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Investigations on Repellent and Insecticidal Effects of *Xanthium strumarium* L. on Colorado Potato Beetle *Leptinotrasa decemlineata* Say (Col: Chrysomelidae)

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Abstract: The repellent effects of the extracts of *Xanthium strumarium* fruits and leaves dilueted with 1/6, 1/8, 1/10 water (w/v) for fruits and 1/6, 1/8 (w/v) for leaves were investigated with randomised plot design and 25 replicates under laboratory conditions. Insecticidal effect was also studied in laboratory. It was found that insecticidal effect was low, where as repellent effect was quite high.

On the other hand, the effect of 1/6 concentration of fruit extract against adult and larvae of Colorado Potato Beetle was investigated under field conditions and the repellent effect was confirmed.

Domuz Pıtrağı (*Xanthium strumarium* L.)'nın Patates Böceği ((*Leptinotarsa decemlineata* Say (Col.: Chrysomelidae))'ne Repellent ve İnsektisid Etkileri Üzerinde Araştırmalar

Özet: Domuz pıtrağı meyvesinin 1/6, 1/8, 1/10, (ağırlık/hacim), yapraklarının ise 1/6, 1/8 (ağırlık/hacim) oranındaki su ekstraktlarının laboratuvarda repellent etkileri tesadüf parselleri deneme desesine göre 25 tekerrürlü olarak araştırılmıştır. Ayrı bir deneme ile de insektisit etkili olup olmadığı saptanmaya çalışılmıştır. İnsektisit etki düşük, repellent etki yüksek bulunmuştur.

Domuz pıtrağı meyvesinin 1/6 oranında hazırlanmış su ekstraktının patates böceğinin ergin ve larvalarına tarla koşullarındaki etkileri araştırılmıştır. Deneme eş yapma deneme desesine göre 6 tekerrürlü olarak kurulmuş ve ekstraktın patates böceğinin ergin ve larvalarının beslenmesini engelleyip kaçırdığı tespit edilmiştir.

Introduction

Potato is an important crop with 4300000 tons production and 192000 hectars growing area in Turkey (1).

Adults and larvae of Colorado Potato Beetle feeding on potato plants cause yield losses. Some pesticides are used to control *Leptinotarsa decemlineata* Say. It is well - known that pesticides have side - effects on the environment. For this reason, repellent effects of some weeds on Colorado Potato Beetle has gained importance in recent years. It was reported that xanthatin of *X. strumarium* leaves ED 50, LD 50 values on molluscs were more than 500 ppm (2). Repellent effect of xanthatin was greater than $CuSO_4$ and xanthatin was less toxic than $CuSO_4$.

Material and Method

To prepare the concentrations of fruits and leaves of *X. strumarium*, the leaves and fruits were kept at laboratory conditions. Then fruits, leaves were ground with a mill and each one was put in a mortar and crushed with a pestle. The concentrations of 1/6, 1/8, 1/10 (w/v) of fruits and 1/6, 1/8 (w/v) of leaves were used in the experiment. Each concentration was kept over one night and then centrifuged (3). Fruits and leaves of *X. strumarium* were collected from Ankara province.

A- Laboratory experiments

1- Research on repellent effect

Adults of Colorado Potato Beetle were brought from producers' fields in Kazan. The larvae used in experiments were obtained from eggs laid by the adult. For adults and each larval instar, experiments were seperately set up. For this purpose, healty potato leaves were dipped in the prepared concentrations and one leaf was put in a 300 ml jar. Then one first instar larvae, one second, one third,

Table 1. Repellent effects of leaf and fruit water extract's concentrations of *X.strumarium* on adults taking leaf area consumed (mm^2) into consideration.

