Enhanced and sustainable management approach for the control of swallow-wort in Israel's desert agriculture

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Summary

Swallow-wort (*Cynanchum acutum* L.) is a perennial vine that is mainly associated with wet habitats in Israel, and in the last years, its range has expanded to the date orchards of the Arava valley. Swallow-wort climbing vines can fully cover the date palm and the fruit bunches and hence inhibit their development, reduce yield production, and cause significant economic losses. In this project we investigate the phenology of the vine, the impact of pollination on seed production and rhizome development, and which control methods result in the least vine development. Our main objective is to develop enhanced control methods for swallow-wort based on the knowledge gained, that will be suitable for conventional and organic date orchards. Control options will include combined chemical

and physical methods that are based on a deeper understanding of the weed's biology, pollination and propagation, and the interconnected human impact (social-ecological approach). New control protocols and a better understanding of the swallow-wort biology and propagation will help to achieve enhanced and sustainable control in agricultural sites.

Background, problem description, and objectives

The economy of the Southern Arava heavily relies on date fruit production. Swallow-wort, or Cynanchum acutum L., is a perennial twining vine weed that grows in wet places, mostly in northern Israel (Fig. 1A).

Recently, its range has expanded to the Arava region as a major pest in the date orchards. It has a lot of seeds and rhizomes that can grow into new plants. It can grow to be more than 3 meters tall and has a lot of branches and woody stems (Shu, 1995; Schackermann personal observations). The vigorous climbing vines can fully cover the palms and the fruit bunches (Fig. 1 F,G), inhibit development, and reduce yield production, causing significant economic losses (Schackermann personal communication).

