REPORT 1: <u>Garden symphylan</u>
Project Title

Management Approaches for Thrips and Garden Symphylans in Lettuce

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Abstract

The garden symphylan (*Scutigerella immaculate*) is a serious soil pest whose root feeding affects yield and survival of several high valued crops in the California's central coast. Laboratory bioassays were conducted to determine insecticide efficacy through repellency and lethality. To determine indirect repellency (non-contact) of insecticides, choice assays were conducted where five garden symphylans were introduced into the arena to choose between insecticide-treated and untreated wells whereas, in direct repellency (contact) assays, three insecticide-treated 1-cm diameter discs were pasted into the arena and the number of visits, time spent per visitation and number of long-duration (> 10 s) stays of five garden symphylans were quantified. To determine efficacy through direct mortality, number of garden symphylan died after 72 h were determined by introducing 10 garden symphylans to insecticide-treated soil assays. In indirect exposure bioassays, seven (Belay, Vydate, Mustang, Lorsban, Mocap, Aza-Direct and Leverage out of 14 insecticides tested elicited repellency to garden symphylan. Of six insecticides tested in the direct exposure assays, only Torac elicited contact repellency. In soil assays, after 72 h of introduction, Capture, Vydate, Belay, Mustang and Torac caused 100, 95, 80, 44, and 44 % garden symphylan mortality, respectively, which was significantly greater than distilled water and four other insecticides. The insecticide trial did not yield any conclusive information.

Objective

Understand the efficacy of insecticide chemistries to symphylans through:

I. Repellency A). Indirect contact exposure, and B) Direct contact exposure
II. Lethality
III. Field insecticide efficacy trial

Procedures

The data from thrips projects were presented in the 2014 annual report.

I (A). Indirect exposure bioassay. The bioassay arenas were constructed using clear, non-venting Petri dishes as shown in the Fig. 1. Two vials were glued to the Petri dishes. The holes on the cap and Petri dish allow the symphylans to move to the well. A barrier was created between the Petri dish and the inner bottom surface of the dish was uniformly roughened using sandpaper to facilitate garden symphylan movement. Dried soil was added into the vials, and then 1-mL of insecticide solution or distilled water was added into the vial. In the first set of experiments, soil in both the vial was treated only with distilled water. In the later experiments, one vial was treated only with distilled water and other with insecticide solution. Fourteen insecticides were tested for indirect exposure, and the details of active ingredients, and the rates used are listed in Table 1 (indicated by symbol*).

Once the soil was added into the wells, five symphylan were added to the center of the Petri dish. The Petri dish was then covered with the lid and the edges were sealed using Parafilm to reduce desiccation of symphylan. After 6 hours, those five symphylan were located and their locations inside the arena were documented. For each insecticide treatment, bioassays were replicated 18 times and a total of 90 symphylans were used for each insecticide product.

I (B). Direct exposure bioassay. A clear, non-venting polystyrene Petri dish was used for the direct exposure bioassay. White filter paper was dipped for 2 seconds in distilled water and placed on the bottom of the dish. For this bioassay, 1-cm diameter filter paper discs were made from 4.7-cm black qualitative filter paper. These black discs were dipped into 45-mL insecticide solution in a container for 5 seconds then air dried for 20 minutes. Three insecticide-treated discs were pasted on to the wet white filter paper using a washable glue stick. Black colored filter paper was selected for the discs because they would be in contrast to white or off-white symphylans and help with evaluation.

Five symphylans were introduced to the center of the Petri dish using a soft paint brush. The movement of five symphylans was videotaped for 20-min. Nine insecticides were tested using this bioassay (Table 1, indicated by symbol†) and every insecticide treatment was videotaped and replicated 6 times per insecticide product. The videos were evaluated for number of times symphylans visited the black discs, time spent per visit on the black discs, and number of times symphylans spent > 10 seconds on the black discs. Stop watch and clickers were used to quantify those parameters. Insecticides belonging to class pyrethroids were not tested in this bioassay because they are more likely to trigger hyperactivity after exposure.

