J. Plant Prot. and Path., Mansoura Univ., Vol.9 (6): 363 – 367, 2018

Effect of Different Host Plants on the Sugar Beet Fly *Pegomyia mixta* vill. and its Associated Parasitoid *Opius nitidulator* (Nees)

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ABSTRACT

The present study was carried out for two seasons 2015/2016 and 2016/2017 on sugar beet ,fodder beet ,table beet and chard sown at the experimental farm of Sakha Agricultural Research Station . Kafr El –Sheikh , Egypt .The average number of *P. mixta* eggs were recorded the highest average on fodder beet followed by table beet, sugar beet and chard during the first season 2015/16 and represented by 157.2±3.3, 93.9±3.5, 89.04±6.4 and 45.5±4.8 eggs, respectively. The average number of *P. mixta* eggs were recorded the highest average on fodder beet followed by table beet, sugar beet and chard during the second season 2016/17 and represented by 150.4 ±6.1, 96.6 ±4.2, 59.7 ±3.0 and 40.3 ±4.7 eggs, respectively. The highest average number of *P. mixta* larvae were recorded on fodder beet plants followed by sugar beet plants, table beet plants and chard during the first season 2015/16 and represented by 85.5 ±4.2, 54.02 ±3.5,41.1+5.3 and 27.7±6.5 larvae, respectively. The highest average number of *P. mixta* larvae were recorded on fodder beet plants followed by table beet plants, sugar beet plants and chard plants during the second season 2016/17 and represented by 96.4 ±5.2, 57.7 ±3.9, 48.9 ±4.4 and 22.3 ±3.1 larvae, respectively. Fodder beet attractive the highest average number of the parasitoid followed by sugar beet and chard during the first season 2015/16 and represented by 9.9 ±1.96, 9.4 ±2.8, 7.2 ±1.9 indiv., respectively. Moreover table beet plants came in the last category and attractive the lowest average number of the parasitoid and represented by 4.3 ±0.7 indiv. Sugar beet attractive the highest average number of the parasitoid followed by chard and fodder beet, during the second season 2016/17 and represented by 11.8 ±2.1, 9.0 ±1.2 and 7.5 ±0.6 indiv., respectively. Moreover, table beet plants came in the last category and attractive the lowest average number of the parasitoid and represented by 4.1 ±0.9 indiv. Fodder beet came in the first rank with an average percentage of parasitism 14.9% followed by sugar beet 14.2% and table beet 10.7%, while chard plants was the least average percentage of parasitism 9.8% in the first season 2015/2016 . Sugar beet came in the first rank with average percentage of parasitism 17.1% followed by fodder beet 11.6% and table beet 11.4% while chard plants came the least average percentage of parasitism 10.9% in the second season 2016/2017.

INTRODUCTION

Sugar beet, *Beta vulgaris* L. is one of the two principal sugar crops and provides about 40% of the world sugar production and represents the second source, after sugar-cane. This crop is annually planted in Egypt and 37.4% of the cultivated area is concentrated in Kafr El-Sheikh Governorate (Anonymous, 2010). The sugar beet fly *Pegomyia mixta* vill. is one of the most important insect pests of sugar beet in Egypt. The insect had 3-4 peaks of eggs while the larval population recorded 2-3 peaks of abundance. The highest average numbers of eggs and larvae observed in April. (Awadalla *et al.,*1991 and 1992; Youssef 1994; Abou-Attia 1999; Abou-ElKassem 2010 Bazazo 2010 and Bazazo *et al.* 2017).

The braconid parasitoid, *Opius nitidulator* (Nees) was recorded as internal larval parasitoid on *Pegomyia mixta* vill. Attacking the full-grown larvae. the role of natural enemies in pest control is becoming more and more important because countries around the world are developing national standards for organic farming and for the marketing of organic products (Whipps and Lumsden , 2001). Few studies concerning the role of the parasitoid on this insect pest have been carried out (Hassanein et al.,1993; El-Agamy et al.,1994; Awadalla, 1997; Abou-Attia,1999; Abou-El-Kassem,2010 and Bazazo et al., 2017) . Takabayashi et al. (1991) indicated that during foraging , natural enemies of insect herbivores may employ volatile allelochemicals that originate from an interaction between the herbivore and its host plant which attract natural enemies. They added that the type of plant is more important than the herbivore in affecting the composition of the volatile blends emitted. Therefore, the aim of the present study was to shed some light on the following points:

