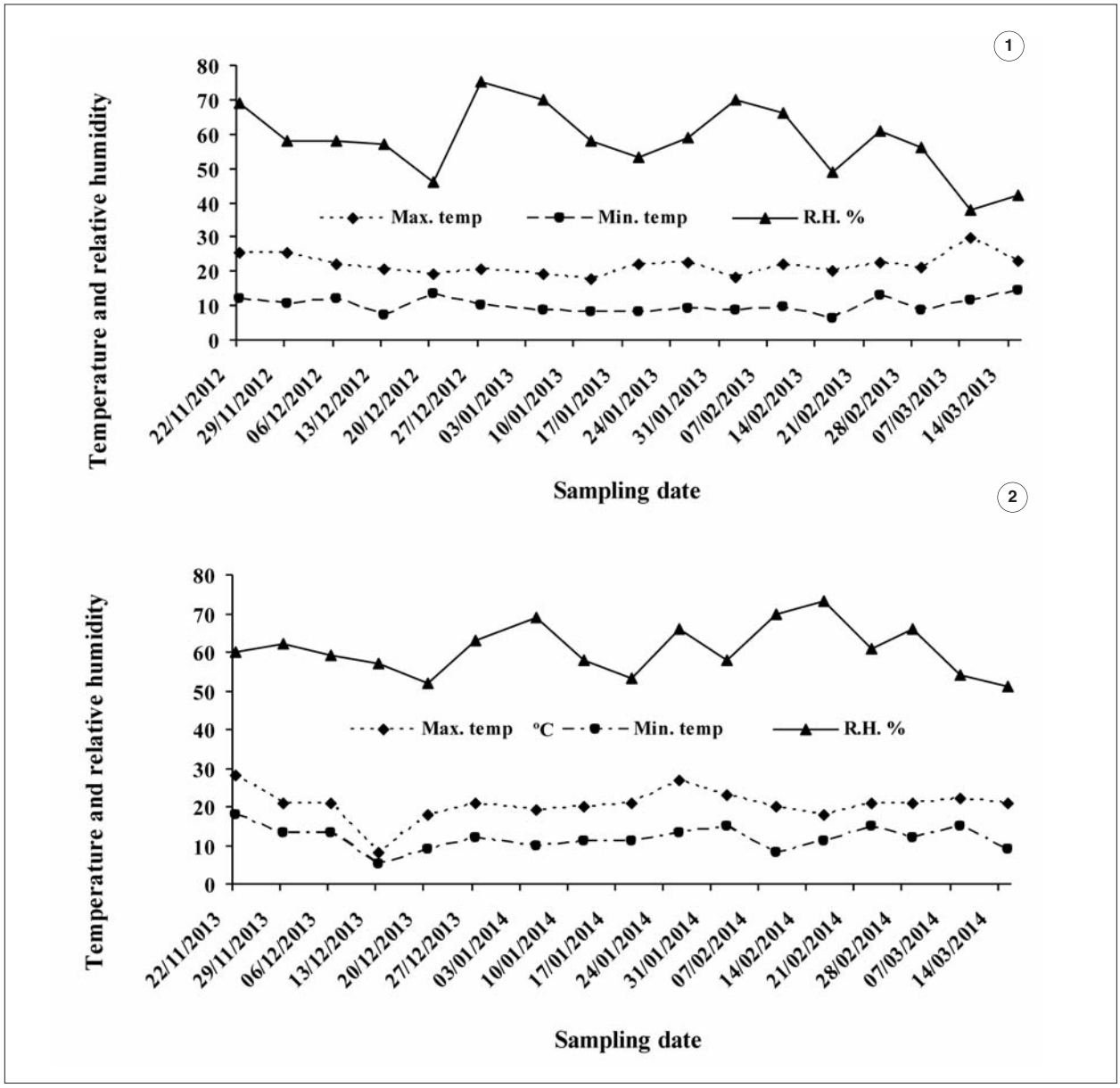

Fig. I – Mean daily maximum and minimum temperatures and relative humidity during the growing seasons at the Experimental farm, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt: 1) 2012/2013 and 2) 2013/2014.

Table 1 – Insect pests of canola plants throughout the growing season of 2012/2013 and 2013/2014.

