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ECOLOGICAL STUDIES ON PIERCING-SUCKING INSECTS INFESTING SWEET PEA PLANTATION AT MANSOURA DISTRICT.

El-Serafi, Hala A.K.; A.A. Ghanim and M. El-Adl
Economic Entomology Dept., Fac. of Agric., Mansoura Univ.

ABSTRACT

Field studies were carried out in a field belonging to Economic Entomology Department, Faculty of Agriculture, Mansoura University during the two successive seasons 1998/99 and 1999/2000 on sweet pea (*Pisum sativum* L.), to study the population density of piercing sucking insects attacking this crop and the effect of certain weather factors on the population density of these insect pests.

The results indicated the presence of eight piercing sucking insect species infesting sweet pea. These species are namely ; *Aphis craccivora* Koch, *Empoasca lybica* DeBerg, *Achrosiphum pisum* Harr., *Empoasca descipiens* Paoli, *Bemisia tabaci* Genn., *Thrips tabaci* Lind., *Nezara viridula* L. and *Lygus hesperus*. The dominant species among them was *A. craccivora* (36.67 and 39.92% from the total catch) in the two seasons, respectively.

Nine predators were also found inhabiting sweet pea, namely; *Coccinella undecimpunctata* L., *Cydonia vicina isis* Gr., *Cydonia vicina nilotica* Muls, *Scymnus syriacus*, *Paederus alferii* Koch, *Metasyrphus corollae* F., *Paragus compeditus, Chrysoperla carnea* (Steph) and *Orius albidipennis* (Reut.), while there were three aphid parasitoid found in sweet pea namely; *Diaeretiella rapae* (M'Intosh), *Trioxys angelicae* (Haliday) and *Aphidius sp.* The dominant predator species among them was *O. albidipennis* and its ratio was 29.83 and 30.62% during the two seasons of study. The result showed that *A. craccivora* and *A. pisum* started to appear in the third week of December during the two seasons of study, then the population during of these species increased gradually and reached its maximum during the first and second week of March, during the two seasons of study. Also, the results recorded four peaks for *E. lybica* and *E. discipiens* in each season of study. *B. tabaci* had five peaks in sweet pea in 1998/99 season, while it was three peaks in 1999/2000 season. *T. tabaci* and *L. hesperus* had three peaks during the two seasons of study. The results cleared that temperature and relative humidity affect the catch of the piercing sucking insect species in the two seasons of study, and their combined effect was higher.

INTRODUCTION

Sweet pea (*Pisum sativum* L.) is one of the important vegetable crops in Egypt and many countries of the world. It is important for human nutrition because for its source of protein.

In Egypt, the cultivated area of sweet pea reached about 55 thousands feddans (Ministry of Agriculture Report in 1999). Among this, about twelve thousands feddans are cultivated at Dakahlia Governorate. Some insect species inhabiting sweet pea cause great economic injury to all stages of the plant, while other insects are beneficial due to their entomophagous habits.

Numerous investigators in different parts of the world have studied the major insect species and their associated beneficial insects as well as the effect of certain weather on the population density of these insect species inhabiting sweet pea (Pungerl, 1984 & 1986; Soenarjo, 1987; Soroka and Mackay, 1990 a and b & 1991; Castillo *et al*., 1993; Daibar, 1994; Bedford *et al*., 1995; Bommarco and Ekbom, 1995; Bijjus and Verma, 1995 & 1996; Bommarco and Ekbon, 1996; Mohammed, 1996; Sandstrom, 1996; Ahmed, 1997; Sood *et al*., 1997; Chakraborty and Dutta, 1998 and Girsch *et al*., 1999.

Therefore, this investigation has been proposed aiming to study the following:-

Population density of piercing sucking insects attacking sweet pea, their associated beneficial insect species and the beneficial / prey ratios at Mansoura district.

The effect of certain weather factors (temperature and R.H.) on the population density of major insect species infesting sweet pea at Mansoura district.

MATERIALS AND METHODS

Studies were carried out in the field of the Economic Entomology Department, Faculty of Agriculture, Mansoura University during the two successive growing seasons 1998/1999 and 1999/2000 on sweet pea (*Pisum sativum*). The cultivated area was half feddan in both seasons. The sowing date was on the third week of November in the two seasons. The sweet pea variety was Little Marvel. The area of study was divided into plots, each of 42 m^2 (1/100 feddan). The common agricultural practices were followed regularly without any pesticidal treatments throughout the growing season.