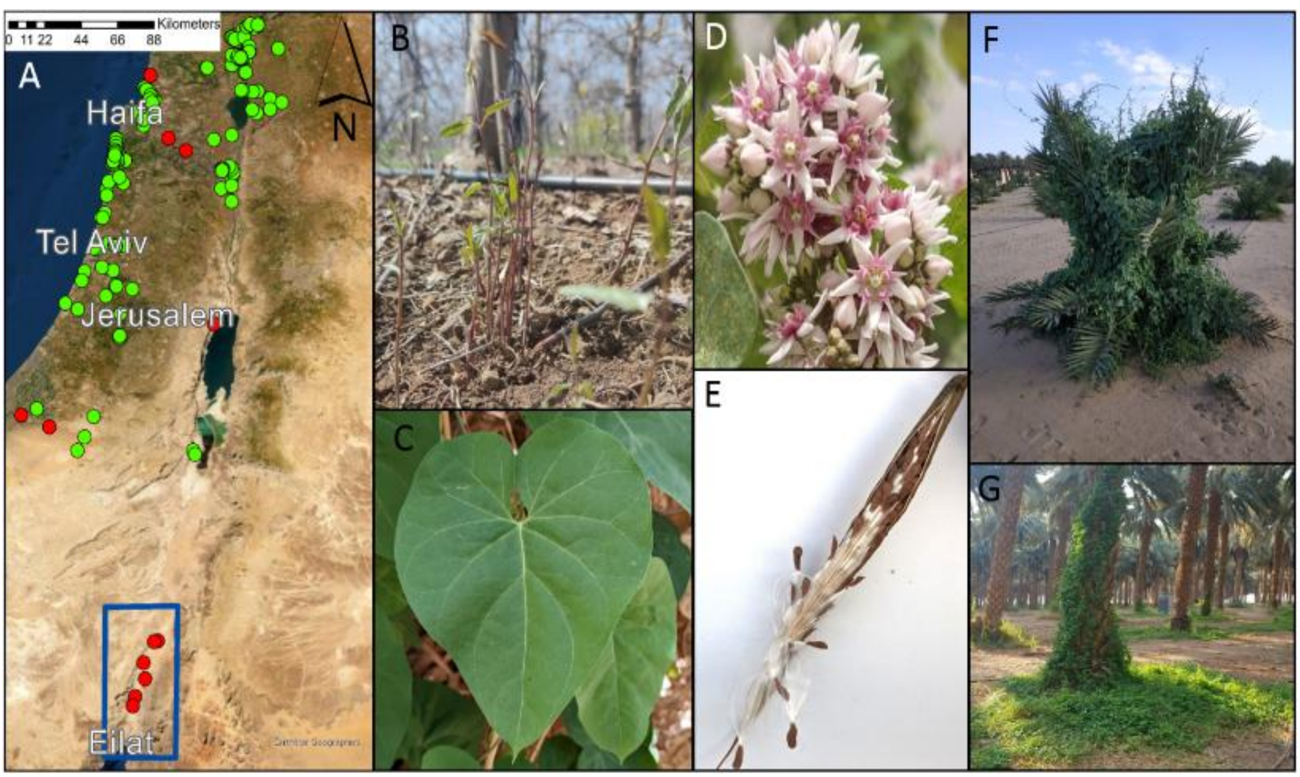

Figure 1. C. acutum distribution in Israel according to GBIF organization (GBIF.org (26 May 2022) GBIF Occurrence Download https://doi.org/10.15468/dl.n6rrq2) (green points) and information collected during the current study (red points). The blue frame is the experimental region in the southern Arava (A). C. acutum shoots sprouting from underground rhizomes (B), leaves (C) inflorescence (D), and seedpod (E). C. acutum infestation in a young (F) and mature orchard (G) in the southern Arava

The common control practice in date orchards includes the application of post-emergence herbicides (e.g., glyphosate, glufosinate, or fluroxypyr), sometimes followed by hand weeding or mowing (Schackermann personal communication), and is done in seasons when the manpower is available and hence not necessarily when the weed is most vulnerable. Farmers report poor swallow-wort control using herbicides; several weeks after treatment the weed recovers and additional treatments are required. Hand weeding may be used to control the plant; however, it is tedious, expensive, and must be repeated throughout the growing season (Lawlor, 2000). As this weed keeps expanding into new regional areas, costs and damages are predicted to increase.

The objective of the project is a. to understand the underlying ecological, biological, management, economic and social factors that shape the distribution and spread of the swallow-wort in the southern Arava b. based on the outcomes of a. create holistic control protocols using integrated weed management combining chemical and physical control methods, also considering management, social and economic limitations of the farmers and c. give farmers a sustainable and highly efficient solution to controlling the swallow-wort and limiting its spread.

To reach this objective we use the following three focal goals, guided by the underlying research questions:

1. Study the distribution and spread of swallow-wart, and explore possible underlying mechanisms:

a. What are the spatial patterns and inter-annual rates of swallow-wart spread within and between date plantations in the southern Arava?

b. What are the possible factors (management approaches and social/economic factors) shaping these patterns?

2. Study the pollination of swallow-wart and its impact on warts biology:

a. Which insects visit the flowers of swallow-wort along its blooming period?

b. What is the effect of biotic pollination on swallow-wart fruit/seed set, germination rate, and rhizome development?

3. Study Swallow-wart eradication/management approaches and create new/enhanced protocols:

a. What are the most effective physical and chemical control methods and approaches?

b. What are the ideal combinations of these approaches for conventional and organic plantations considering also human impacts and the biology of the weed?

Table 1 Implementation status of the research, methods used (plan vs execution)

	Task	Implementation status and changes	Task detail as proposed
YEAR 2 (2024)			
1	**Vine distribution data collection in the 6 plantations from the previous study.**	Fully implemented The project team did a 3-day survey in the mentioned 6 plantations in May 2024. Data has been integrated into the bigger data set.	To make a long-term data set for spatial analyses of swallow-wort distribution over 5 years, we will add data from 6 plantations that we monitored in our last project to the data set we already have from the first 3 years.

		Data analysis is in progress.	Each of the six previously surveyed orchards will be visited during the same month. From our previous research, we have identified that May is the best month for distribution surveys as swallow-wort is present at all orchards. For the young orchards, we will assess ground and tree coverage for each tree. For the mature orchards, we will assess ground coverage and the number of climbing shoots for each tree. We will generate maps (using ArcGIS) with swallow-wort locations and densities.
2	**Data collection about pollinators of the vine in 6 plantations of the same variety, similar age, size, and with high wort infestation.**	Fully Implemented We conducted a standardized survey of visitation frequency on three date plantations (study sites), and in each study site, we used three plots and two sample sites per plot. In each sampling site, we observed two swallow-wort blooms of the same size and ~6 flowers per bloom. Using three complementary methods, we visited two sites twice and one site thrice during the swallow-wort's blooming period.	We will conduct standardized surveys of swallow wort's flower visitors twice along its blooming period, using a) ***Visitation observations*** to record the identity and visitation frequency (#visits/flower/unit time) of dominant flower visitors and b) ***Water traps*** (pan-traps—colored plastic bowls filled with soapy water attracting flying insects; commonly used in pollinator surveys) to collect the visiting insects and allow their taxonomic identification. (c) ***Netting*** will be done to capture flying insect visitors and late taken for taxonomic identification. Observations and netting will be conducted once on

