Bio-Efficacy of Plant Extracts against Mustard Aphid (*Lipaphis erysimi* Kalt.) on Rapeseed (*Brassica campestris* Linn.) under Field and Laboratory Conditions

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Abstract

The bio-efficacy of eight plant aqueous extracts *viz* Neem (*Azadiracta indica*), Bakaino (*Melia composite*), Asuro (*Adhatoda vasica)*, Titepati (*Artimesia vulgaris)*, Khirro (*Sapium insigne)*, Bojho (*Acorus calamus)*, Tobacco (*Nicotinia tabaccum)* and Marigold (*Tagetes erecta)* were tested on Lumle tori-1 variety of rapeseed against mustard aphid (*Lipaphis erysimi* Kalt.) during rabi season of 2018/19 under field and lab conditions at Institute of Agriculture and Animal Science (IAAS), Lamjung Campus, Lamjung, Nepal. The treatments were eight plant extracts, cypermethrin 10% EC (@1.5 mL/L), and water as control. Aphids were deliberately exposed to the treatments and then the numbers of alive and dead aphids were counted. The plant extracts showed highly significant effect on aphid mortality in both field and lab condition. In the lab, cypermethrin was found to be the most effective against aphid offering the highest aphid mortality (96%) followed by neem extract (88%) whereas the lowest aphid mortality (14.67%) was observed in control plot. Under field condition the highest percentage of aphid reduction was observed with use of cypermethrin followed by neem and tobacco leaf extracts whereas, control plot showed the lowest percentage of aphid reduction. Among all treatments, the highest grain yield of rapeseed (2104.44 kg/ha) was obtained from plot treated with cypermethrin followed by neem extract (2048.44 kg/ha) and tobacco extract (2020.22 kg/ha) whereas, control plot produced the lowest rapeseed yield (1133.67 kg/ha). All the treatments of plant leaf extracts showed better insecticidal activity. However, neem extract followed by tobacco extract reduced the aphid population to a great extent. Therefore, neem and tobacco extracts could be the best alternative for controlling aphids.

Keywords: Cypermethrin, Mustard aphid, Plant extracts, Rapeseed.

Introduction:

Brassica campestris L. commonly known as Rapeseed belongs to the family *cruciferae* is one of the major short duration oilseeds crop. It contributes about 85% of total acreage among the total oilseed producing crops of Nepal (Ghimire *et al.,* 2000). It is cultivated in the area of 16.405 ha with the annual production of 159.710 MT resulting the productivity of 996 kg/ha (MOAD, 2016/17). The productivity of rapeseed in Nepal is considerably lower as compared to the world productivity. There are several factors responsible for the low productivity of rapeseed, in general, mustard aphid (*Lipaphis erysimi* Kalt.) which plays a vital role. It had been reported that about 25 species of pests are vulnerable to rapeseed production and among them mustard aphid is most important pest which can cause loss up to 27 to 91.30% of total production (Singh, 1986) Mustard aphid is the soft bodied insect which suck cell sap from leaves, stems, inflorescence and even from pods. As a result, plant shows yellowing, rolling and dehydration of leaves. Aphids also produce honeydew which results in the presence of black spots on leaves and stems due to the growth of sooty molds that hinders the photosynthesis process (Mishra and Kanwat, 2018). For the control of insects primarily mustard aphids, most of the rapeseed growing farmers of Nepal apply synthetic pesticides and even banned pesticides in some cases in a repeated manner with the higher doses. Due to the repeated doses of insecticide, aphid has gained resistance over pesticides and haphazard use of pesticide has induced phyto-toxicity, destruction of beneficial organism, disruption of agro-ecosystem and human health hazards (Mcintire *et al.*, 1989). So, the alternative of chemical pesticide can be bio-insecticide which is economically cheaper, environmentally sound and non-hazardous to human, animal and natural predator and pollinator but effective against harmful pests. Regarding to that, this research was conducted to determine the most efficient plant extracts against mustard aphids.