Sampling started four weeks after sowing. Two methods (sweep net and direct count) were used for collecting insect species inhabiting sweet pea plantation.

a. Sweep net:

A regular sweep net was used and weekly samples were taken at 8 a.m. and 2 p.m. in the same day, from the four directions (North, south, east, west and middle) of the area of study. Nineteen samples were done during the period of study in each season. The collected insects were put in a plastic bag, immediately anesthetized by ether, then transferred to the laboratory for classification, counting and recording. The sample was represented by fifty double strokes of sweeping net from each direction of the field, thus 250 double strokes were taken from the tested area in each sampling date.

b. Direct counting on sweet pea:

Weekly samples of 50 plants and 100 leaflets of sweet pea were randomly selected from the replicates starting from the third week of December until the end of April during the two seasons of study. The counting on the plants and on leaflets were done twice at 10 a.m. and 2 p.m. daily. The insect found on leaflets were put in a plastic sac and transferred to the laboratory for examination, identification, counting and recording. An

aspirator was used for collecting fast, mobile and flying insects. The beneficial / prey ratios were calculated as follows:-

$$\frac{\text{Total number of piercing - sucking insects}}{\text{Total number of beneficial insects}}$$

To study the effect of certain weather conditions on the population density of the major insects attacking sweet pea. The daily minimum, maximum and average of temperature and relative humidity were obtained from the Meteorological Station Ministry of Defense at Shawa (about five kilometers in the east of Mansoura). The mean weekly degrees of these weather factors were calculated. The relationship between the mean weekly degrees of these weather factors and the weekly catch of the injurious insects were studied by calculating the correlation, and the neumerical relation was also calculated by the regression coefficient.

RESULTS AND DISCUSSION

Abundance of major insect pests and their associated beneficial insects:

Table 1 shows the numbers and ratios of piercing sucking insects infesting sweet pea during the two seasons (1998/1999 and 1999/2000) at Mansoura district. The numbers and ratios of these species were as follows: *Aphis craccivora* Koch (17872 individuals = 36.67% in the first season and 13245 individuals = 39.92% in the second season), *Empoasca lybica* De Berg (8749 = 17.95% in the first season and 6068 = 18.29% in the second season); *Acythosiphon pisum* (6111 = 12.54% in 1999 and 2162 = 6.51% in 2000). These results agree with the findings of Soroka and Mackay (1990), Bijjur and Verma (1996), Ahmed (1997), Chakraborty and Dutta (1998) and Girsch *et al*., (1999). *Empoasca discipiens* Paoli (5381 = 11.04% in 1999 and 4158 = 12.53% in 2000); *Bemisia tabaci* Gennandius (3876 = 7.95% in 1999 and 1385 = 4.17% in 2000); *Trips tabaci* Lind. (2729 = 5.6% in 1999 and 1744 = 5.25% in 2000); *Nezara viridula* L. (2364 = 4.85% in 1999 and 3462 = 10.43% in 2000) and *Lygus hesperus* (1644 = 3.40% in 1999 and 951 = 2.9% in 2000). The results assured that the dominant species infesting sweet pea during the two season of study was *A. craccivora*

Table 1:. Abundance of piercing sucking insect species in relation to the total catch in sweet pea plantation during the two seasons of study at Mansoura district.

Year / Injurious insects	1998/99		1999/2000	
	Total No.	%	Total No.	%
A. craccivora	17872	36.67	13245	39.92
E. lybica	8749	17.95	6068	18.29
A. pisum	6111	12.54	2162	6.51
E. descipienis	5381	11.04	4158	12.53
B. tabaci	3876	7.95	1385	4.17
T. tabaci	2729	5.60	1744	5.25
N. viridula	2364	4.85	3462	10.43
L. hesperus	1644	3.40	951	2.90
Total				

Table 2 illustrate the abundance of beneficial insect species in relation to the total catch of these insects in sweet pea during the two successive seasons of study. It can be seen that there were nine predators inhabiting sweet pea, these species were namely; *Coccinella undecimpunctata* L., *Cydonia vicina Isis* Cr., *Cydonia vicina nilotica* Muls, *Scymnus syriacus* Mars, *Paederus alfierii* Koch, *Metasyrphus corollae* F., *Paragus compeditus* Wied., *Chrysoperla carnea* Steph. and *Orius albidipennis* Reut., while there were three aphid parasitoids found in sweet pea, namely; *Diaeretiella rapae* M'Intosh, *Triaoxys angelicae* Haliday and *Aphidiu sp.* These findings are in partial agreement with those of Bijjur and Verma (1996), Mohammed (1996), Ahmed (1997), and Sood *et al*. (1997).