Order	Family	Species	Common name
Lepidoptera	Plutellidae	*Plutella xylostella* (L.)	Diamondback moth
	Noctuidae	*Agrotis ipsilon* (Hufnagel)	Black cutworm
	Noctuidae	*Spodoptera exigua* (Hb.)	Beet armyworm
	Noctuidae	*Spodoptera littoralis* Boisduval	Egyptian cotton worm
	Noctuidae	*Autographa gamma* (L.)	Silver Y moth
Diptera	Agromyzidae	*Liriomyza* sp.	Leafminer
Coleoptera	Chrysomelidae	*Phyllotreta cruciferae* (Goeze)	Crucifer flea beetle
Thysanoptera	Thripidae	*Thrips tabaci* Lindeman	Onion thrips
Homoptera	Aleyrodidae	*Bemisia tabaci* (Gennadius)	Tobacco whitefly

Table 2 – Flower and pod insect pests of canola plants throughout the growing season of 2012/ 2013 and 2013/2014.

Order	Family	Species	Common name
Coleoptera	Nititulidae	*Glischrochilus quadrisignatus* (Say)	Four spotted sap beetle
	Scarabaeidae	*Tropinata squalida* (Scop.)	Hairy rose beetle
Homoptera	Aphididae	*Brevicoryne brassica* L.	Cabbage aphid
		Myzus persicae (Sluzer)	Green peach aphid
Lepidoptera	Plutellidae	*Plutella xylostella* (L.)	Diamondback moth

Table 3 – Natural enemies of canola present throughout the growing season of 2012/2013 and 2013/2014.

Order	Family	Species	Common name
Coleoptera	Coccinellidae	*Coccinella undecimpunctata* L.	Eleven- spotted lady beetle
		Coccinella septempunctata L.	Seven- spotted lady beetle
Neuroptera	Chrysopidae	*Chrysoperla carnea* (Stephens)	Green lacewing
Diptera	Syrphidae	*Syrphus corollae* Fabricius	Hoverfly
Hemiptera	Anthocoridae	*Orius* spp.	Minute pirate bug
Hymenoptera	Braconidae	*Diaretiella rapae* Mc´Intosh	Braconid wasp
		Aphidius sp.	Cereal aphid parasite
		Cotesia plutellae (Kurdjumov)	Braconid wasp
	Ichneumonidae	*Diadegma insulare* (Cresson)	Diadegma wasp

Table 4 – Pollinators (bees) visiting canola flowers throughout the growing season of 2012/2013 and 2013/2014.

Order	Family	Species	Common name
Hymenoptera	Apidae	*Apis mellifera* L.	Honey bee
	Andrenidae	*Andrena mariana* Warncke	Sand bees
		Andrena savignyi Spinola	
		Andrena fuscosa Erichson	
		Andrena ovatula Kirby	
	Colletidae	*Colletes lacunatus* Dours	Plasterer bees
	Halictidae	*Lasioglossum vagans* (Smith)	Sweat bees
		Nomioides sp.	
	Megachilidae	*Osmia latreillei* Spinola	Mason bees

includes pests, natural enemies and pollinators that may have a great impact on the total yield. In this study, the data obtained of the faunal insect diversity, phenology, infestation rate and parasitism of *P. xylostella* will provides a baseline that will help to prepare integrated pest management programs.