		(i) We conducted visitation observations to record the identity and visitation frequency (#visits/flower/unit time) of dominant flower visitors. (ii) We placed pan traps along two points in each sampling plot in the morning at approximately 7:00 and left them there for a period of 7 hours. (iii) Netting was done once per sampling day between 8:00 and 12:00 when flying insects were observed. Weather condition measurements, including temperature (°C), relative humidity (%), solar radiation (Lux), wind velocity (m/s), cloud cover (%), and sky condition (clear/hazy) were made in the morning just before the netting and observation rounds started in each experimental plot. We transferred the collected specimens to the laboratory, curated them, and sent them to expert taxonomists for further species-level identification (to the extent possible).	sampling day between morning and midday to allow sampling of visitors of varied activity patterns. The specific duration of each sampling session will be determined based on preliminary work at the beginning of the study. Pan traps will be placed at 7:00 near each other on the ground on top of the vine between flowers and left for ~7 hours. 24 traps (per plot and 3 plots per site) will be located on each plantation. Weather conditions (temperature, humidity, solar radiation, and wind velocity) will be recorded before each netting session. Collected specimens will be sorted and curated in the lab and sent to expert taxonomists with whom Mandelik has ongoing collaboration for further species-level identification (to the extent possible). These surveys will provide information on both the diversity of insect visitors of the wort and on dominant visitors, possibly providing pollination services.

3	**Field trial of chemical and physical control approaches in two young orchards**	Fully implemented Trials were carried out in May-June 2024. Herbicides were applied in May, and monitoring continued for the following weeks. The data has been integrated into the bigger data set and initial analyses have been carried out. For the first results see the results section. We couldn't conduct pre-emergence herbicide application as we didn't find any suitable orchard. Hence we added three more treatments to the post-emergence trial. Also, the post-emergence treatment of glyphosate 2% (Roundup®, Bayer) + glufosinate 1% (Basta®, BASF), has been changed based on previous results, to glyphosate 2% + saflufenacil 0.1% (Hit®, BASF) + surfactant (Shatah 90®, ADAMA-Makhteshim, 0.05%).	Experiments will be conducted in two young orchards exhibiting high swallow-wort infestation in the Arava region. Pre- and post-emergence herbicide treatments will be held using a backpack sprayer with a moving nozzle delivering 20L per dunam at 300kPa. The following herbicides will be used in the experiment: For pre-emergence, indaziflam (Alion®, Bayer) at a rate of 15 grams per dunam. For post-emergence glyphosate 2% (Roundup®, Bayer) + glufosinate 1% (Basta®, BASF). We will choose trees that have a high infestation of swallow-wort. Treatments will include: (1) untreated control - leaving swallow-wort ground and tree cover for the duration of the experiment (2) mechanical removal - tree and ground cover (3) pre-emergence herbicide treatment alone, (4) post-emergence herbicide treatment alone, and (5) pre + post combination. Experiments will be conducted in a fully randomized design. A single tree will be considered as a replicate. Based on previous studies, treatment efficacy will be estimated 28, 38 days after herbicide application by estimating the percentage of damage of swallow-wort at each

			replicate, and the level of infestation for tree and ground cover on a scale of 0-100. Forty-three days after the first treatment, we will apply the second round of mechanical cutting and post-emergence herbicide application in treatments 3 and 4. Treatment efficacy will be evaluated as described above. Data will be subjected to statistical analysis to determine the efficiency of different treatments.