REPLICATES	FRUIT			LEAF		CONTROL
	1/6	1/8	1/10	1/6	1/8	
1	0	6	0	1389	1603	872
2	0	5	63	1220	1048	2933
3	1	10	0	1410	2	1233
4	15	0	0	0	774	2112
5	0	0	0	6	2671	1051
6	0	0	0	1	582	806
7	6	0	0	1094	1058	3565
8	4	132	2	904	1744	2304
9	2	0	0	983	219	980
10	0	0	0	25	1031	724
11	0	0	0	47	796	4511
12	0	0	0	92	37	1714
13	0	0	0	1145	9	1621
14	0	0	73	52	1509	3385
15	0	0	0	781	1746	2345
16	7	0	0	465	1881	845
17	0	7	1	138	884	866
18	0	1	2	1176	255	519
19	0	0	0	2755	714	3189
20	12	0	2	190	2100	952
21	0	0	1	1684	311	3153
22	0	0	1	1493	253	556
23	0	0	3	1476	1267	1101
24	605	0	331	1066	25	1559
25	0	5	0	1089	3981	2045

$F=90.76>F_{1\%\ Table}=3.02$

Duncan's Multiply Range Test 1%:

A : 1/8 concentration of leaf and control

AB : 1/8 and 1/6 concentrations of leaves

C : 1/6, 1/8 and 1/10 concentrations of fruit

one fourth instar larvae and one adult were placed on the leaf in the jar for each replicate. The experiments were carried out with randomised plot design 3 concentrations of fruit extract, 2 concentrations of leaves extract and control with 25 replicates. During the experiment, the larvae and adults were kept at 22-25°C, 60-65% humidity, 16 hours day light and 8 hours darkness.

During the experiment, the old leaves and the consumed completely leaves were changed with new leaves. The new and fresh leaves were dipped in the prepared concentrations. Then these leaves were put into jars. In each replicate, the amount eaten was calculated as mm^2 (4, 5). To calculate how much the leaves were aten during the experiment, the leaves before placing them in a jar and the eaten leaves during the experiment were copied. Experiments were continued until larvae reached pupa stage and the adults experiments were also continued for ten days. The repellent effects were subjected to F - test and Duncan's Multiply Range Test. The amounts consumed on leaves were calculated and statistical analysis was made according to t-test.

2- Researches on the insecticidal effect

Table 2. Repellent effects of leaf and fruit water extract's concentrations of *X.strumarium* on first larvae stage taking leaf area consumed (mm^2) into consideration.

REPLICATES	FRUIT			LEAF		CONTROL
	1/6	1/8	1/10	1/6	1/8	
1	0	3	8	4	0	355
2	0	5	51	7	5	847
3	0	10	0	19	8	278
4	1	54	2	17	225	997
5	0	0	52	4	1988	1690
6	10	18	8	544	2113	2060
7	13	2	44	6	335	1278
8	6	35	6	1	12	381
9	0	121	0	9	2	2552
10	47	9	0	994	2616	39
11	0	4	10	12	1413	1046
12	9	1	2	1194	10	1001
13	0	1	0	4	8	37
14	25	0	3	20	0	195
15	0	0	37	9	246	1354
16	3	0	35	3	1975	623
17	0	6	4	2133	13	171
18	2	0	7	0	8	3410
19	8	0	2	26	885	3131
20	0	21	1	3	2228	1811
21	9	0	0	1004	309	2056
22	7	0	1	533	1266	259
23	1	0	2	10	2403	920
24	3	0	1	4	7	523
25	5	45	0	12	629	2014

$F=28.528>F_{1\%\ Table}=3.02$

Duncan's Multiply Range Test 1%:

A : Control

B : 1/8 and 1/6 concentrations of leaves

C : 1/6, 1/8 and 1/10 concentrations of fruit

The concentrations of 1/6, 1/8 of the fruits and 1/6 of the leaves were investigated on insecticidal effect on Colorado Potato Beetle. Research conditions were similar to the repellent experiment. Randomised plot design with 3 replicates were used. The shoots of potatos and the insects were treated with each character by using a hand pulverizator. The bottom of the shoots were wrapped with wet cotton and each shoot was placed into a 800 ml jar. Then 10 larvae from first stage, 6 larvae from second stage, 4 larvae from third stage, 3 larvae from fourth stage and ten adults were put into each jar (6).

Countings of alive larvae and adults were made 1., 3., 5., 7., 10. days after the treatment. The effectiveness of the concentration was calculated according to the Abbot formula.