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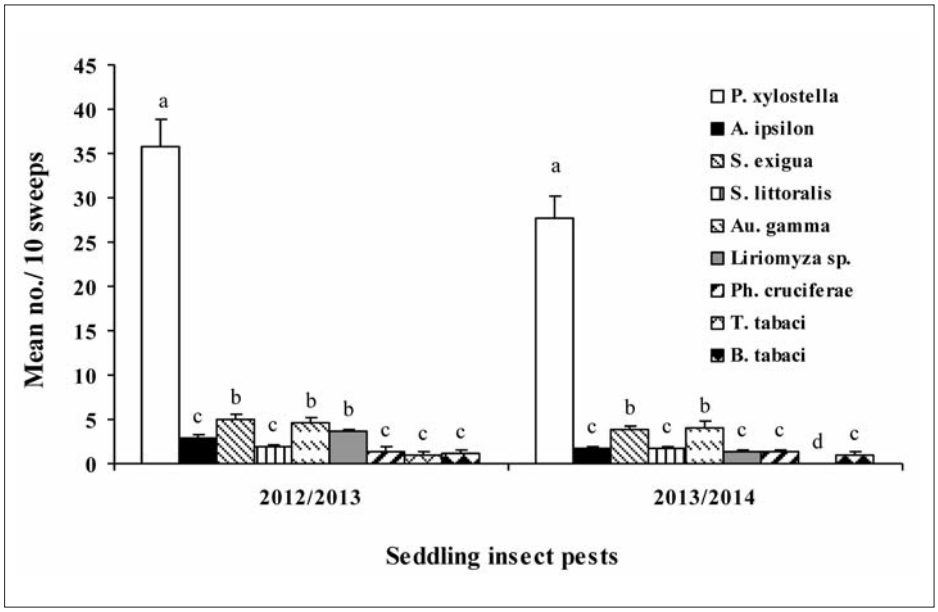

Fig. II – Mean number (±SE) of individuals of foliage feeding insects collected at five locations during the 2012/ 2013 and 2013/ 2014 growing seasons at the Experimental farm, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt. Different letters indicate significance (Tukey test, $P \leq 0.05$).

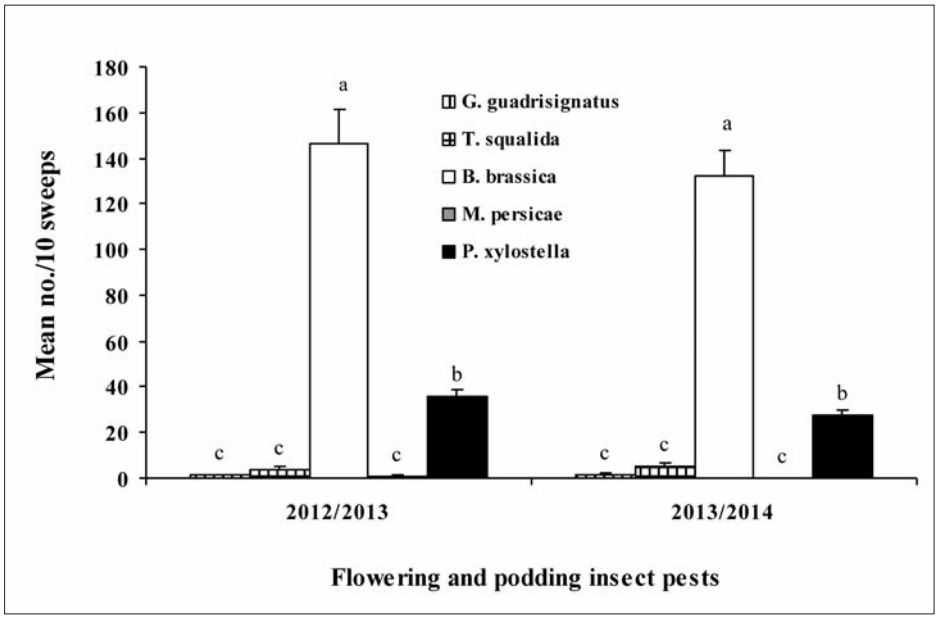

Fig. III – Mean number (±SE) of individuals of flower and pod feeding insects collected at five locations during the 2012/ 2013 and 2013/ 2014 growing seasons at the Experimental farm, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt. Different letters indicate significance (Tukey test, $P \leq 0.05$).