4	**Experiments about rhizome development dependent on pollination efficiency and seed pot development**	Fully implemented We filled fifty 10-liter black plastic pots with commercial potting mixture (Tuff, Marom Golan, Israel) enriched with slow-release fertilizer (Osmocote®). We transferred the pots into a prepared net house and watered them. We planted pieces of the 5 cm rhizomes, one piece per pot, in the planting pots at a depth of 1 cm. To assess the pollination requirements of the swallow-wort, we carried out the following tests to assess the maximal fruit and seed set. **Selfing assessment - We** used 8 plants. We covered all the pre-anthesis flowers with fine organza bags until they wilted. After that, the fruit and seed sets were observed and recorded. **Hand pollination assessment -** We picked **f**lower inflorescences from different plants from the net house and keenly observed them under a microscope (Zeizz, Stemi 2000–C 459306) to locate the exact position of the reproductive system and the exact position of the pollinia. We then extracted pollinia from each of the	We will prepare pots containing one 5 cm rhizome that will be sown into 10L plastic pots filled with commercial potting mixture (Tuff, Marom Golan, Israel) enriched with slow-release fertilizer (Osmocote®). We will conduct the following pollination experiments: a) To assess the pollination requirements of swallow-wort we will cover pre-anthesis flowers with fine muslin nets for the duration of the bloom, till they wilt. We will then record the fruit and seed set. b) To assess the maximal fruit and seed set potential, selfing, and pollination limitation, we will hand-pollinate flowers using a fine brush to apply collected pollen on the stigma. We will use pollen collected either from the same plant (testing self) or from a different plant. We will then cover the pollinated flowers till they wilt and monitor fruit and seed set. For each of the experiments, we will use 8 potted plants, 4> flowers per plant. The experiments will be conducted in

		picked flowers using forceps. The extracted pollinia were applied to the stigma of the assigned flowers in the net house, covered with fine organza bags, and observed till the flowers wilted. We used five vines, four inflorescences per flower, and six flowers per inflorescence. We covered the hand-pollinated flowers in fine organza bags until they wilted. We monitored and recorded the fruit and seed sets. **Insect pollination assessment -** Assessing insect pollination services, 8 Potted plants were placed outside the net house on a yellow background sheet. We left the plants out for 7 days, irrigating them as needed. We observed insect visits daily for the 7 days we placed the plants outside, at various intervals and for specific durations. Under keen observations, dominant flower visitors' identity and visitation frequency (#visits/flower/unit time) were recorded. We covered five observed inflorescences with insect visits in fine organza bags. We returned the plants to the net house to monitor the fruit and seed set.	greenhouses under controlled conditions. c) To assess pollination services delivered under field conditions, we will place 8 potted plants outside the net house in an open space on a yellow background sheet for 7 days and irrigate as needed. Insect visit observations will be made daily for the 7 days the place will be outside, and dominant flower visitors' identity and visit frequency (#visits/flower/unit time) will be recorded. Five observed inflorescents with insect visits will be covered in fine organza bags. the plants were then transferred back to the net house for fruit and seed set monitoring. After recording the fruit and seed set for all plants, four plants from each experimental group will be dissected into root and shoot. Plant roots will be washed thoroughly from the soil. Both shoot and root will be oven-dried and weighed.

		We dissected four plants from each experimental treatment into root and shoot. We thoroughly washed the plant roots from the soil. We oven-dried and weighed both the shoot and the root. We analyzed the final datasets and made comparisons among different treatments.	
5	**Data analyses**	We evaluated swallow-wort's spatial-temporal distribution using developed heatmaps (using ArcGIS) with swallow-worts' locations and densities. We used data visualization and statistical testing to conduct the temporal analysis. We then used a generalized linear model (GLM) and a binomial logit link function to assess swallow-worts's changes over time. We analyzed pollinator and pollination data using GLMMs to see if there was a	We will conduct all statistical analyses using RStudio. Evaluating swallow-wort spatial-temporal distribution, we will generate maps (using ArcGIS) with swallow-wort locations and densities. We will evaluate the "border" impact on swallow-wort distribution and characterize its pattern (e.g., sporadic or clustered) and potential spatial correlations between patches. We will determine the temporal impact on swallow-wort patch size and evaluate changes through the years.

		link between pollinators, fruit sets, and rhizome growth. Chemical control trials were analyzed using RStudio (R Core Team, 2020).	Pollinator and pollination data will be analyzed using GLMM's to investigate the correlation between pollinators, seed pods, and rhizome development. We will also analyze the general attractiveness of swallow-wort for observed pollinators. Chemical and physical control trials will be analyzed using the JMP PRO (ver. 16) statistical package (SAS Institute Inc., Cary, NC, USA) and R (R Core Team, 2020).
6	**Meetings with farmers**	Farmers were informed about the project at conferences, field meetings, and phone calls. In addition, a flyer was produced and circulated via email, online, and in WhatsApp groups (Appendix 1)	We will hold individual and group meetings with farmers on open days, farming conferences, and other events to update them on the project's progress.