II. Soil bioassay. Nine insecticides were tested to determine efficacy against symphylans. The details of active ingredients and tested rate are listed in Table 1 (indicated by symbol‡). The soil bioassays were performed using 100-mL cups with soil. Twenty five grams of oven-dried soil was added to the cup and 7-mL of insecticide solution or distilled water per cup was uniformly pipetted on to the surface of the soil within the cup. After adding the insecticide solution or distilled water, the soil was stirred five times using a glass rod to facilitate movement of symphylans within the gaps in soil. Ten symphylans were introduced into each cup and the cups were covered with perforated caps to allow air flow. Each insecticide treatment was replicated at least 15 times (cups) for a total of 150 symphylans per insecticide product. Seventy two hour after introduction, the bioassays were evaluated for mortality.

III. Insecticide efficacy trial. This study was conducted on a lettuce field in Salinas that was reported with garden symphylan incidence and plant damage. All the treatments were assigned to previously identified hot spot within the field. The lettuce seeds were planted on 12 March 2014. Four replicates of each treatment were assigned to a 10-feet long 40”beds (two seed lines/bed) according to a completely randomized block design. The insecticides used and theirs rates were Radiant (spinetoram) at 10 fl oz/acre, Entrust (spinosad) at 10 fl oz/acre, Belay (clothianidin) at 12 fl oz/acre, Warrior II (lamda-cyhalothrin) at 1.6 fl oz/acre, and Mustang (zeta-cypermethrin) at 4 fl oz/acre. All insecticides were applied along the seed line (3-inch band) on 13 March. Spray application was done using one-nozzle sprayer at 30 PSI. The water volume used all applications was 100 gal/acre. No adjuvant was added.

The potato slice was used as bait to monitor garden symphylans in the trial. One potato slice was deployed per plot and was retained for 2 days in the field. The monitoring was initiated on 22 March (weeks after planting) and was repeated on (weeks after planting). Ten plant samples were randomly collected from each plot on 3 April (4 weeks after planting) to determine plant growth. The fresh and dry weights of these plants were measured.

Results

I (A). Indirect exposure bioassay. Of the 1,338 symphylans used for this experiment, 90.5% entered either of the vials in 6-hours. Similar number of garden symphylans were collected from both the vials suggesting that there were no particular preference. More number of symphylans was found in the well with distilled water when the other well was treated with Belay, Lorsban, Mocap, Mustang, Vydate, Aza-Direct and Leverage. On the other hand, more symphylans were found in the well with Verimark than in the well with distilled water. When the products, Radiant, Warrior, Torac, Capture, Ecotek, and Tritek were treated to a vial, the number of symphylans settled in similar number is both the vials.

I (B). Direct exposure bioassay. When symphylans were in direct contact with insecticide-treated surface, symphylans exhibited lesser number of visits and time spent on the discs treated with Torac than distilled water. However, these numbers on the discs treated with Torac were not different from those on discs with Belay, Vydate, and Ecotek. Similarly, number of times symphylans spent > 10 seconds on distilled water discs was higher than that on Torac-treated discs.

II. Soil bioassay. Soil treated with insecticides Vydate, Capture, Torac, Belay and Mustang caused greater symphylan mortality than distilled water treated soil (Fig. 2). Mortality of symphylans was 100% and was greater with Torac-treated soil than with all other insecticide treatments expect Capture. More symphylans died with Vydate than with Belay and Mustang treated soil.

III. Insecticide efficacy trial. The number of garden symphylans, fresh and dry weight of lettuce was not statistically different among various treatments. The number of garden symphylans captured in potato-slice bait was numerically lower in Radiant, Belay, Warrior II and Mustang than in the untreated check (UTC) (Fig. 5). The numerically lowest numbers of garden symphylans were captured from Mustang than UTC or other treatments. The fresh and dry weight of lettuce was numerically greater in the Mustang treatment than UTC (Figs. 6 and 7).

Conclusion

This study established relative efficacy of insecticides against symphylans by determining relative repellency, and lethality of insecticides through laboratory bioassays. The data suggest that certain insecticides, but not all, are repellent to symphylans before contact. Only tolfenpyrad elicited repellency after contact. Reduced risk insecticides included in the assays were neither repellent nor lethal to foraging symphylans. More number of symphylans died when insecticides, Vydate, Capture, Torac, Belay and Mustang were applied to soil relative to water treated-soil. The future studies will evaluate the efficacy of insecticides when delivered using various methods encompassing the properties of insecticide and soil, and the behavior and ecology of symphylans in vegetable production.

Table 1. Insecticides evaluated against symphylans in laboratory bioassays.