Materials and Methods:

Both field and lab experiments were conducted during rabi season of 2018/19 at the horticultural field and entomological lab of Tribhuvan University, Institute of Agriculture and Animal Science (IAAS), Lamjung campus, Lamjung, Nepal. A total of 10 treatments (8 botanical extracts; Cypermethrin 10% EC as a standard check and water as a control) were used which were replicated thrice.

Experimental site:

The experimental study was carried out at research field (horticultural field) of Tribhuvan University, Institute of Agriculture and Animal Science (IAAS), Lamjung Campus, Sundarbazar, Lamjung Nepal. It has a humid tropical climate with an annual rainfall of 280 cm, at the latitude of 28° 8' 41"N and longitude of 84° 24' 43" E and elevation of 610 masl (Mahato *et al.*, 2018). Seeds of Rapeseed variety Lumle tori-1 were sown by line sowing method on 21st November in 2m×2.1m size plots following randomized complete block design with 10 treatments and 3 replications. Land was well pulverized and levelled with the help of tractor. Spacing between rows was maintained at 30 cm and plant to plant distance was maintained at 5 cm during the time of thinning out. FYM was applied 7 days before the sowing of rapeseed. The nutrients were applied @ 60:40:20 kg NPK/ha through Urea, Diammonium Phosphate (DAP) and Murate of Potash (MOP) respectively. The first irrigation was given after the first weeding and further irrigation was done as per the requirement to keep crop healthy. Sprinkler system of irrigation was applied. Finally, the grains were harvested from each plot at full maturity stage. They were harvested and left to dry until they contained the desired level of moisture. The harvested grain was weighed and converted from kg per plot to MT per ha respectively.

Preparation of extracts:

Fresh leaves, rhizomes and flowers were collected, surface cleaned and shade dried for 5-6 days. After drying of leaves, they were grinded in a mechanical grinder. For the preparation of 5% aqueous solution of plant extract, 50 gm of each dried powder was dissolved in 950ml of distilled water and left for 3-4 days. After that, the extracts were filtered by the help of clean muslin cloth. For the preparation of chemical solution, 1.5 ml Cypermethrin 10% EC was added in 1lt. of distilled water (Pal *et. al*., 2018).

Laboratory evaluation:

Adult aphid of similar size and age were collected from rapeseed growing in field and were conditioned for 8-10 hrs. Fresh leaves were also collected, surface cleaned and dipped in solution containing treatments for 30 minutes. The treated leaves were kept under fan to evaporate water and placed over Petri dish of 6.5cm diameter. 10 aphids were released in each Petri dish and number of alive aphids were counted at 24, 48 and 72 hours and mortality percentage was calculated by Abbott's formula (Abbott, 1925):

$$\text{Percentage mortality} = \frac{\text{Pre treatment count} - \text{Post treatment count}}{\text{Pre treatment count}} \times 100$$

$$Mortality = \frac{\text{n in Co} - \text{n in T}}{\text{n in Co}} \times 100$$

Where n = Insect population, T = treatment, Co = control

Field Evaluation

All the agronomic practices were followed except insect control method. Before the application of spray, 5 plants from each plot were selected and tagged. Plant extracts were sprayed on each plot at 30, 45 and 60 days after sowing (DAS) by the help of hand compression sprayer of 2 L capacity. The aphids on the tagged plants were counted with the help of hand lens of 10X magnification at 1 day before spray (DBSp) as pre count and 3, 6 and 9 days after spray (DASp) as post count on every spray. Percentage of reduction of population over control (PROC) was calculated by Henderson and Tilton (1955) formula.

PROC = [1-{(Ta × Cb) / (Tb × Ca)}] ×100

Where, Tb = Population in treatment before spray,

Ta = Population in treatment after spray,

Cb = Population in control before spray,

Ca = Population in control after spray.

Statistical Analysis:

The data recorded in experiments of different 10 treatments were designed in CRD for lab evaluation and RCBD for field evaluation, with three replicates. The data were subjected to one-way analysis of variance (ANOVA) and analyzed by using R software and means were compared by using Duncan's Multiple Range Test (DMRT) at 5% (Gomez and Gomez, 1984; Devkota *et al.*, 2019; Shrestha, 2019; Kandel and Shrestha, 2019).