- Effect of different host plants (sugar beet, fodder beet, table beet and chard) on *P.mixta* female egg-laying
- Effect of different host plants on *P.mixta* larvae
- Effect of different host plants on the percentage of parasitism by the parasitoid *O.nitidulator*

MATERIALS AND METHODS

This experiment was conducted at the experimental Farm of Sakha Agriculture Research Station Kafr El-Sheikh Governorate during the two successive seasons, 2015/16 and 2016/17 to study the population of the sugar beet fly *P.mixta* and its endoparasitoid *O.nitidulator* . An area of half feddan was prepared and divided to 16 replicates. Each replicate was ca 130 m^2 . sugar beet variety (pyramid cultivar), fodder beet variety (local cultivar), table beet variety (Al-Shamah cultivar) and chard , were used as a host plants and Each host plant sown in four replicates arranged in complete randomly design. In the beginning of November in both seasons .All recommended agricultural practices were applied along the growing season without insecticides applications.

Samples started one month after sowing date and continued weekly till harvest. Each sample comprised 20 plants (5 plants for each replicate). Leaves infesting with *P.mixta* for the examined plants were picked and transferred to the laboratory for counting the eggs and larvae of *P.mixta.* Leaves with the insect larvae were kept in glass jars until pupation of *P.mixta* larvae. Formed pupae were introduced in Petri-dishes till adult emergence of the beet fly, *P.mixta* or its parasitoid *O. nitidulator* , then both numbers were counted and recorded . The percentages of parasitism were calculated for each host plant.

Statistical analysis:

Data were subjected to analysis of Variance (ANOVA) and means were compared using Duncan's Multiple Range Test (1955) and Least Significant Differences (LSD) at 5% probability level.

RESULTS AND DISCUSSIONS

Effect of different host plants on female egg-laying by P.mixta:

Data in Table (1) showed the monthly average number of eggs on different host plants during the first season 2015/2016. The highest monthly average number of egg-laying on sugar beet recorded in Febraury 2016 and represented by 214 eggs, while on fodder beet the highest monthly average number of egg-laying recorded in March and represented by 316 eggs and on table beet the highest monthly average number of egg-laying recorded in March and represented by 213.4 eggs, while on chard recorded in March and represented by 136.6 eggs.

Data presented in Table (1) revealed that, the average number of *P. mixta* eggs were recorded the highest average on fodder beet followed by table beet, sugar beet and chard during the first season 2015/16 and represented by 157.2±3.3, 93.9±3.5, 89.04±6.4 and 45.5±4.8 eggs, respectively. Statistical analysis indicated that, a significantly differences between the different host plants and the female of *P. mixta* egg- laying.

Table 1. Monthly average number of *P. mixta* eggs according to different host plants during the first season 2015/16 in Kafr El-Sheikh region:

Months	Average No. of eggs in different host plants			
	Sugar beet	Fodder beet	Table beet	Chard
December	25.2	19.4	4.2	7.8
January	70.5	59.0	21.5	26.5
February	214.0	241.0	178.8	45.3
March	116.0	316.0	213.4	136.6
April	19.5	150.8	51.8	11.3
Mean±SE	89.0 ±6.4 b	157.2 ±3.3 a	93.9 ±3.5 b	45.5 ±4.8 c

Means followed by the different letters are significantly differences at 0.05 level of probability (Dancun's Multiple Range Test).

Data in Table (2) showed the monthly average number of egg on different host plants during the second season 2016/17. The highest average number were recorded in March 2017 in fodder beet, table beet, sugar beet and chard and represented by 374.6 , 262.6, 202.8 and 157.6 eggs, respectively.

Data presented in Table (2) revealed that, the average number of *P. mixta* eggs were recorded the highest average on fodder beet followed by table beet, sugar beet and chard during the second season 2016/17 and represented by 150.4 ±6.1, 96.6 ±4.2, 59.7 ±3.0 and 40.3 ±4.7 eggs, respectively. Statistical analysis indicated that, a significantly differences between the different host plants and the female of *P. mixta* egg- laying.