Class	Insecticide	Formulation	Rate per acre
Neonicotinoids	Clothianidin*†‡	Belay	12 fl oz
Pyrethroids	Bifenthrin*†‡	Capture	6.8 fl oz
	Zeta-cypermethrin*‡	Mustang	4.2 fl oz
	Lambda-cyhalothrin*‡	Warrior II	1.9 fl oz
Neonicotinoids + Pyrethroids	Imidacloprid + Beta-cyfluthrin*	Leverage	6 fl oz
Organophosphates	Ethoprop*†‡	Mocap	34 lb
	Chlorpyrifos*	Lorsban	2.3 pint
Carbamates	Oxamyl*†‡ [c]	Vydate	32 fl oz
Spinosyn	Spinetoram*†‡	Radiant	
Ryanodine receptor activator	Cyantraniliprole*†‡	Verimark	13.5 fl oz
Pyridazinone	Tolfenpyrad*†‡	Torac	21 fl oz
Tetranortriterpenoids	Azadirachtin*†‡ [e]	Aza-Direct	32 fl oz
	Essential oils * [e, f]	Ecotek	28 oz
	Mineral oil * [e]	Tritek	1.5 gal

Insecticides included in indirect exposure experiment (*), direct exposure experiment (†), and mortality experiment (‡). Dose determined based on 40 gal per acre.

Table 2. Garden symphylan response to direct exposure of insecticides.

Insecticide	Symphylan on treated black discs		
	No. of visits	Time spent (s)	> 10-s spent
Belay	67.8 ± 9.1ab	7.8 ± 1.3ab	5.7 ± 1.5abc
Radiant	118.2 ± 26.5a	7.4 ± 1.5ab	3.3 ± 0.8bc
Verimark	126.2 ± 32.9a	7.1 ± 1.4ab	4.1 ± 2.5bc
Vydate	100.3 ± 19.5ab	8.3 ± 0.8a	7.2 ± 1.2ab
Ecotek	80.5 ± 20.0ab	7.3 ± 1.8ab	6.2 ± 1.6ab
Torac	49.7 ± 13.3b	3.1 ± 0.9b	0.9 ± 0.4b
Distilled water	104.1 ± 8.1a	10.1 ± 1.8a	12.4 ± 1.4a

Same letters within each column are not different.

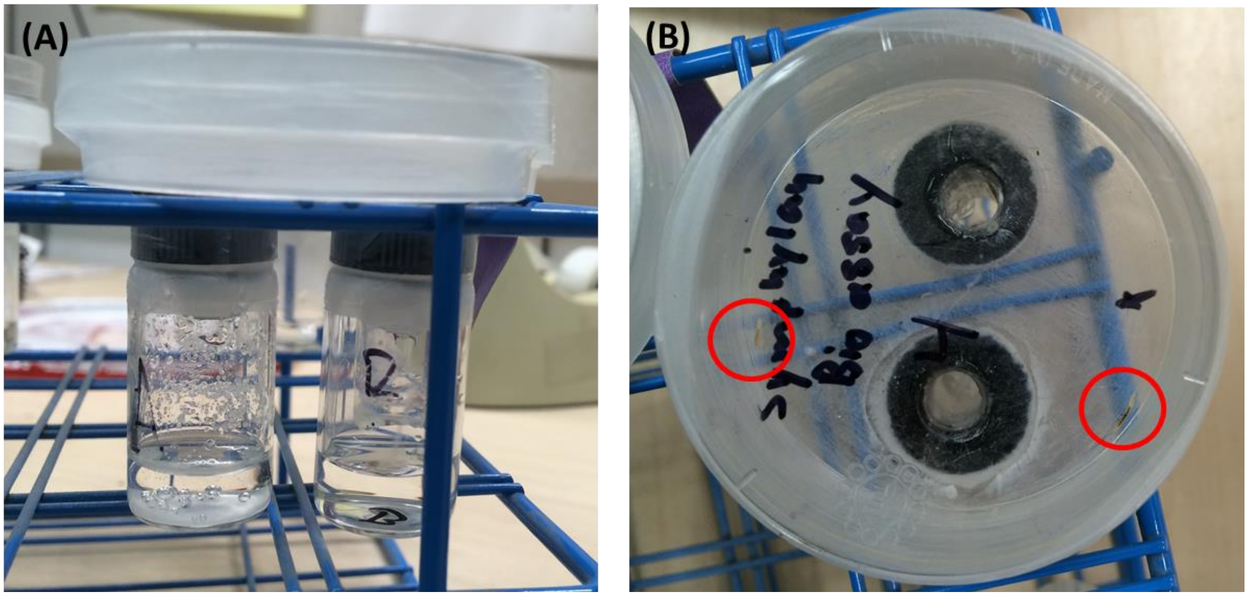

Fig. 1. Indirect choice bioassay to determine the effect of insecticides on garden symphylans when on vial was provided with distilled water and other with various insecticides or distilled water.