Results:

1- Under field condition:

Data recorded on third days at first spray showed that maximum PROC was observed in cypermethrin treatment (75.2) which was followed by neem extract (56.87) and tobacco extract (52.03) which were not statistically significant. Data taken on 6th day exhibited similar results as in the 3rd day after spray where chemical was found most effective (89.27) which was followed by neem extract (75.9) and tobacco extract (71.52). All the plant extracts possessed significantly greater reduction of aphid population over

control. On contrary to data recorded in the 3rd and 6th days after spray, cypermethrin (95.12), neem extract (87.14) and tobacco extract (83.96) possessed similar effect on aphid reduction in the 9th day after spray. Considerably similar effect was observed during second spray where cypermethrin (82.51, 94.64 and 97.71 % at 3rd, 6th, and 9th day respectively) possessed maximum reduction of aphids which was followed by neem extract (61.92, 80.79 and 89.01% at 3rd, 6th and 9th respectively), and tobacco extract (64.5, 80.31 and 87.33 at 3rd , 6th and 9th day). As in the 1st spray, all the plant extracts possessed significantly higher reduction of aphids over untreated plots. During the third spray, cypermethrin (76.48) possessed maximum reduction of aphid which was superior over all the treatments at 3rd days of spray whereas, cypermethrin (85.56 and 93.1%) was statistically at par with neem extract (77.5 and 88.46%) and tobacco extract (78.6 and 88.16%) at 6th and 9th days after spray respectively.

Highest grain yield was found in plot treated with cypermethrin (2.1 t/ha) followed by neem extract (2.05 t/ha) and tobacco extract (2.02 t/ha) which were statistically at par and were superior over remaining treated and untreated plots. All the plots treated with plant extract possessed significantly higher yield over untreated plots (1.13 t/ha).

2-Under lab condition:

Result on lab test showed that both cypermethrin (62, 80.67 and 96%) and neem extract (57, 73 and 88%) had the highest percentage of aphid mortality at 24, 48 and 72 hrs respectively, which were statistically similar and were superior over all the treatments. All the plant extracts showed superiority on aphid mortality over untreated Petri dish.

Discussion:

Highest mortality of cypermethrin was similar to the findings of Khurana and Batra (1989) who stated that cypermethrin was most effective against mustard aphid infesting on mustard under late sown condition. Similar result was observed in the study of Mandal *et al.*, (2012) who stated that highest mortality (92.76%) and yield (1.876 t/ha) was recorded in plot treated with cypermethrin + chloropyriphos. Effectiveness of neem extract was quite similar to the study of Ali *et al.*, (2018), who stated that neem contains active ingredients, called tri-terpene or limnoids. Among them, Azadirachtin Salannin, and Nimbin are the best limonoid compounds which express the insecticidal property in a greater extent (Feinstein, 1952; Debashri and Tamal, 2012). Direct effect of Azadirachtin is feeding deterrent, repellent, toxicity and oviposition deterrent whereas, indirect effect are anti-fertility, hinderance of metamorphosis which ultimately resulted in reduction of aphid population up to 73-83% (Bishwas, 2008, 2013; Akbar *et al.*, 2010; Jacobson, 1989). Neem based insecticides shows superiority over other chemicals in the perspective of low residual effect to human, animals and nature as a whole (Schmutterer, 1990). Similarly, physiologically active chemicals such as nicotine, nicotine sulphate and nor-nicotine in tobacco are responsible for disrupting metabolic activities resulting in aphid mortality (74-90%) (Bahar *et al.*, 2007; Pedigo, 2002; Bajpai and Sehgai, 2000) and indirectly acts as deterrents, antifeedants and modify ovipositor (Sarmamy *et al.*, 2011). Tobacco possess no hazards on predators. This may be due to detoxification mechanism inflicted by predators against phytochemical produced from tobacco (Markandeya and Divakar, 1999).