Table 2: Abundance of the beneficial insect species in relation to the total catch of these insects in sweet pea during the two seasons of study at Mansoura district.

Years / Predatory insects	1998/99		1999/2000	
	Total No.	%	Total No.	%
C. undecimpunctata	166	11.05	197	15.20
Cy. vicina isis	97	6.50	115	8.87
Cy. vicina nilotica	92	6.12	104	8.02
S. syriacus	195	12.98	104	8.02
P. alfierii	76	5.05	55	4.24
M. corallae	151	10.05	67	5.16
P. compeditus	90	5.99	60	4.62
Ch. carnea	70	4.66	102	7.87
O. albidipennis	398	26.49	355	27.39
D. rapae	96	6.39	82	6.32
T. angelicae	55	3.66	31	2.39
Aphidius sp.	16	1.06	24	1.90
Total	1502	100	1296	100

The dominant predator insect was *Orius albidipennis* and its ratio was 26.49 and 27.39% during the two seasons of study, respectively, while the

lowest was *Paederus alfierii*, and its ratio was 5.69 and 4.62% during the two seasons, respectively.

Figures 1 and 2 show the population density of major piercing sucking insect species infesting sweet pea plantation during the two successive seasons of study. From these figures, it can be seen that *A. craccivora* started to appear in the third week of December during the two seasons of study. The population density of this insect increased gradually and reached its maximum during second week of March in the first season, while that was in the end of March in the second season, then the population density decreased sharply till the end of the season. The abundance of *A. pisum* started to appear in the third week of December, then its abundance increased gradually and reached its maximum in first week of March during the two seasons of study. The abundance of this insect decreased sharply till the end of season (Figs. 1 and 2).

From the same Figures, it can be noted that *E. lybica* and *E. discipiens* had four peaks in each season of the study. The first peak recorded in the second week of January, the 2nd, the 3rd and the 4th peaks occurred during first week of February, last week of the same month and the third week of March, respectively. Also, it can be seen that *B. tabaci* had five peaks in sweet pea in 1999 season, while that was three peaks in 2000 season. The peaks of the first season were recorded during the first week of January, the end of January, first week of March, the end of March and third week of April in 1999 for these peaks, respectively. In the second season, the peaks of this insect were found in the end of December, third week of February and the first week of March. *T. tabaci* had three peaks during the two seasons of study. *L. hesprus* had three peaks during the two seasons of study, while that were two peaks in the case of *N. viridula*. In general, these results agree with the findings of Soroka and Mackay (1990a), Daibar (1994) and Bedford *et al*. (1995).

The results presented in Figure 3 show the total weekly numbers of piercing sucking insect species, total numbers of beneficial insects and the beneficial insects prey ratios during 1998/99 season. It can be noted that the number of piercing-sucking insects increased gradually and reached its maximum in the third week of March, then decreased gradually till the end of March then sharply in the second week of April till the end of study. The maximum numbers of beneficial insects recorded after two weeks from that of the piercing-sucking insects, which occurred in the first week of April (Figure 3). From this figure, it can be seen that the beneficial insects prey ratio was 1:40 at the beginning of study, then the ratio increased and reached its maximum (1:59) on the end of February. Afterwards, these ratios began to narrowed till the end of sweet pea seasons. Because the naturally increase of the beneficial insect numbers in the surround fields (clover and wheat) and migration to sweet pea area of study. Figure 4 illustrated the same results of 1999/2000 season. It can be noted that the number of piercing-sucking insects increased gradually and reached its maximum in the

Fig 1: Population density of major piercing sucking insect species infesting sweet pea plantation during 1998/1999 season at Mansoura district

Fig 2: Population density of major piercing sucking insect species infesting sweet pea plantation during 1999/2000 season at Mansoura district

Fig3: Total number of injuries insects, total number of beneficial insects and beneficial/pre ratios in sweet pea plantation during 1998/1999 season at Mansoura district.

Fig4: Total number of injuries insects, total number of beneficial insects and beneficial/pre ratios in sweet pea plantation during 1999/2000 season at Mansoura district.

second week of March, then decreased gradually till the end of study. The maximum number of beneficial insects occurred by the end of March. Also from this figure, it can be seen that the beneficial insects prey ratios was (1:44) at the beginning of season, then reached its maximum (1:50) in the

first week of January. Afterwards, these ratios began to narrowed till the end of study. These results showed that the beneficial insects can play an effective role in checking the piercing-sucking insects in sweet pea crops under natural conditions.