Table 2. Monthly average number of egg-laying according to different host plants during second season 2016/17 in Kafr El-Sheikh region:

Months	Average No. of eggs in different host plants			
	Sugar beet	Fodder beet	Table beet	Chard
December	7.2	26.2	17.0	8.8
January	10.5	27.5	25.0	27.8
February	61.0	91.5	68.0	44.5
March	202.8	374.6	262.6	157.6
April.	76.8	332.5	178.0	3.3
May	-	50.0	29.0	-
Mean	59.7 ±3.0 c	150.4 ±6.1 a	96.6 ±4.2 b	40.3 ±4.7 d

Means followed by the different letters are significantly differences at 0.05 level of probability (Dancun's Multiple Range Test).

These results are in agreement with those obtained by Abou-Attia (1999) showed that three peaks of *P. mixta* eggs were recorded on sugar beet plants of the two seasons(1995/96 and /1996/97). The highest number of eggs of *P .mixta* were (178 and 183 eggs/20 plants) were observed during the end of April in both seasons, respectively. *Bazazo et al*., (2017) indicate that three or four peaks of egg masses were found on sugar beet plants during two seasons (2014/15 and 2015/16),. Youssef (1994) mentioned that in December plantation *P. mixta* appeared on sugar beet plants from January to June, Three peaks of eggs were recorded. Luczak (1986) recorded that the rate of plant development and plant morphology influenced oviposition by females. Most eggs were laid on varieties with the highest growth rates and with the highest growth rates and with the best plant development. Abou-ElKassem (2010) showed that in September plantation the number of the eggs had five peaks during two seasons 2003/04 and 2004/05 while in December plantation, the number of eggs of *P. mixta* had three peaks during the first season. while in the second season the number of eggs had two peaks.

Effect of different host plants on *P.mixta* larvae rearing:

Data in Table (3) showed that the highest monthly average number of larvae rearing during the first season 2015/16 on fodder beet, table beet, sugar beet and chard were recorded in March 2017 and represented by 226.0, 122.4, 117.6 and 74.6 larvae, respectively.

Data presented in Table (3) revealed that, the highest average number of *P. mixta* larvae were recorded on fodder beet plants followed by sugar beet plants, table beet plants and chard during the first season 2015/16 and represented by 85.5 ±4.2, 54.02 ±3.5, and 27.7±6.5 larvae, respectively. Statistical analysis indicated that, a significantly differences between the average number of *P. mixta* larvae reared on different host plants.

Table 3. Monthly average number of larvae rearing according to different host plants during the first season 2015/16 in Kafr El-Sheikh region:

Months	Average No. of larvae in different host plants			
	Sugar beet	Fodder beet	Table beet	Chard
December	21.0	32.8	2.6	3.2
January	37.8	57.8	8.3	15.0
February	73.8	90.0	50.0	27.8
March	117.6	226.0	122.4	74.6
April	20.0	21.0	22.0	17.8
Mean±SE	54.02 ±3.5 b	85.5 ±4.2 a	41.1±5.3b c	27.7±6.5 c

Means followed by the different letters are significantly differences at 0.05 level of probability (Dancun's Multiple Range Test).

Data in Table (4) showed that the highest monthly average number of larvae rearing during the second season 2016/17 on fodder beet, table beet, sugar beet and chard were recorded in March 2017 and represented by 236.4, 156.4, 145.0 and 44.6 larvae, respectively.

Data presented in Table (4) revealed that, the highest average number of *P. mixta* larvae were recorded on fodder beet plants followed by table beet plants, sugar beet plants and chard plants during the second season 2016/17 and represented by 96.4 ±5.2, 57.7 ±3.9, 48.9 ±4.4 and 22.3 ±3.1 larvae, respectively. Statistical analysis indicated that, a significantly differences between the average number of *P. mixta* larvae reared on different host plants.

Table 4. Monthly average number of larvae rearing according to different host plants during the second season 2016/17 in Kafr El-Sheikh region:

Months	Average No. of larvae in different host plants			
	Sugar beet	Fodder beet	Table beet	Chard
December	2.0	11.4	4.4	5.4
January	9.0	25.8	4.5	15.0
February	33.0	37.8	17.8	20.8
March	145.0	236.4	156.4	44.6
April	55.5	170.8	105.5	25.8
Mean	48.9 ±4.4 b	96.4 ±5.2 a	57.7 ±3.9 b	22.3 ±3.1 c

Means followed by the different letters are significantly differences at 0.05 level of probability (Dancun's Multiple Range Test).