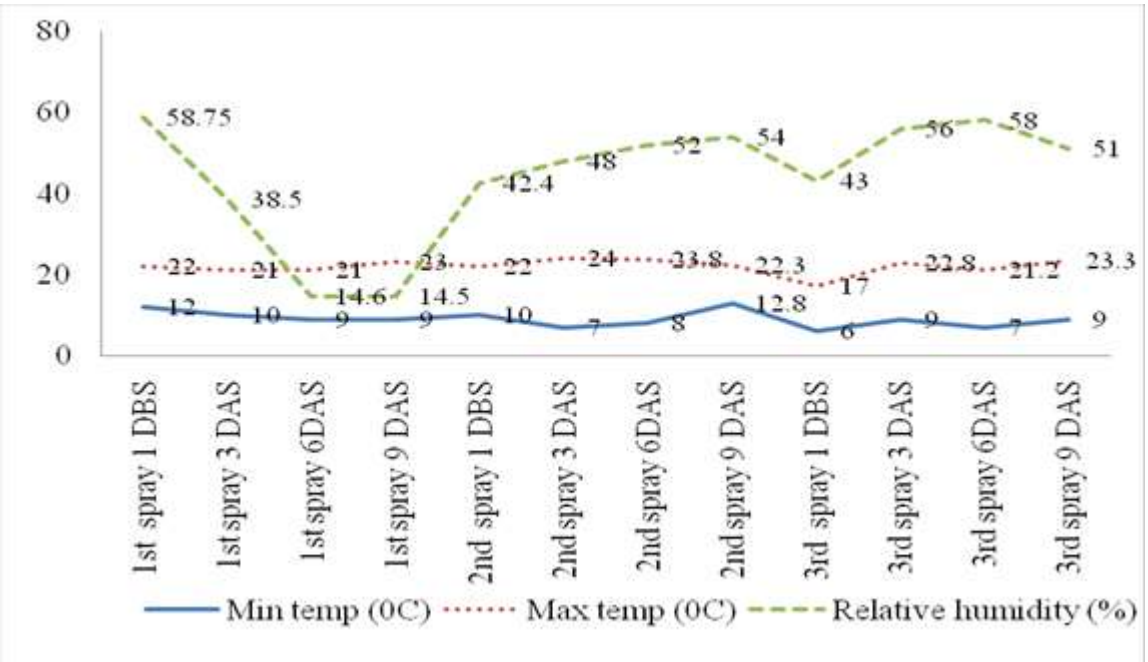

Figure 1. Weather data at different spraying time

Table 1. Efficacy of different plant extracts against mustard aphid on 1st spray under field condition

Treatments	Pre-treatment	Post treatment					
	1 DBS	3 DAS	PROC	6 DAS	PROC	9 DAS	PROC
Neem	19.8	10.73^{cd}	56.87^{b}	6.933^{cd}	75.9^{b}	3.8^{de}	87.14^{a}
Bakaino	31.33	22.13^{bc}	42.83^{bc}	18.2^{bc}	60.0^{d}	16.73^{bc}	62.96^{b}
Asuro	26.60	20.8^{bc}	37.75^{c}	17.07^{bc}	55.81^{d}	13.07^{c}	65.58^{b}
Titepati	25.00	19.33^{bcd}	39.10^{c}	14.87^{bcd}	58.94^{d}	11.87^{bcd}	66.61^{b}
Khirro	24.73	18.2^{bcd}	42.08^{c}	13.87^{bcd}	61.2^{cd}	11.467^{cd}	68.54^{b}
Bojho	27.13	20.53^{bc}	40.71^{c}	17.67^{bc}	55.53^{d}	13.93^{c}	64.69^{b}
Tobacco	35.40	21.6^{bc}	52.03^{bc}	14.67^{bcd}	71.52^{bc}	8.27^{cde}	83.96^{a}
Marigold	38.13	28.33^{b}	40.95^{c}	24.6^{b}	55.64^{d}	22.07^{b}	61.02^{b}
Cypermethrin	23.40	7.47^{d}	75.2^{a}	3.67^{d}	89.27^{a}	1.73^{e}	95.12^{a}
Control	33.00	40.733^{a}	0^{d}	47.0^{a}	0^{e}	47.40^{a}	0^{d}
Grand mean	28.45	20.99	42.75	17.85	58.38	15.03	65.56
SEM(±)	4.18	3.70	4.32	3.67	3.15	2.53	4.16
CD	12.41	10.99	12.83	10.91	9.34	7.52	12.35
CV %	25.42	30.54	17.50	35.63	9.33	29.17	10.98
F Test	**	**	**	**	**	**	**