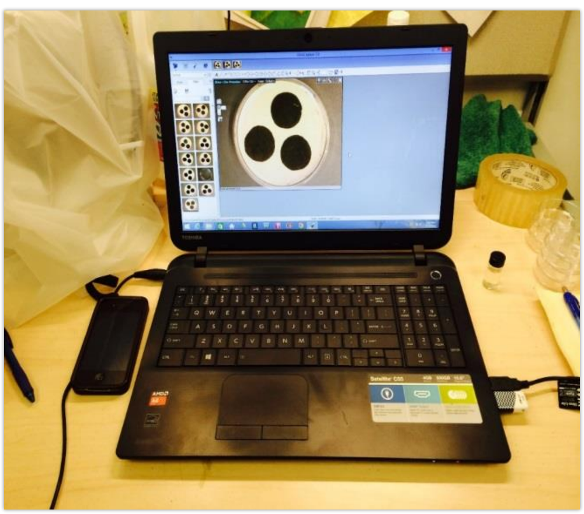

Fig. 2. Direct choice bioassay to determine the effect of insecticides on garden symphylans when the discs were treated with distilled water or various insecticides.

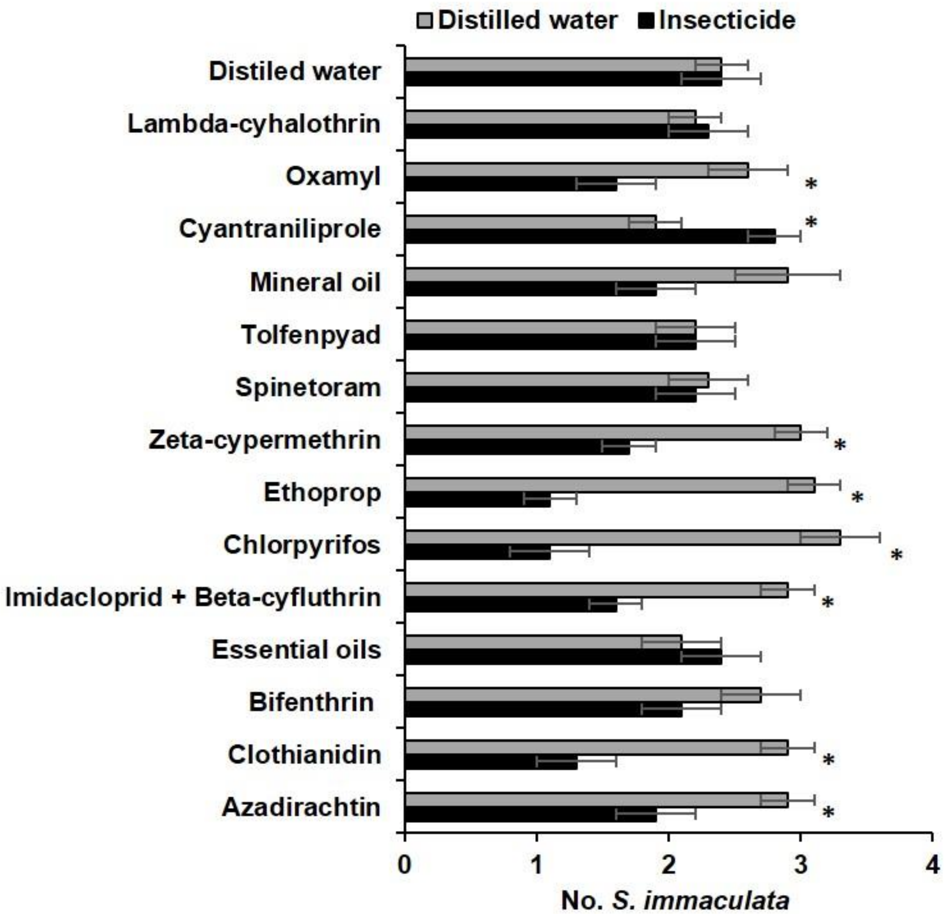

Fig. 3. Number of garden symphylans distributed in indirect exposure choice bioassay arenas with insecticide or distilled water in one well and distilled water in the other well. Pairs of bars with asterisks (*) are different.