Interim results

Task 1 wort distribution in 6 orchards of the region:

The spatial distribution of *C. acutum* in date orchards in the southern Arava

We developed five GIS-based spatial analysis maps (heatmaps) for each plantation for the data collected over the 5 years of the survey from 2020 to 2024 with a color-coded value scale representing the different swallow-wort infestation percentages. Each heatmap corresponds to a specific farm and year, and the scale on the map indicated the following categories: The dark red color indicated areas without (0) swallow-wort infestation. Red-colored areas indicated swallow-wort coverage of 1-2.5%, orange-colored areas indicated 2.5-5% infestation, yellow-colored areas indicated 5-7.5% swallow-wort coverage, light green color indicated 10-13.5% swallow-wort coverage, while dark green-colored areas indicated 13.5-100% swallow-wort coverage.

Yahel Kibbutz

In Yahel Kibbutz plantations, the swallow-wort coverage percentage increased steadily from 2020 to 2023 and dropped slightly in 2024. In 2020 the swallow-wort infestation percentage cover was 37%, in 2021 it was 62%, in 2022 it increased to 80%, in 2023 it was 84%, and in 2024 it reduced to 78% (fig.2).

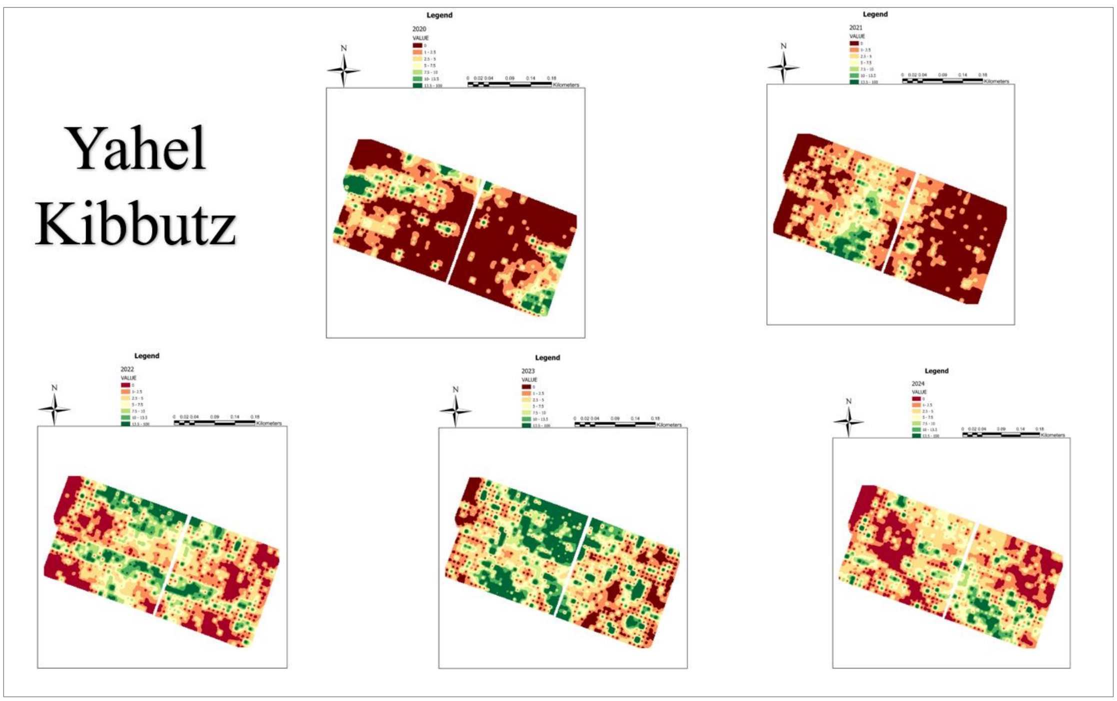

Figure 2: Heatmaps showing swallow-wort distribution in Yahel Kibbutz date orchards in the southern Arava from 2020-2024

Yahel North

In Yahel North, the swallow-wort cover percentage increased steadily from 2020 to 2024. In 2020 the swallow-wort infestation percentage cover was 2%, in 2021 it was

14%, in 2022 it increased to 29%, in 2023 it was 38%, and in 2024 it reached 40% (fig.3).