B- Field experiments

Adults and larvae of Colorado Potato Beetle were brought from producers' fields in Kazan. Fruits of *X. strumarium* were ground with a mill and were put in a mortar and crushed with a pestle to obtain water extracts to use in experiments. The concentration 1/6 was used in the experiment. Paired design with 6 replicates in 1993

Table 3. Repellent effects of leaf and fruit water extract's concentrations of *X.strumarium* on second larvae stage taking leaf area consumed (mm^2) into consideration.

REPLICATES	FRUIT			LEAF		CONTROL
	1/6	1/8	1/10	1/6	1/8	
1	2	0	5	2460	4226	2587
2	0	0	6	5	1073	2908
3	2	20	2	230	1393	754
4	3	21	0	211	18	1637
5	5	2	0	2271	102	2927
6	1	1	4	2465	1123	228
7	3	6	0	70	18	2270
8	10	0	0	1054	0	432
9	10	1	15	43	405	1213
10	7	0	8	676	211	2972
11	1	1	19	44	127	1926
12	1	41	10	3481	9	2045
13	13	3	6	2900	172	2538
14	1	1	12	1786	245	3050
15	5	3	128	786	177	1338
16	1	1	4	42	203	2582
17	0	10	16	375	52	2181
18	0	1	0	31	113	2725
19	1	9	35	54	543	1900
20	1	0	15	8	8	1478
21	19	2	13	2330	94	1789
22	3	4	2	1094	1197	1952
23	0	18	5	151	145	259
24	13	1	4	13	213	1378
25	1	7	4	356	403	3928

$F=66.431>F_{1\%\ Table}=3.02$

Duncan's Multiply Range Test 1%:

A : Control

B : 1/8 and 1/6 concentrations of leaves

C : 1/6, 1/8 and 1/10 concentrations of fruit

and 5 replicates in 1995 was used. In each replicate, two row potatoes were put in beds. In each row in a plot there were ten plants. Space between two rows was 1m and space between potatoes on the rows was 50 cm. Space between plots was 1m. In each plot one row potato plants were treated. In the spraying, 100 ml water extract was enough to wet plants completely. In the field experiments, 500 ml hand sprayer was used. In 1993, 5 adult+ 5 larvae; in 1995 10 adults+10 larvae were put on each plant before treatment. On the third, seventh, fourteenth, twenty first days after treatment, larvae, adult countings were made and egg masses were recorded. Percent repellency and percent effect were calculated using Henderson-Tilton formula. Moreover, the damage rate on each plant were also determined. To calculate damage rate, the scale given below was used (6).

1: 0-20%

2: 21-40%

3: 41-60%

4: 61-80%

Table 4. Repellent effects of leaf and fruit water extract's concentrations of *X.strumarium* on third larvae stage taking leaf area consumed (mm^2) into consideration.

REPLICATES	FRUIT			LEAF		CONTROL
	1/6	1/8	1/10	1/6	1/8	
1	70	97	3	2676	1505	1530
2	26	73	59	1612	1139	709
3	32	117	60	1375	1658	1540
4	8	74	102	878	144	1820
5	47	57	13	2096	1981	1407
6	14	113	8	1648	407	2019
7	1	56	35	968	1741	2664
8	13	48	28	1251	1190	2974
9	144	409	109	1572	1342	1937
10	11	27	21	1245	105	3063
11	30	16	0	1931	672	1598
12	8	21	14	1233	156	1610
13	20	3	70	834	3315	2655
14	97	0	2	923	1815	1632
15	105	0	3	2226	226	2724
16	413	11	39	1817	972	4708
17	38	3	48	421	1272	1141
18	15	11	74	171	139	1133
19	26	25	26	1180	125	1135
20	1	7	100	58	1779	952
21	3	4	8	1213	1287	1580
22	12	190	29	270	1179	1906
23	195	27	93	644	1675	3383
24	26	18	4	489	1827	2433
25	0	15	195	202	1576	2221

$F=65.47>F_{1\%\ Table}=3.02$

Duncan's Multiply Range Test 1%:

A : Control
B : 1/8 and 1/6 concentrations of leaves
C : 1/8 and 1/10 concentrations of fruit
D : 1/6 concentration of fruit

5:81-100%

Values of percent damage on plant were subjected to arcsin percentage transformation. The new values were subjected to t-test.