These results agree with those obtained by Bassyouny (1993) who showed that *P. mixta* larvae recorded on sugar beet plants in December then increased gradually until reached its peak in March. Youssef (1994) mentioned that in December plantation *P. mixta* appeared on sugar beet plants from January to June. The larval stage had two peaks of abundance in two successive season of study. Abou- Attia (1999) showed that the larval populations have two peaks of abundance in each season of the study (1995 / 96 and 1996 /97).The highest numbers of larvae *P. mixta* were observed during the end of April in both seasons, Helal (2004) indicated that *P. mixta* population gradually increased until it reached its highest density in March and April. El-Dessouki (2014) recorded the highest infestation by sugar beet fly *P. mixta* from March to April and the insect larvae recorded three peaks , the first from mid to late December, the second from late January to early February , the third in mid March. Bazazo *et al.,* (2017) indicated that the larval population of *P. mixta* have three peaks were found on sugar beet plants during two seasons (2014/15 and 2015/16) respectively.

Effect of different host plants on the seasonal activity of the parasitoid *Opius nitidulator*:

Data arranged in Table (5) showed that, the monthly average number of the parasitoid *O. nitidulator* during the first season 2015/16 it can be noticed that, the highest monthly average number of the parasitoid on fodder beet, sugar beet, chard and table beet were recorded in March 2016 and represented by 22.6, 16.4 and 7.6 indiv., respectively. While on chard in February 2016 by 12 indiv.

Table 5. Monthly average number of the parasitoid *Opius nitidulator* according to different host plants during the first season 2015/16 in Kafr El-Sheikh region:

Months	Average No. of the parasitoid *Opius nitidulator* in different host plants			
	Sugar beet	Fodder beet	Table beet	Chard
December	5.2	6.2	3.6	4.6
January	14.3	15.0	3.0	6.5
February	9.3	3.8	4.5	12.0
March	16.4	22.6	7.6	11.6
April	2.0	2.0	3.0	1.3
Total	47.2	49.6	21.7	36.0
Mean±SE	9.4 ±2.8 a	9.9 ±1.96 a	4.3 ±0.7 a	7.2 ±1.9 a

Means followed by the different letters are significantly differences at 0.05 level of probability (Dancun's Multiple Range Test).

Data presented in Table (5) revealed that, fodder beet attractive the highest average number of the parasitoid followed by sugar beet and chard during the first season 2015/16 and represented by 9.9 ±1.96, 9.4 ±2.8, 7.2 ±1.9 indiv., respectively. Moreover table beet plants came in the last category and attractive the lowest average number of the parasitoid and represented by 4.3 ±0.7 indiv. Statistical analysis indicated that, insignificantly differences between

the average number of the parasitoid on different host plants.

Data arranged in Table (6) showed that, the monthly average number of the parasitoid *O. nitidulator* during the second season 2016/17. It can be noticed that the highest monthly average number of the parasitoid on sugar beet, chard, fodder beet and table beet were recorded in March 2016 and represented by 25.8 , 20.4, 19.6 and 6.8 indiv., respectively.

Data presented in Table (6) revealed that, sugar beet attractive the highest average number of the parasitoid followed by chard and fodder beet, during the second season 2016/17 and represented by 11.8 ±2.1, 9.0 ±1.2 and 7.5 ±0.6 indiv., respectively. Moreover, table beet plants came in the last category and attractive the lowest average number of the parasitoid and represented by 4.1 ±0.9 indiv.. Statistical analysis indicated that, a significantly differences between the average number of the parasitoid *O. nitidulator* on different host plants.

Table 6. Monthly average number of the parasitoid *O. nitidulator* according to different host plants during second season 2016/17 in Kafr El-Sheikh region:

Months	Average No. of the parasitoid *Opius nitidulator* in different host plants			
	Sugar beet	Fodder beet	Table beet	Chard
December	7.6	1.6	2.2	4.4
January	5.8	4.5	5.3	6.8
February	12.0	12.0	5.3	8.3
March	25.8	19.6	6.8	20.4
April	7.6	0.0	1.0	5.0
Mean±SE	11.8 ±2.1 a	7.5 ±0.6 b	4.1 ±0.9 a b	9.0 ±1.2 a

Means followed by the different letters are significantly differences at 0.05 level of probability (Dancun's Multiple Range Test).