Effect of certain weather factors on population density of studied insects:

Tables 3 and 4 showed the simple correlation coefficient between temperature, relative humidity and the weekly catch of piercing sucking insects infesting sweet pea during the two seasons of study. It can be seen from the results in these tables that minimum and average temperature showed significant negative correlation on the population density of *E. lybica* and *E. dicipiens* in 1998/1999 season (Table 3). The average temperature showed significant positive correlation on the population density of *N. viridula* during the first season (Tables 3 and 5). The minimum relative humidity showed significant negative correlation on the population density of *A. craccivora, B. tabaci, T. tabaci* and *N. viridula* in the first season of study. Also, it can be seen from Tables 3 and 5 that the proportional effect (explained variance) of temperature and relative humidity parameters showed high variation on the catch of the eight piercing sucking insect species. The combined effect of temperature and relative humidity degrees studied was higher than their single effect in season 1998/99. These results agree with the findings of Castillo *et al*. (1993), Ahmed (1997) and Sood *et al.* (1997).

From Table 4 and 6, it can be seen that the minimum temperature showed highly significant positive correlation on the catch size of *N. viridula*, while the average temperature showed significant positive correlation on the population density of *A. pisum* and *N. viridula* in the second season of study. The minimum relative humidity showed highly negative correlation on the catch size of *A. craccivera, A. pisum, E. descipnie, B. tabaci, L. hesperus* and *T. tabaci*. The average relative humidity showed highly negative correlation on the population density of *A. craccivora, A. pisum, E. descipnies, L. hesperus* and *T. tabaci*. While there was highly positive correlation in the case of *B. tabaci* in the second season of study (Tables 4 and 6). Also, it can be seen from this table that the proportional effect (explained variance) of temperature and relative humidity parameter tested on the catch of the eight piercing sucking insect species was high in the second season of study. The combined effect of temperature and relative degrees studied was higher than their single effect in the two seasons of study.

Table3+4

Table5+6

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دراسات بيئية على الحشرات الثاقبة الماصة التى تصيب زراعات البسلة فى منطقة المنصورة

هاله أحمد كامل الصيرفى - عبد البديع غانم - محمد العدل

قسم الحشرات الإقتصادية - كلية الزراعة - جامعة المنصورة

تم إجراء دراسات حقلية بالحقل التابع لقسم الحشرات الإقتصادية بكلية الزراعة - جامعة المنصورة على نبات البسلة خلال موسمين متتاليين وهما 1998/99 و 1999/2000 وذلك لدراسة الكثافة العددية للحشرات الثاقبة الماصة التى تصيب هذا المحصول وتأثير بعض العوامل المناخية (الحرارة والرطوبة) على الكثافة العددية لهذه الآفات الحشرية0 وقد أظهرت النتائج وجود ثمانية أنواع من الحشرات الثاقبة الماصة التى تصيب البسلة وهذه الأنواع هى:

Aphis craccivora Koch, *Empoasca lybica* DeBerg, *Achrosiphum pisum* Harr., *Empoasca descipiens* Paoli, *Bemisia tabaci* Genn., *Thrips tabaci* Lind., *Nezara viridula* L. and *Lygus hesperus*.

وكان أكثر الأنواع شيوعا هو *A. craccivora* والتى بلغت نسبته 36.67 ، 39.92% من المجموع الكلى للحشرات الثاقبة الماصة خلال موسمى الدراسة0

أيضا أظهرت الدراسة وجود 9 أنواع الحشرات الثاقبة المفترسة على نباتات البسلة وهى كالآتى:-

Coccinella undecimpunctata L., *Cydonia vicina isis* Gr., *Cydonia vicina nilotica* Muls, *Scymnus syriacus*, *Paederus alferii* Koch, *Metasyrphus corollae* F., *Paragus compeditus, Chrysoperla carnea* (Steph) and *Orius albidipennis* (Reut.),

بالإضافة إلى ذلك وجود ثلاثة أنواع من طفيليات المن وهى:-

Diaeretiella rapae (M'Intosh), *Trioxys angelicae* (Haliday) and *Aphidius sp.*

وكان النوع السائد من المفترسات هو *O. albidipennis* والتى كانت نسبه تواجده هى 26.49 ، 27.39% خلال موسمى الدراسة على الترتيب0