Phytotoxicity was also examined.

Results

A- Repellent and insecticidal effects of *X. strumarium*

Repellent effects of fruits of *X. strumarium* on adults and larvae of *L. decemlineata* were given in Table 1, 2, 3, 4, 5. Data of insecticidal effect were given in Table 6 and 7. The feeding of adults was inhibited significantly at the concentration of 1/6 of fruits (Table 1). On tenth day, adults did not die.

Repellent effects on the first stage larvae were given in Table 2. The concentrations of fruits inhibited feeding and made one group according to Duncan's Multiple Range test. The two concentrations of the leaves inhibited

Table 5. Repellent effects of leaf and fruit water extract's concentrations of *X.strumarium* on fourth larvae stage taking leaf area consumed (mm^2) into consideration.

REPLICATES	FRUIT			LEAF		CONTROL
	1/6	1/8	1/10	1/6	1/8	
1	3	288	3	277	22	68
2	2	29	4	63	0	180
3	0	253	0	19	189	861
4	86	30	4	167	193	7
5	0	0	35	8	239	231
6	45	30	10	47	185	177
7	0	0	1	499	0	1012
8	111	96	10	156	114	227
9	0	0	3	174	229	685
10	0	0	5	243	3	2101
11	35	4	375	211	45	1215
12	0	0	0	8	10	30
13	30	2	25	188	48	1624
14	0	3	4	15	12	725
15	215	0	17	93	122	23
16	0	23	0	33	15	1038
17	0	0	7	209	67	100
18	0	0	8	24	67	88
19	0	6	10	300	94	1869
20	0	38	51	0	84	913
21	35	41	14	383	58	16
22	0	0	4	246	191	363
23	25	0	0	113	16	121
24	33	0	30	28	179	387
25	8	123	33	252	145	26

$F=18.841>F_{1\%\ Table}=3.02$

Duncan's Multiply Range Test 1%:

A : 1/6 concentration of leaf and control

AB : 1/8 and 1/6 concentrations of leaves

C : 1/6, 1/8 and 1/10 concentrations of fruit

feeding of the first stage larvae and these two concentrations made one group different from the control. Control made a different group first stage larvae died in different periods. Three larvae became pupae at the concentrations of leaves.

The repellent effects on second stage larvae were given in Table 3. The concentrations of fruits, leaves and control made seperate groups. Feeding was inhibited at important rate. Second stage larvae died completely in different periods. According to the concentrations of 1/6, 1/8 of leaves, 4-8 larvae became pupae, respectively.

The repellent effects on the third stage larvae were given in Table 4. These effects were examined and the differences among control the concentrations of leaves and the concentrations of fruits were statisticaly significant and they made different groups. Third stage larvae died in different periods. According to the concentrations of 1/6, 1/8 of leaves, 13-16 larvae became pupae, respectively.

As shown in Table 5, feeding of the fourth stage larvae was inhibited by concentrations of fruits. Fruit concentrations was found statisticaly different from

Table 6. Counting alive larvae and adults of *L. decemlineata* to find insecticidal effects of leaf and fruit water extract's concentrations of *X. strumarium*.

		first day					third day					fifth day					eighth day				tenth day		
Concentration	Stages L3 Replicate	Adult L4	L1	L2	L3	L4	Adult	L1	L2	L3	L4	Adult	L1	L2	L3	L4	Adult	L1	L2	L3	L4	Adult	L1
3	1	10	10	6	4	3	10	8	5	2	3	10	6	4	1	3	10	4	4	1	3	10	3
Fruit 1	2	10	10	6	4	3	10	4	2	2	3	10	4	1	2	3	10	4	1	1	3	10	4
1/6 1	3	10	10	6	4	3	10	5	1	4	3	10	3	1	4	3	10	3	1	3	3	10	2
1.6	Ave. 1.3	10 2.6	10	6	4	3	10	5.6	3	2.6	3	10	4.3	2	2.3	3	10	3.6	2	1.6	3	10	3
4	1	10	10	6	4	3	10	9	6	3	3	10	8	6	2	3	10	8	5	2	2	10	7
Fruit 3	2	10	10	6	4	3	10	7	4	3	3	10	6	3	2	3	10	6	3	3	3	9	4
1/8 3	3	10	10	6	4	3	10	7	5	4	3	10	7	4	2	3	9	7	4	2	2	9	6
3.3	Ave. 2	10 2.3	10	6	4	3	10	7.6	5	3.3	3	10	7	4.3	2	3	9.6	7	4	2.3	2.3	9.3	5.6
4	1	10	10	6	4	3	10	6	4	2	3	10	5	4	2	3	10	5	4	2	3	8	4
Leaf 1	2	10	10	6	4	3	10	6	4	3	3	10	5	2	3	3	9	5	1	3	2	9	5
1/6 4	3	10	10	6	4	3	10	8	6	2	3	10	5	6	2	3	10	5	6	2	3	10	4