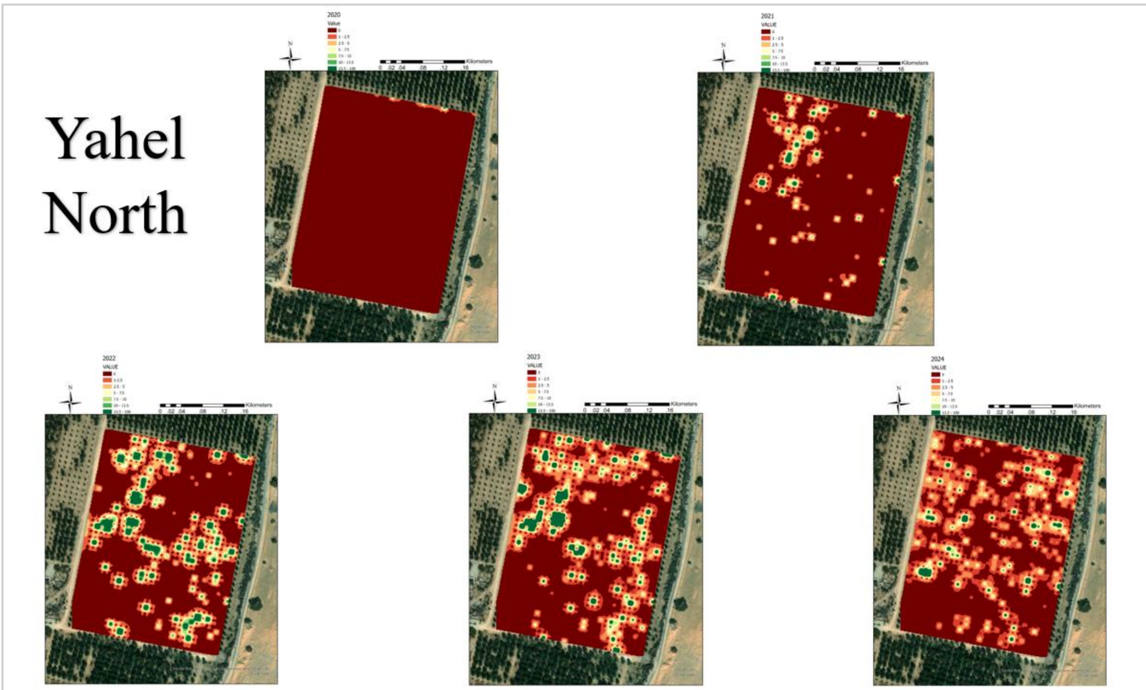

Figure 3: Heatmaps showing swallow-wort distribution in Yahel North date orchards in the southern Arava from 2020-2024.

Yahel Ramon

In Yahel Ramon, the swallow-wort cover percentage increased steadily from 2020 to 2024. In 2020, the swallow-wort infestation percentage cover was 45%; in 2021, it was 58%; in 2022, it increased to 74%; in 2023, it was 95%; and in 2024, it reached 98% (fig.4).