Effect of different host plants on the percentage of parasitism by the parasitoid *O. nitidulator*:

Data presented in Table (7) showed the monthly average percentage of parasitism by parasitoid *O. nitidulator* during the first season 2015/16. The highest monthly average percentage of parasitism in sugar beet and fodder beet were recorded in January 2016 with an average of 18.9% and 19.9% respectively. While in table beet was in March 2016 with an average percentage 16.5% and in chard plants was in February 2016 with an average percentage 14.3%.

Data in Table (7) show that the fodder beet came in the first rank with an average percentage of parasitism 14.9% followed by sugar beet 14.2% and table beet 10.7%, while chard plants was the least average percentage of parasitism 9.8% . Statistical analysis indicated that, a non significantly differences in the percentage of parasitism by *O. nitidulator* in different host plants.

Table 7. Monthly average percentage of parasitism by *O. nitidulator* on different host plants during 2015/16 season in Kafr El-Sheikh region:

Months	Average of parasitism on different host plants			
	Sugar beet	Fodder beet	Table beet	Chard
December	13.8	23.3	8.0	7.9
January	18.9	19.9	10.2	8.8
February	14.1	6.6	9.0	14.3
March	15.2	17.6	16.5	13.3
April	8.8	7.03	9.7	4.9
Mean±SE	14.2±3.0 a	14.9±1.8 a	10.7±3.2 a	9.8±1.96 a

Means followed by the different letters are significantly differences at 0.05 level of probability (Dancun's Multiple Range Test).

Results in Table (8) showed that The highest monthly average percentage of parasitism by *O. nitidulator* in sugar beet , chard were recorded in March 2017 and fodder beet plants was recorded in February 2017 with an average of 24.3%, 20.1% and 18.5% respectively, while in table beet was recorded in March 2017 with an average percentage of parasitism 16.5%.

Table 8. Monthly average percentage of parasitism by *O. nitidulator* on different host plants during 2016/17 season in Kafr El-Sheikh region:

Months	Average percentage of parasitism on different host plants			
	Sugar beet	Fodder beet	Table beet	Chard
December	10.6	10.2	9.2	7.5
January	9.4	13.4	16.4	8.4
February	23.9	18.5	12.2	11.0
March	24.3	15.8	16.5	20.1
April	17.3	0.0	2.9	7.6
Mean±SE	17.1 ±2.1 a	11.6 ±0.6 b	11.4 ±0.8 b	10.9 ±1.2 b

Means followed by the different letters are significantly differences at 0.05 level of probability (Dancun's Multiple Range Test).

Data in Table (8) indicated that the sugar beet came in the first rank with average percentage of parasitism 17.1% followed by fodder beet 11.6% and table beet 11.4% while chard plants came the least average percentage of parasitism 10.9% Statistical analysis indicated that, insignificantly differences in the percentage of parasitism caused by *O. nitidulator* in chard, fodder beet and table beet plants and a significantly differences between sugar beet and others in the percentage of parasitism caused by *O. nitidulator*.

These results are in agreement with those obtained by El-Agamy *et al.* (1994) who found that in September

population, the whole season percentage of parasitized larvae and pupae of *P.mixta* by *O. nitidulator* averaged between 13.6% and 16.0% while in December plantations, it was between 18.8% and 21.0%. Awadalla (1997) indicated that the percentage of parasitism ranged from 3.8 to 52.9% with an average rate of parasitism reached 32.3%. Abou-Attia (1999) showed that the percentage of parasitism caused by *O. nitidulator* on *P.mixta* in sugar beet plants varied from 3.2% to 46.1% with an average rate of parasitism 12.8% in the first season, while in chard varied from 1.8% to 32.2% with an average rate 7.8%, while it varied from second season. Mousa (2005) indicated that *O. nitidulator* a main factor in regulating the population density of *P.mixta* in sugar beet fields. The average of parasitism in the first season 18.36% and 20.21% in the second season. Bazazo *et al.* (2017) indicated that the percentage of parasitism ranged between 1.2% to 100% and 9.9% to 52.8% in the two seasons, respectively. Average rates of parasitism throughout the growing seasons, reached 25.11% and 27.73% in the two seasons, respectively.