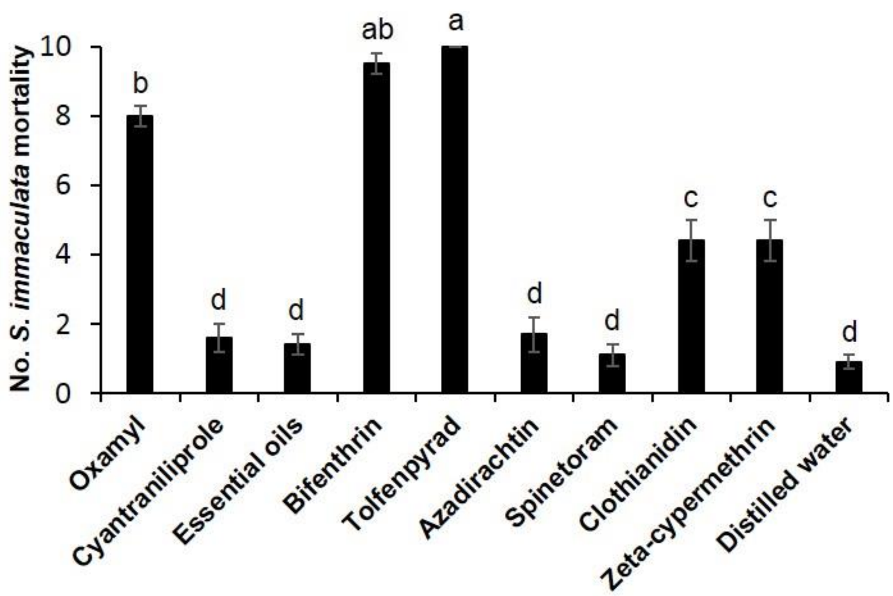

Fig. 4. Garden symphylan died when exposed to insecticides in the soil bioassay for 72 h. Bars with same letters are not different.

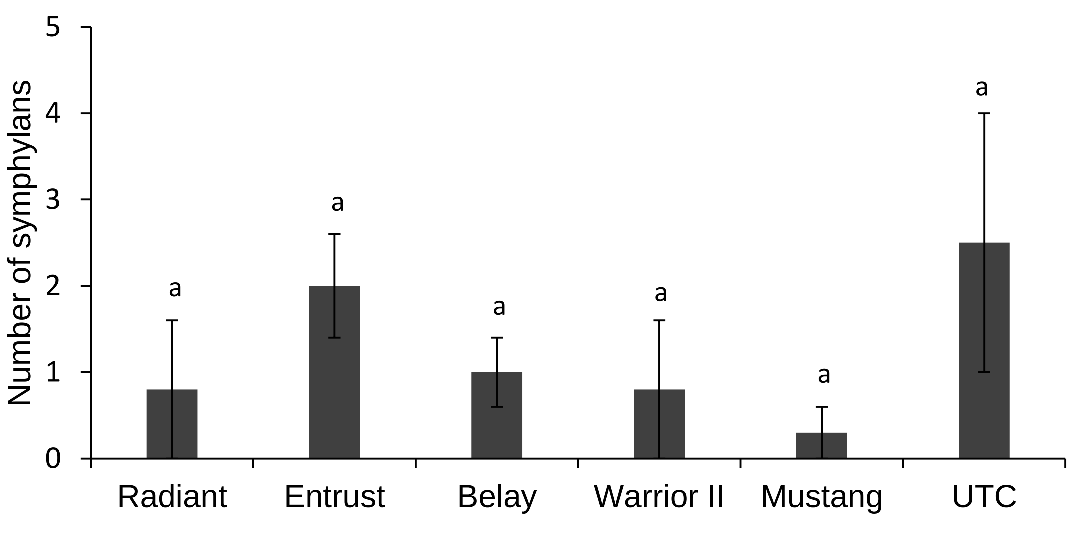

Fig. 5. Number of garden symphylan captured using potato-slice bait.