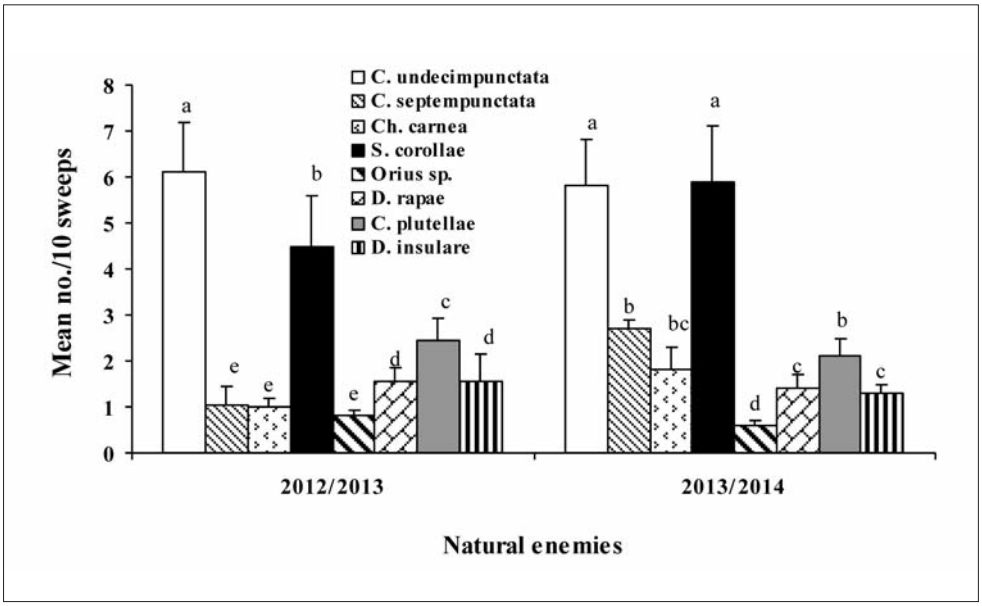

Fig. IV – Mean number (±SE) of insect natural enemies collected at five locations during the 2012/ 2013 and 2013/ 2014 growing seasons at the Experimental farm, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt. Different letters indicate significance (Tukey test, $P \leq 0.05$).

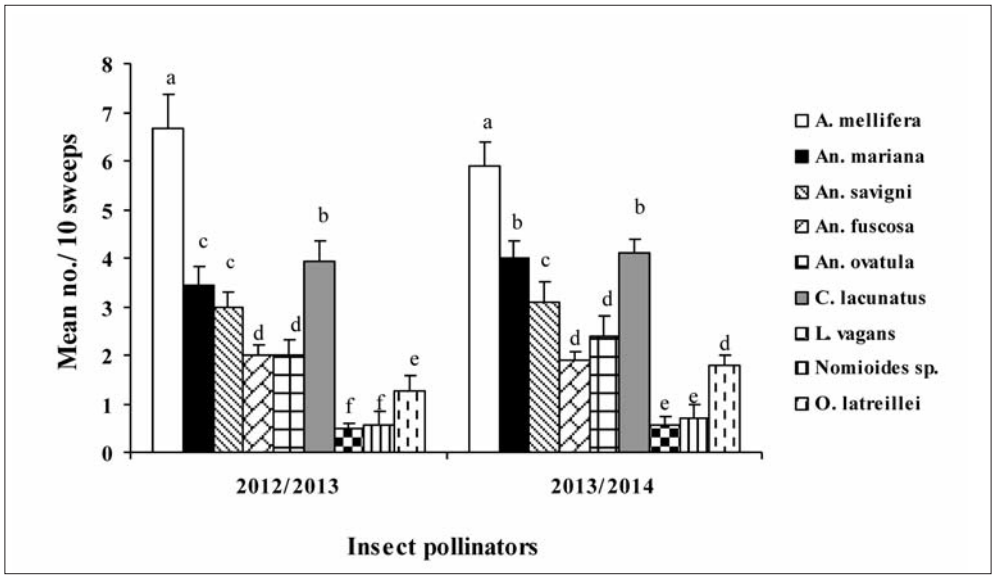

Fig. V – Mean number (±SE) of individuals of pollinating insects collected at five locations during the 2012/ 2013 and 2013/ 2014 growing seasons at the Experimental farm, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt. Different letters indicate significance (Tukey test, $P \leq 0.05$).