Means followed by same letters did not differ significantly at p<0.05 by DMRT. **indicates the highly significant difference among the treatments (where, p is <0.05). DBS: days before spray, DAS: days after spray, PROC: percentage reduction over control. CD: critical difference

Table 2. Efficacy of different plant extracts against mustard aphid on 2nd spray under field condition

Treatments	Pre-treatment	Post treatment					
	1 DBS	3 DAS	PROC	6 DAS	PROC	9 DAS	PROC
Neem	61.27	32.733^{cd}	61.92^{bc}	21.47^{c}	80.79^{b}	12.33^{cd}	89.01^{b}
Bakaino	84.93	52.33^{bc}	55.91^{bc}	34.80^{bc}	76.97^{bcd}	33.133^{b}	78.14^{cd}
Asuro	70.4	54.27^{b}	43.55^{d}	42.0^{b}	68.01^{e}	36.93^{b}	71.54^{e}
Titepati	59.27	36.27^{bcd}	56.26^{bc}	30.13^{bc}	72.25^{de}	25.8^{bc}	76.24^{cde}
Khirro	60.8	41.87^{bcd}	51.53^{cd}	29.87^{bc}	73.7^{cde}	24.13^{bc}	78.87^{c}
Bojho	48.2	33.47^{cd}	52.4^{cd}	26.13^{bc}	70.69^{de}	23.53^{bc}	73.31^{de}
Tobacco	44.27	22.2^{de}	64.5^{b}	16.^{cd}	80.31^{bc}	10.33^{cd}	87.33^{b}
Marigold	71	47.13^{bc}	52.25^{cd}	34.2^{bc}	73.09^{de}	28.13^{b}	77.97^{cd}
Cypermethrin	16.6	4.07^{e}	82.51^{a}	1.6^{d}	94.64^{a}	0.67^{d}	97.71^{a}
Control	67.27	95.07^{a}	0^{e}	123.4^{a}	0^{f}	123.4^{a}	0^{f}
Grand mean	58.4	41.94	52.09	35.96	69.04	31.84	73.01
SEM(±)	8.44	6.15	3.34	6.04	6.15	5.11	1.64
CD	25.08	18.27	9.94	17.94	6.15	15.18	4.89
CV %	25.03	25.4	11.12	29.08	5.19	27.8	3.90
F Test	**	**	**	**	**	**	**

Means followed by same letters did not differ significantly at p<0.05 by DMRT. **indicates the highly significant difference among the treatments (where, p is <0.05). DBS: days before spray, DAS: days after spray, PROC: percentage reduction over control. CD: critical difference

Table 3. Efficacy of plant extracts against mustard aphid on 3rd spray under field condition.