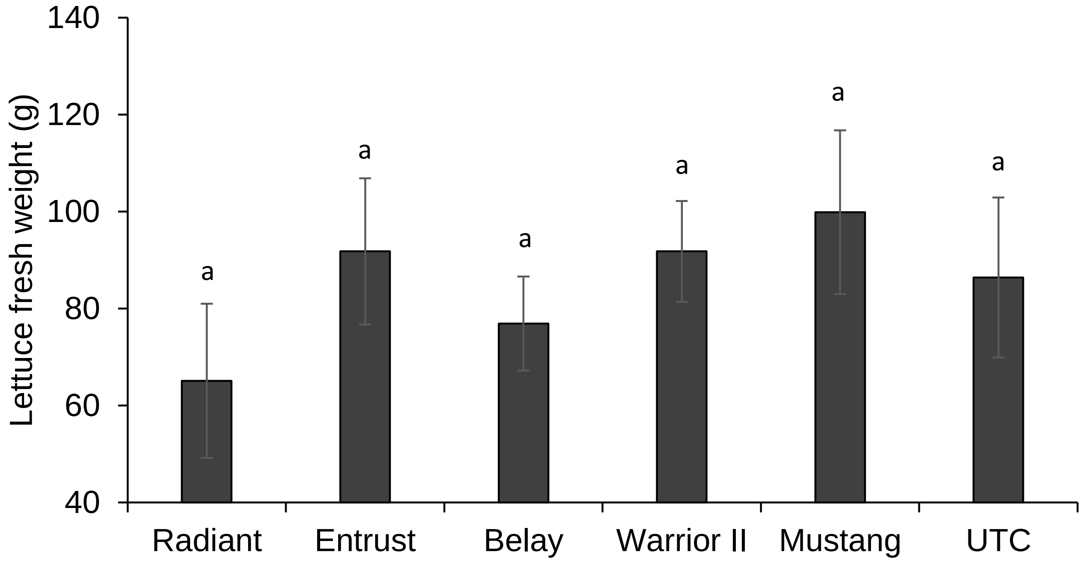

Fig.6. Fresh weight of lettuce sampled from various treatments.

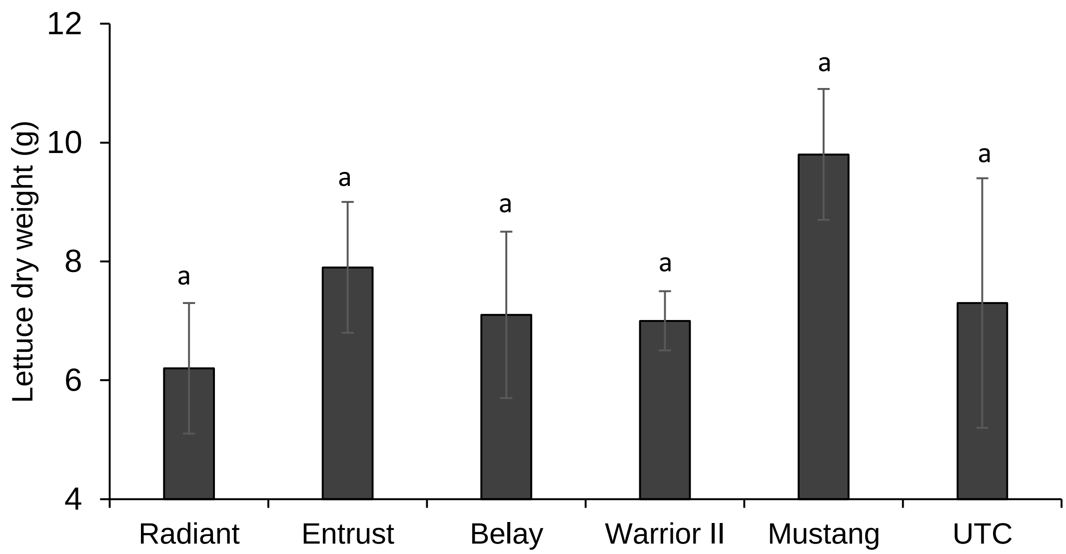

Fig.7. Dry weight of lettuce sampled from various treatments.