Table 7. The Insecticidal percent effets of leaf and fruit water extract's concentration of *X. strumarium* on larvae and adults of *L. decemlineata*

	first day					third day					fifth day					eighth day					tenth day		
Stages L3	Adult L4	L1	L2	L3	L4	Adult	L1	L2	L3	L4	Adult	L1	L2	L3	L4	Adult	L1	L2	L3	L4	Adult	L1	L2
Concentration																							
Fruit 63.66 1/6	0 11.34	0	0	0	0	0	39.35	50.09	33.5	0	0	56.7	60	41.75	0	0	60.77	50	54.64	0	0	60.83	50.16
Fruit 45.35 1/8	0 22.34	0	0	0	0	0	23.4	6.19	16.75	0	0	30	13.4	50	0	0	24.97	0	36.33	22.34	3.41	26.1	0

control and leaves concentrations. The significant effect was not determined with the concentrations of leaves. Some of larvae became pupae without feeding at the concentrations of fruits and leaves. Three larvae did not become pupae, they died at the concentration of 1/6 of fruits of *X. strumarium.*

Counting alive larvae and adults of *L. decemlineata* were given Table 6 made to calculate insecticidal effect. Insecticidal effect was not determined on adults and fourth stage larvae. Insecticidal effect on other larvae was found out low. Adults have not fed and laid eggs at the concentration of 1/6 of fruit extract contrary to untreated control.

B- The repellent effects under field experiments

In 1993, percent effects were observed on alive adult and larvae and damage rates at each replicate were given in Table 8. Adults and larvae were not seen on treated plants at third day counting. Three larvae were found at seventh day counting on treated three plants. The number of larvae increased while percent effect decreased from 100% to 59.51% at twenty first day counting. Percent effects were calculated with Henderson-Tilton formula. As shown Table 9, egg masses were determined on seventh day and it increased on fifteen treated plants. There was a significant differences between control and treated plants on third, seventh and fourteenth day

Table 8. Percent effect of 1/6 fruit water extract concentration of *X. strumarium* against the adults and larvae of Colorado Potato Beetle in field experiments (determined by alive counts) and rates of damage.

Replicates	third day	seventh day	fourteenth day	twenty-first day	Damage rates % Fruit 1/6	Control
1	100	100	67.2	51.8	0.45	7.85
2	100	100	81.6	68.8	0.2	5.95
3	100	98.4	95.7	71.2	0	8.1
4	100	98.8	82.4	64.3	0.5	7.75
5	100	97.9	98	52.9	0	14
6	100	100	87.8	48.1	1.5	9.5
Total	600	595.1	512.7	357.1	2.65	53.15
Average	100	99.18	85.45	59.51	0.44	8.85

Table 9. t-test comparison of 1/6 fruit water extract concentration of *X. strumarium*, determined by egg mass counts, with the control.