وقد أظهرت النتائج أيضا أن الأنواع *A. pisum, A. craccivora* بدأت فى الظهور فى الأسبوع الثالث من نوفمبر أثناء موسمى الدراسة ثم بدأ تعداد هذين النوعين فى الزيادة التدريجية حتى وصل ذروته فى الإسبوع الأول والثانى من شهر مارس خلال موسمى الدراسة0 وقد سجلت النتائج أيضاً وجود 4 ذروات لكل من النوعين *E. discipiens, E. lybica*0 أما النوع *B. tabaci* فله خمسة ذروات فى موسم 98/99 وثلاثة ذروات فى 99/2000 وكان لكل من نوعى الحشرات الثاقبة الماصة *E. hesperus, T. tabaci* ثلاثة ذروات خلال موسمى الدراسة0

ولقد أوضحت النتائج العلاقة العددية بين تعداد الحشرات الثاقبة وتعداد الحشرات الضارة ونسبه تواجد كل منهما للآخر0 وأظهرت النتائج الدور الفعال للحشرات الثاقبة فى ضبط التواجد العددى للحشرات الضارة بعد حوالى أسبوعين من وصول الحشرات الضارة إلى ذروتها ثم ضاقت النسبة بعد ذلك حتى نهاية المحصول0

وبينت التجارب بصورة واضحة أن درجة الحرارة والرطوبة النسبية يؤثران تأثيراً واضحاً على التعداد الديناميكى لجميع الحشرات الثاقبة الماصة فى كل من موسمى الدراسة0

Table 3: Simple correlation coefficient between temperature, relative humidity and total number of piercing sucking insect infesting sweet pea during 1998/99 season at Mansoura district.

Insect / Weather factor	Correlation coefficient R							
	A. craccivora	*A. pisum*	*E. lybica*	*E. decipines*	*B. tabaci*	*L. hesperus*	*T. tabaci*	*N. viridula*
Max. temperature	-0.2187	-0.1901	-0.0774	0.0025	-0.1837	-0.1722	-0.1963	-0.1645
Min. temperature	-0.0203	-0.2453	-0.3634	-0.5943	-0.1163	-0.2481	-0.0305	0.3198
Average temp.	0.0614	-0.2714	-0.3479	-0.579	-0.0026	-0.2644	0.0917	0.5205
Max. R.H.	0.01155	0.2050	-0.2045	-0.3257	0.0528	-0.0151	-0.0424	0.02561
Mini. R.H.	-0.4635	0.0047	0.0445	0.2283	-0.3445	0.1044	-0.5292	-0.7520
Average R.H.	-0.2401	0.0495	0.0044	0.2140	-0.2202	-0.1396	-0.3956	-0.4703
Mutt correlation R^2	0.4590	0.3856	0.,2614	0.4524	0.3261	0.2682	0.426	0.6492

Table 4: Simple correlation coefficient between temperature, relative humidity and total number of piercing sucking insect infesting sweet pea during 1999/2000 season at Mansoura district.

Insect / Weather factor	Correlation coefficient R							
	A. craccivora	*A. pisum*	*E. lybica*	*E. decipines*	*B. tabaci*	*L. hesperus*	*T. tabaci*	*N. viridula*
Max. temperature	0.2376	0.2444	-0.2342	-0.2246	-0.2065	0.1489	0.5728	0.6410
Min. temperature	0.1935	0.3716	-0.1932	0.1546	0.2487	0.02432	0.4093	0.4853
Average temp.	0.2656	0.5387	-0.1333	0.2159	0.4123	0.1676	0.4681	0.6042
Max. R.H.	0.0526	0.0959	0.3171	0.1789	0.1573	0.3466	0.0146	0.0733
Mini. R.H.	-0.5903	-0.7747	-0.2000	-0.5854	-0.6590	-0.4320	-0.5935	-0.7535
Average R.H.	-0.6021	-0.7009	-0.3031	-0.7650	0.6604	-0.4373	-0.7432	0.7298
Mutt correlation R^2	0.5075	0.8086	0.2678	0.8346	0.7393	0.6186	0.8584	0.8637

Table 5: Numerical relation between temperature, relative humidity and total number of piercing sucking insect infesting sweet pea during 1998/99 season at Mansoura district.