Treatments	Pre-treatment	Post treatment					
	1 DBS	3 DAS	PROC	6 DAS	PROC	9 DAS	PROC
Neem	32.40	18.47^{de}	52.28^{b}	10.53^{cd}	77.5^{a}	6.4^{de}	88.46^{a}
Bakaino	129.93	99.33^{ab}	36.98^{c}	72.53^{b}	62.36^{b}	64.13^{b}	72.37^{b}
Asuro	111.67	93.8^{b}	28.76^{c}	65.33^{b}	59.02^{b}	48.00^{bc}	74.66^{b}
Titepati	69.40	56.2^{bcd}	30.4^{c}	35.6^{bcd}	64.24^{b}	28.33^{cde}	75.99^{b}
Khirro	109.93	87.87^{b}	31.26^{c}	57.27^{b}	62.75^{b}	42.07^{bcd}	77.28^{b}
Bojho	85.93	68.27^{bc}	32.45^{c}	49.4^{bc}	60.06^{b}	37.53^{bcd}	74.1^{b}
Tobacco	39.60	19.53^{cde}	58.19^{b}	11.8^{cd}	78.6^{a}	7.93^{de}	88.16^{a}
Marigold	107.53	83.33^{b}	33.8^{c}	53.8^{b}	64.31^{b}	44.6^{bc}	75.55^{b}
Cypermethrin	16.07	4.27^{e}	76.48^{a}	3.27^{d}	85.56^{a}	2^{e}	93.1^{a}
Control	126.73	147.2^{a}	0^{d}	179.53^{a}	0^{c}	211.4^{a}	0^{c}
Grand mean	82.92	67.83	38.06	53.91	61.44	49.24	71.97
SEM(±)	16.75	15.02	2.91	12.01	2.75	10.77	2.63
CD	49.76	44.63	8.63	35.68	8.16	32.00	7.80
CV %	34.98	38.35	13.22	38.58	7.74	37.88	6.32
F Test	**	**	**	**	**	**	**

Means followed by same letters did not differ significantly at p<0.05 by DMRT. **indicates the highly significant difference among the treatments (where, p is <0.05). DBS: days before spray, DAS: days after spray, PROC: percentage reduction over control. CD: critical difference

Table 4. Efficacy of different plant extracts against mustard aphid under lab condition

Treatments	Mortality (%)		
	24 hrs	48 hrs	72 hrs
Neem	57^{a}	73^{ab}	88^{a}
Bakaino	23.33^{d}	54.67^{cd}	72^{b}
Asuro	32^{c}	56^{cd}	65.33^{bc}
Titepati	34^{c}	54.33^{cd}	64.33^{bc}
Khirro	25^{d}	48.33^{d}	57.67^{c}
Bojho	32^{c}	55^{cd}	65.67^{bc}
Tobacco	41^{b}	62.67^{bc}	73.67^{b}
Marigold	22^{d}	56.67^{cd}	70^{b}
Cypermethrin	62^{a}	80.67^{ab}	96^{a}
Control	7^{e}	10.33^{e}	14.67^{d}
Grand mean	33.53	55.2	66.7
SEM(±)	2.188	3.61	3.3
CD	6.499	10.73	9.81
CV %	11.3	11.3	8.6
F Test	**	**	**

Means followed by same letters did not differ significantly at p<0.05 by DMRT. CD: critical difference
****indicates the highly significant difference among the treatments (where, p is <0.05)**