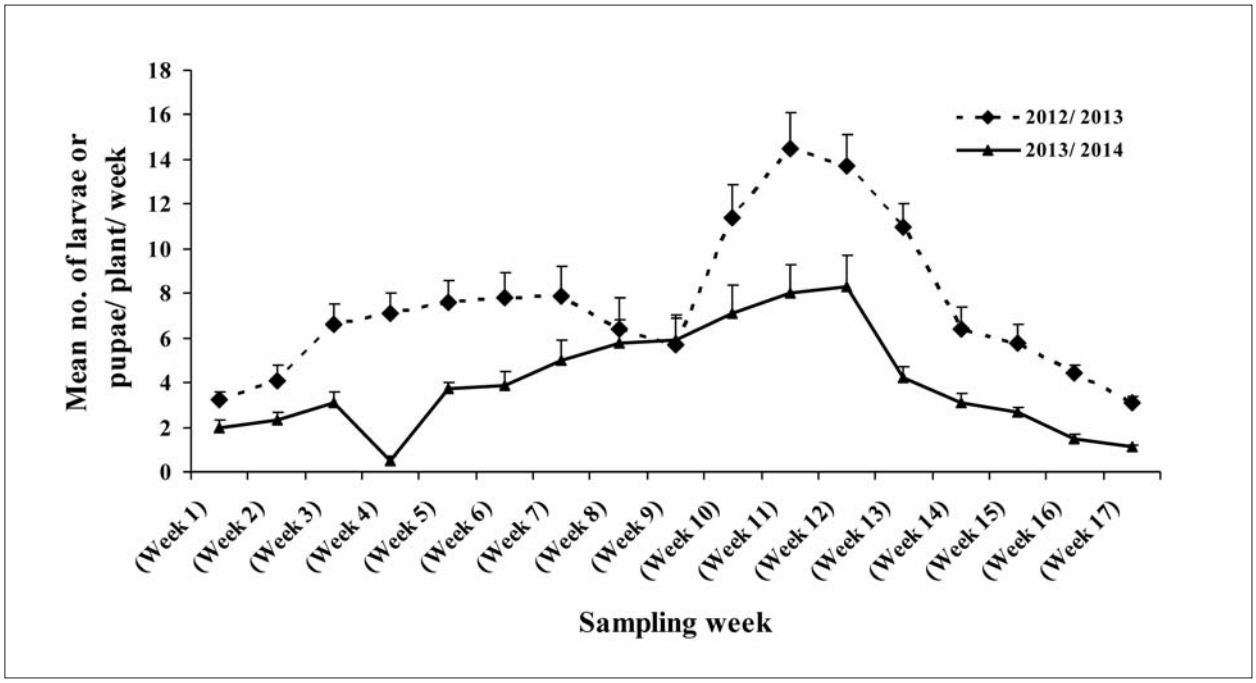

Fig. VI – Mean number (±SE) of immature *Plutella xylostella* collected from canola plants at five locations during the 2012/2013 and 2013/2014 growing seasons at the Experimental farm, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt.

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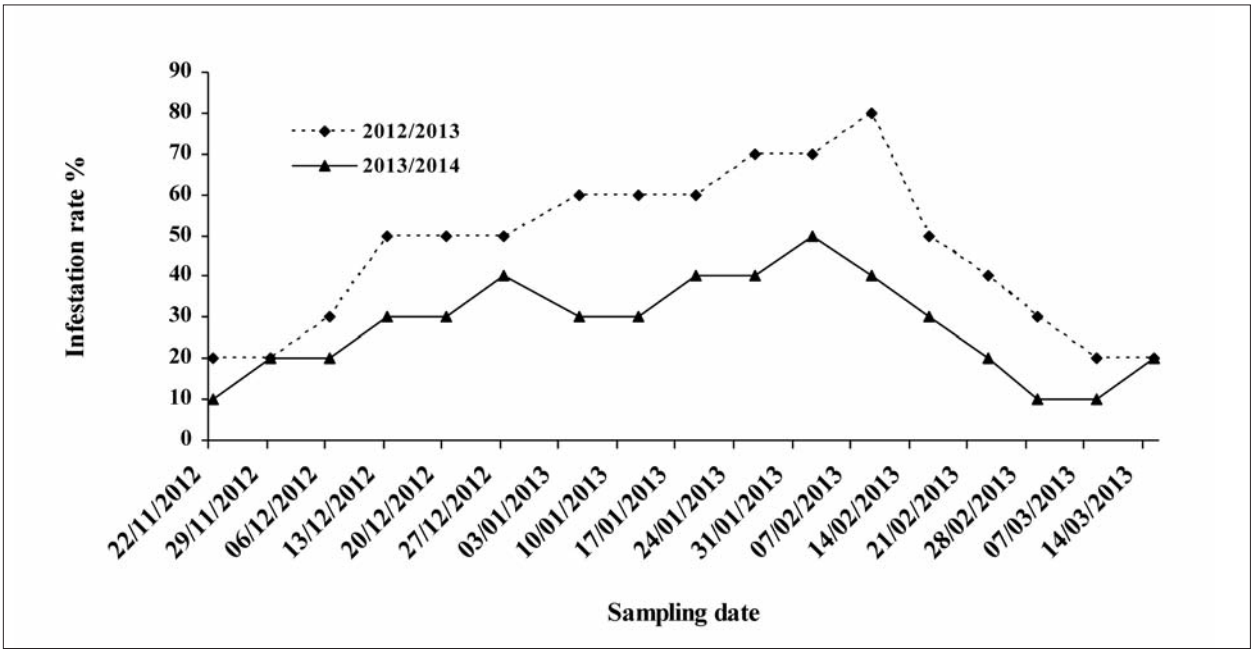