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تاثير العوائل النباتيه المختلفه علي ذبابه بنجر السكر *Pegomyia mixta* والطفيل المرتبط بها (Nees) *Opius nitidulator*

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اجريت هذه الدراسه لمده موسمين ٢٠١٥/٢٠١٦ , ٢٠١٦/ ٢٠١٧ علي بنجر السكر,بنجر العلف , بنجر المائده و نبات السلق و تم زراعتها في المزرعه البحثيه لمحطه البحوث الزراعيه بسخا - كفر الشيخ – مصر. حيث تم تسجيل اعلي متوسط لعدد بيض ذبابه البنجر علي بنجر العلف يليه بنجر المائده ثم بنجر السكر ثم السلق خلال الموسم الاول ٢٠١٥/٢٠١٦ و كانت المتوسطات ١٥٧.٢+٣.٣ , ٩٣.٩+٣.٥ , ٨٩.٠٤+٦.٤ , ٤٥.٥+٤.٨ بيض علي التوالي. بينما في الموسم الثاني ٢٠١٦/٢٠١٧ وجد اعلي متوسط لعدد بيض ذبابه البنجر علي بنجر العلف يليه بنجر المائده ثم بنجر السكر ثم نبات السلق وكانت المتوسطات١٥٠.٤+٦.١ , ٩٦.٦+٤.٢ , ٥٩.٧+٣.٠ , ٤٠.٣+٤.٧ بيض علي التوالي. تم تسجيل اعلي متوسط لعدد يرقات ذبابه البنجرعلي بنجر العلف يليه بنجر السكر ثم بنجر المائده السكر ثم نبات السلق خلال الموسم الاول ٢٠١٥/٢٠١٦ و كانت المتوسطات ٨٥.٥+٤.٢ , ٥٤.٠٢+٣.٥ , ٤١.١+٥.٣ , ٢٧.٧+٦.٥ يرقه علي التوالي . بينما في الموسم الثاني ٢٠١٦/٢٠١٧ وجد اعلي متوسط لعدد يرقات ذبابه البنجر علي بنجر العلف يليه بنجر المائده ثم بنجر السكر ثم السلق بمتوسطات ٩٦.٤+٥.٢ , ٥٧.٧+٣.٩ , ٤٨.٩+٤.٤ , ٢٢.٣+٣.١ يرقه علي التوالي. وجد ان بنجر العلف جذب اعلي متوسط لتعداد الطفيل يليه بنجر السكر , السلق في الموسم الاول ٢٠١٥/٢٠١٦ و كانت المتوسطات ٩.٩+١.٩٦ , ٩.٤+٢.٨ , ٧.٢+١.٩ فرد علي التوالي . و جاء بنجر المائده في المرتبه الاخيره وجذب اقل متوسط لتعداد الطفيل بمتوسط ٤.٢+٠.٧ فرد. و في الموسم الثاني ٢٠١٦/٢٠١٧ جذب بنجر السكر اعلي متوسط لتعداد الطفيل يليه السلق ثم بنجر العلف و كانت المتوسطات ١١.٨+٢.١ , ٩.٠+١.٢ , ٧.٥+٠.٦ فرد علي التوالي. و جاء بنجر المائده في المرتبه الاخيره وجذب اقل متوسط لتعداد الطفيل بمتوسط ٤.١+٠.٩ فرد. جاء بنجر العلف في الترتيب الاول بمتوسط نسبه التطفل ١٤.٩% يليه بنجر السكر بمتوسط نسبه التطفل ١٤.٢% بنجر المائده ١٠.٧% بينما نباتات السلق كانت اقل متوسط لنسبه التطفل ٩.٨% في الموسم الاول ٢٠١٥/٢٠١٦وجاء بنجر السكر في الترتيب الاول بمتوسط نسبه التطفل ١٧.١% يليه بنجر العلف ١١.٦% , بنجر المائده ١١.٤% بينما نبات السلق جاء باقل نسبه للتطفل ١٠.٩% في الموسم الثاني ٢٠١٦/٢٠١٧.