Insect / Weather factor	Simple regression equations							
	A. craccivora	***A.Pisum***	***E. lybica***	***E. decipines***	***B. tabaci***	***L. hesperus***	***T. tabaci***	***N. viridula***
Max. temperature	--	--	--	--	--	--	--	--
Min. temperature	--	--	--	y = 603.16 - 31.68	--	--	--	--
Average temp.	--	--	--	y = 761.15 - 29.09	--	--	--	y = 800.38 - 111.87
Max. R.H.	--	--	--		--	--	--	--
Mini. R.H.	y = 2644.88 - 42.38	--	--		--	--	y = 522.63 - 9.42	y = 1283.70 - 46.89
Average R.H.		--	--		--	--	--	y = 3946.38 - 96.75
Mutt regression equations	y = -189.42 -2.66 x_1 + 180.48 x_2 - 351.42 x_3 + 96.41 x_4 -106.62 x_5 + 26.05 x_6	y = 3983.93 - 2.11 x_1 + 11.14 x_2 - 121.60 x_3 + 75.46 x_4 - 24.49 x_5 + 6.11 x_6	y = 1960.34 - 0.50 x_1 + 41.15 x_2 -101.62 x_3 - 1.63 x_4 - 22.40 x_5 + 12.38 x_6	y = 1556.10 - 0.35 x_1 - 2.0 x_2 - 32.00 x_3 - 10.50 x_4 - 5.89 x_5 + 7.10 x_6	y= -1546.82 - 0.90 x_1 - 28.71 x_2 - 1.96 x_3 + 28.34 x_4 - 9.15 x_5 - 1.36 x_6	y= -288.67 - 0.48 x_1 + 13.96 x_2 -42.47 x_3 + 12.41 x_4 - 7.84 x_5 + 1.18 x_6	y = -560.54 -0.63 x_1 + 4.10 x_2 -32.42 x_3 + 20.61 x_4 - 14.50 x_5 - 0.97 x_6	y = -789.46 - 0.18 x_1 - 13.99 x_2 + 23.74 x_3 + 13.33 x_4 - 7.57 x_5 - 3.38 x_6

Table 6: Numerical relation between temperature, relative humidity and total number of piercing sucking insect infesting sweet pea during 1999/2000 season at Mansoura district.

Insect / Weather factor	Simple regression equations							
	A. craccivora	***A. pisum***	***E. lybica***	***E. decipines***	***B. tabaci***	***L. hesperus***	***T. tabaci***	***N. viridula***
Max. temperature	--	--	--	--	--	--	y = -241.04 + 16.40	y = -49.87 - 5.83
Min. temperature	--	--	--	--	--	--	--	y = 598.21 -109.18
Average temp.	--	y = -150.75 + 19.12	--	--	--	--	y = -133.40 + 16.01	y = -422.05 + 42.72
Max. R.H.	--	--	--	--	--	y= -876.66 + 10.92	--	--
Mini. R.H.	y = 2964.07 - 54.82	y = 600.65 - 11.79	--	y = 963.97 - 14.85	y = 707.55 + 13.97	y = 294.91 - 5.16	y = 451.32 - 8.70	y= 1604.76 - 57.35
Average R.H.	y = 8245.77 - 114.84	y = 1532.33 - 21.57	--	y = 2813.63 - 37.40	y= -2022.17 - 28.75	y = 785.55 - 10.67	y= 1526.13 -21.82	y = 12330.45 -343.13
Mutt regression equations	y= -11589.14 + 4.53 x_1 + 41.50 x_2 + 2.14 x_3 + 400.02 x_4 + 174.61 x_5 - 474.55 x_6	y= -2863.91 + 0.319 x_1 + 1.96 x_2 + 23.11 x_3 + 5.21 x_4 - 37.52 x_5 + 56.26 x_6	y = -649.37 - 0.35 x_1 - 17.58 x_2 + 11.82 x_3 + 63.83 x_4 + 42.99 x_5 - 99.06 x_6	y = -2621.70 + 0.071 x_1 + 18.26 x_2 + 13.13 x_3 - 16.75 x_4 - 72.87 x_5 + 108.47 x_6	y = -4227.20 + 0.66 x_1 - 25.62 x_2 + 54.17 x_3 + 77.38 x_4 + 19.29 x_5 - 59.85 x_6	y = -1585.24 - 36.66 x_1 - 6.45 x_2 + 61.42 x_3 + 10.36 x_4 - 17.50 x_5 + 20.90 x_6	y = -1811.73 - 8.83 x_1 + 11.23 x_2 + 28.23 + 3.62 x_4 - 26.72 x_5 + 35.73 x_6	y = -3358.88 - 31.40 x_1 + 28.51 x_2 + 51.63 x_3 + 12.92 x_4 - 46.72 x_5 + 59.09 x_6