Fig. VII – Percentage of canola plants infestated by *Plutella xylostella* during 2012/2013 and 2013/2014 seasons.

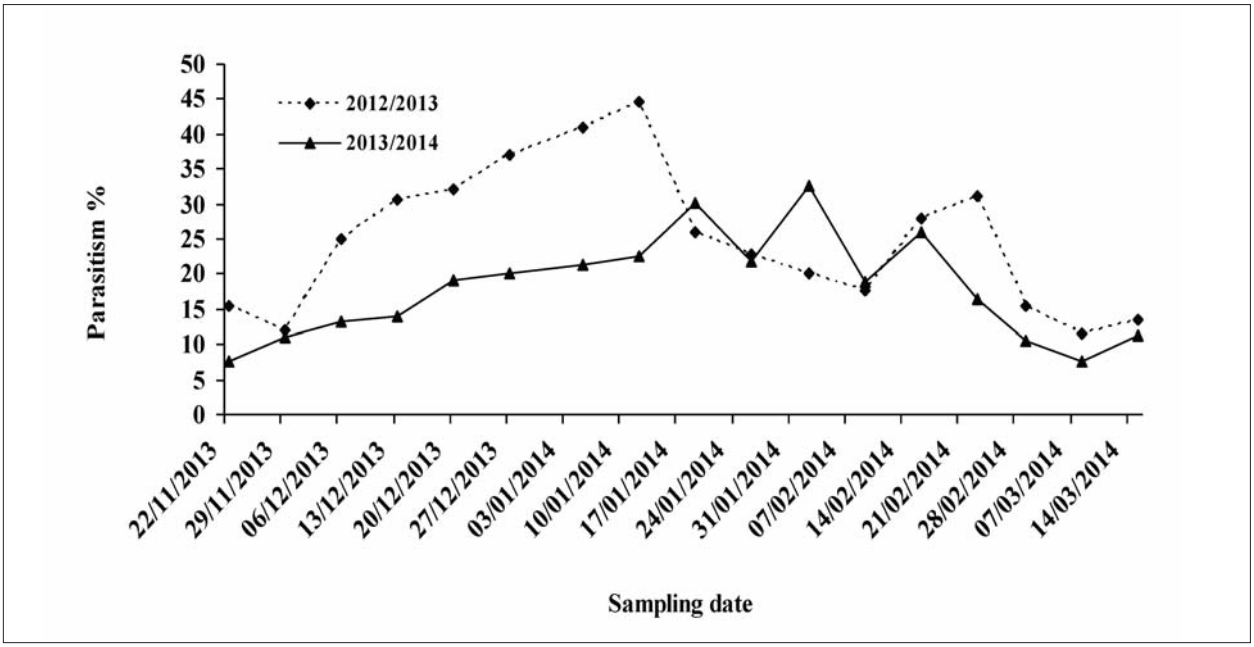

Fig. VIII – Percentage of total parasitism among the larvae and pupae of *P. xylostella* infesting canola during 2012/2013 and 2013/ 2014 seasons.

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