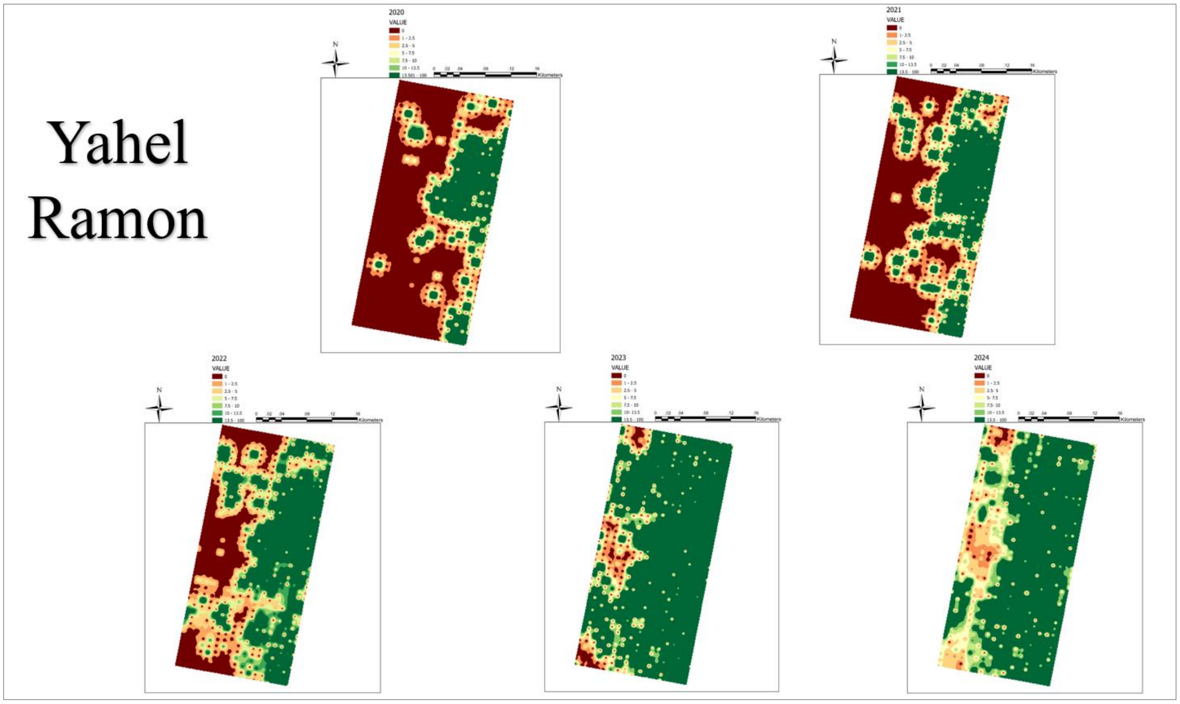

Figure 4: Heatmaps showing swallow-wort distribution in Yahel Ramon date orchards in the southern Arava from 2020-2024.

Task 2 pollinator surveys:

a. Insects visiting the flowers of swallow-wort along its blooming period in Arava date plantations

First results according to the pan trap analysis, the insects that visited the swallow-wort flowers while they were blooming were ants, bees, beetles, wasps, and different types of flies (the Diptera) (fig.5a). The visitation frequency survey showed that the flowers were visited by ants, bees, beetles, butterflies, Diptera, wasps, and Hemiptera (fig.5b).

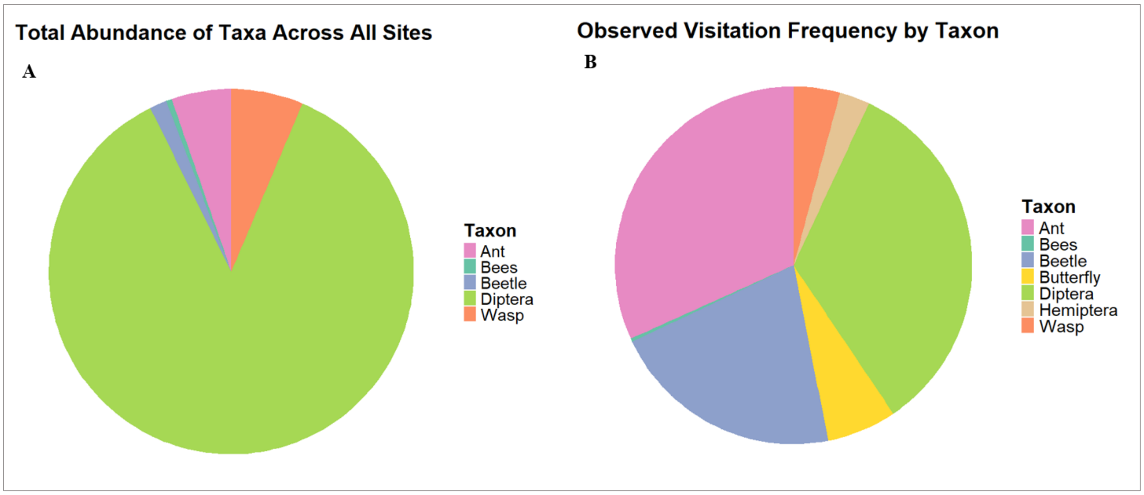

Figure 5: Pie charts showing swallow-wort visitors during its blooming period as identified (A) in the pan trap analysis and (B) in the visitation frequency survey.