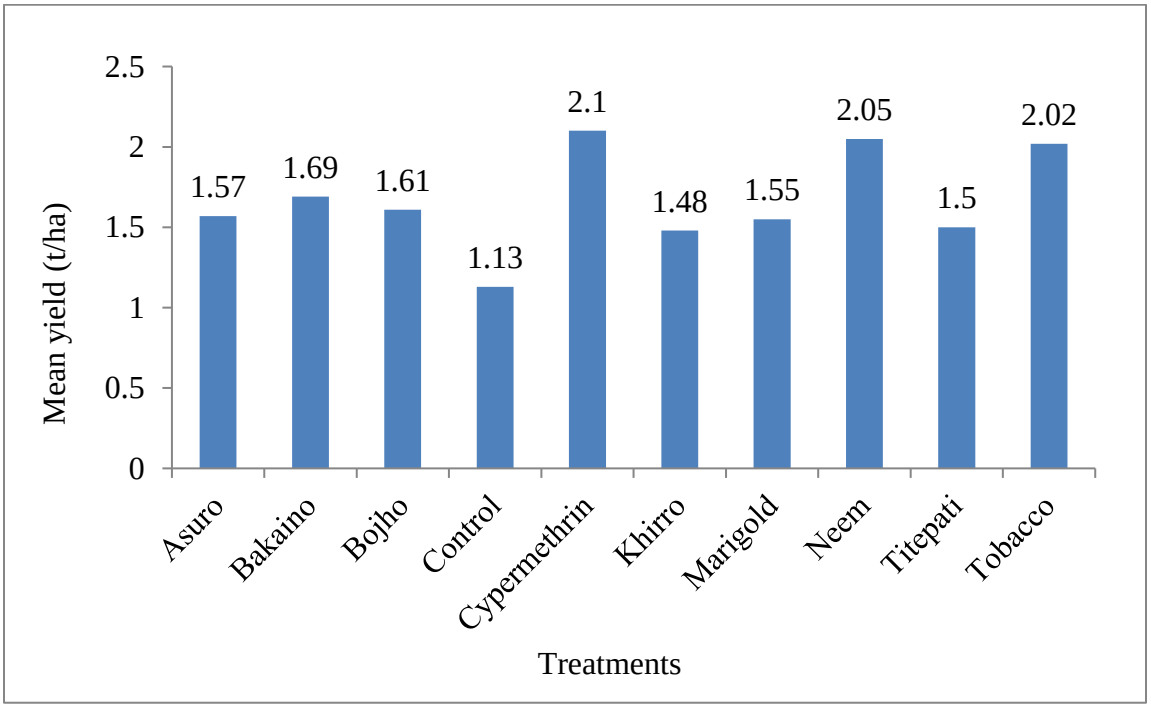

Figure 2: Effectiveness of different plant extracts on yield (t/ha) of rapeseed

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Conflict of interest

The authors have declared that no conflict of interests exists.

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الكفاءة الحيوية لمستخلصات النبات في مكافحة من الخردل (*Lipaphis erysimi* Kalt.) على اللفت (*Brassica campestris* Linn.) تحت ظروف الحقل والمختبر

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الملخص

تم اختبار كفاءة ثمانية مستخلصات نباتية من نباتات: النيم (*Azadiracta indica*)، وشجرة التوت الصيني (*Melia composite*)، وجوز مالابار (*Adhatoda vasica*)، ودود الخشب البري (*Artimesia vulgaris*)، وشجرة الحليب (*Sapium insigne*)، والعلم الحلو (*Acorus calamus*)، والتبغ (*Nicotinia tabacum*)، وماري غولد (*Tagetes erecta*) لمكافحة من الخردل (*Lipaphis erysimi* Kalt.) على صنف اللفت Lumle tori-1 خلال الموسم الربيعي 2019/2018 في ظروف الزراعة الحقلية وفي مختبر معهد علوم الزراعة والحيوان (IAAS)، مخيم لامجونج، لامجونغ، نيبال. تضمن البحث ثمانية مستخلصات نباتية ومبيد cypermethrin 10% EC (@1.5 mL/L) والمعاملة بالماء (معاملة الشاهد). تم تعريض المن للمعاملات المختبرة وتم عد المن الميت والمن المتبقي على قيد الحياة، وقد أظهرت المستخلصات النباتية تأثيراً عالي المعنوية في قتل المن في الحقل والمختبر. في المختبر أظهر مبيد السايبرمثرين أعلى كفاءة في قتل المن بنسبة (96%)، تلاه مستخلص نبات النيم بنسبة قتل بلغت (88%)، في حين كانت أقل نسبة قتل للمن في معاملة الشاهد (14.67%). وفي ظروف الحقل حقق المبيد سايبرمثرين أعلى كفاءة في التقليل من حشرة المن، تلاه مستخلص نبات النيم، ثم مستخلص أوراق نبات التبغ، وحققت معاملة الشاهد أقل نسبة في التقليل من حشرة المن. وصلت أعلى غلة حبية للفت (2104.44 كغ/هكتار) في القطع التجريبية التي عوملت بمبيد السايبرمثرين، ومستخلص التبغ (2020.22 كغ/هكتار)، وبالمقابل بلغت الغلة الحبية في معاملة الشاهد (1133.67 كغ/هكتار). أظهرت كافة مستخلصات الأوراق النباتية كفاءة في التقليل من حشرة المن، ويعتبر نبات النيم والتبغ هما الأكفأ في أن يكونا بديلاً عن المكافحة الكيميائية لحشرة المن.

الكلمات المفتاحية: السيبرمثرين، من الخردل، المستخلصات النباتية، اللفت.