	third day		seventh day		fourteenth day		twenty-first day	
Replicates	Control	Fruit1/6	Control	Fruit1/6	Control	Fruit1/6	Control	Fruit1/6
1	1.7	0	10.6	0	8.5	5	4.7	6.8
2	1.5	0	9.9	0.2	8.4	5.7	4.3	3.7
3	1.8	0	12	0.3	5.4	1.9	1.6	4.1
4	0.8	0	14	1.1	5.7	3.4	0.5	3.1
5	1.4	0	7.4	0.1	3.4	3.7	0.5	1.7
6	1.2	0	9.5	1	5.9	4.2	0.6	0.2
Total	8.4	0	63.4	2.7	37.3	23.9	12.2	19.6
Average	1.4	0	10.56	0.45	6.21	3.98	2.03	3.26

t=9.459> t 1 %table=4.032 t=12.042>t1 %table=4.032 t=3.483> t 5% table=2.571
t=2.109<t5% table=2.571.

countings, but difference was not significant at twentyfirst day counting. It was found out that the differences between the damage rates of treated and control were significant. The damage leaf rates on treated plants was low.

In 1995, percent effects of the concentrations were calculated on alive adult and larvae and the damage rates at each replicate were given in Table 10. Percent effects were calculated with Henderson-Tilton formula. The number of larvae increased while percent effects decreased to 67.69% at twenty first day counting. First day, third day and fifth day after treatment it rained. Damage rates between control and treated plots were important according to t-test 1%. Egg mass countings between control and treated plots were not important statisticaly (Table 11). Egg mass differences between control and treated plots. Phytotoxicity was not observed.

Discussion

In laboratory experiment, it was found out that repellent effect was high, insecticidal effect was low. The experiment related with the repellent effect, fruit concentrations inhibited the feeding of adult and four larvae stages. In the experiment of leaf concentrations, adult and larvae fed with treated leaves in some extent. As larval stage progressed feeding has increased. The concentration of fruit extract has significantly inhibited feeding. Low insecticidal effect was determined (2). This effect may appear because of toxic components of the fruits and leaves of *X. strumarium.* Low toxic components

Table 10. Percent effect of 1/6 fruit water extract concentration of *X. strumarium* against he adults and larvae of Colorado Potato Beetle in field experiments (determined by alive counts) and rates of damage.

Replicates	third day	seventh day	fourteenth day	twenty-first day	Damage rates % Fruit 1/6	Control
1	92.17	91.84	95.42	76.5	2.7	1.1
2	86.9	85.19	85.19	58.6	4.2	1.6
3	87.72	85.57	79.02	50.62	3.6	2.3
4	88.1	84.97	89.18	74.3	5.3	1.2
5	89.69	92.94	99.1	78.34	7.1	2.2
Total	600	595.1	512.7	357.1	2.65	53.15
Average	100	99.18	85.45	59.51	0.44	8.85

Table 11. t-test comparison of 1/6 fruit water extract concentration of *X. strumarium* determined by egg mass count, with the control.

	third day		seventh day		fourteenth day		twenthy-first day	
Replicates	Control	Fruit1/6	Control	Fruit1/6	Control	Fruit1/6	Control	Fruit1/6
1	0.1	0.0	1.2	0.3	3.1	0.0	0.6	0.8
2	0.2	0.0	0.5	0.5	2.9	3.0	3.0	1.3
3	0.1	0.0	0.2	0.1	4.3	2.6	1.5	1.3
4	0.0	0.1	0.2	0.2	2.4	1.7	0.9	0.0
5	0.0	0.0	0.2	0.1	1.0	0.3	0.2	0.0
Total	8.4	0	63.4	2.7	37.3	23.9	12.2	19.6
Average	1.4	0	10.56	0.45	6.21	3.98	2.03	3.26

t= 5%table=2.306>t=1.415 t 5%table=2.306>t=0.647 t 5%table=2.306>t=1.517
t 5%table=2.306<t=3.110
t 1%table=3.355>t=1.415 t 1%table=3.355>t=0.647 t 1%table=3.355>t=1.517
t 1%table=3.355>t=3.110

were hydroquinone and xanthatin. These components are known as repellent components (2). As shown in Table 8, the effect of 1/6 fruit concentration decreased from 100% to 59.91% in 1993 and to 67.69% in 1995 in twentyfirst day in field experiment. The reason of decrease was that the females were laid their eggs on treated plants from seventhy day to twentyfirst day. The number of larvae increased but they did not feed on the treated plants. Damage rates were very low on treated plants.

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