b. Net house experiment

Biotic pollination of *C. acutum* and its impact on plant biology

Visitation Frequency

To ensure that the insect-pollinated treatment plants received a significant number of visits, we observed and counted the total number of visitors per taxon and determined the total and mean visits per hour for the duration the plants were placed outside the net house. For the insect-pollinated treatment, we experimented with 8 plants with blooms that were very similar, with about 16 inflorescences per plant and about 21 flowers per inflorescence at the start of the experiment. Wasp had the highest total visitation frequency of 62.1 visits per hour, honeybees 61.9 visits per hour, beetles 29.4 visits per hour, wild bees 11.7 visits per hour, birds 6 visits per hour, and carpenter bees 5.71 visits per hour (fig.6a). For the mean visitation frequency, honeybees had the highest mean visit abundance of 7.69 visits per hour per taxon, wasps had 4.62 visits per hour per taxon, and beetles had 2.45 visits per hour per taxon; wild bees had 0.93 visits per hour per taxon. birds had 0.5 visits per hour per taxon, and carpenter bees had 0.375 visits per hour per taxon (fig.6b).

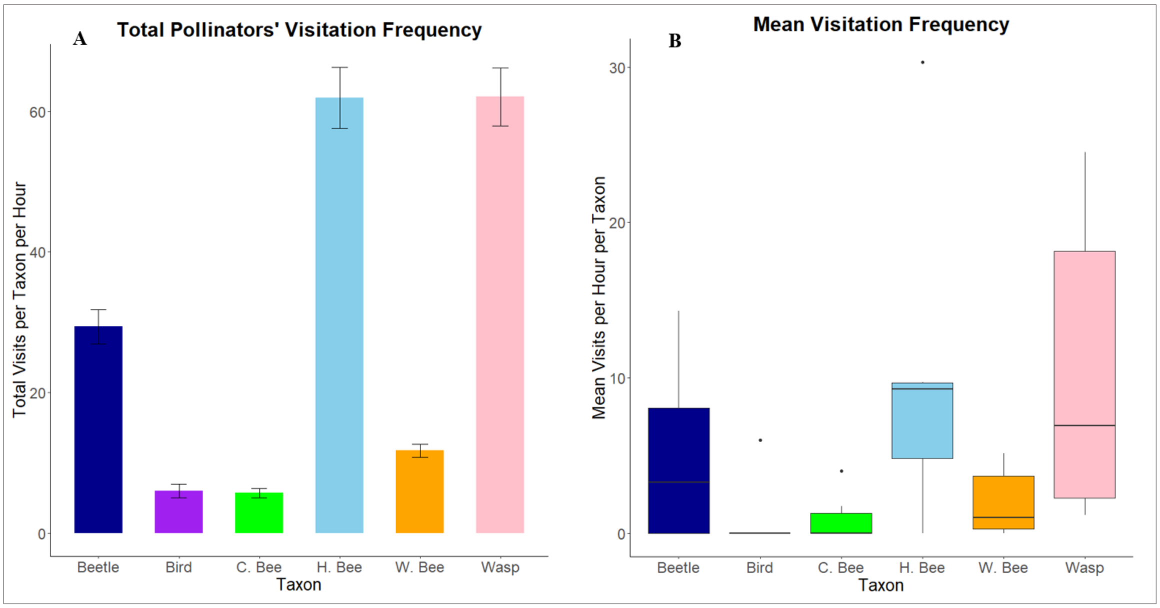

Figure 6: Bar graphs comparing (A) the total pollinators' visitation frequency (total visits per taxon per hour) for different taxa (Beetles, Bird, C. Bee, H.Bee, W.Bee, and Wasp) and (B) mean visitation frequency (mean visits per hour per taxon) for different taxa (Beetles, Bird, C. Bee, H.Bee, W.Bee, and Wasp).

Fruit Set Experiment

For the fruit set experiment, insect-pollinated plants had a higher fruit set compared to the selfing plants. Out of the 8 plants in each treatment, 6 (75%) of the insect-pollinated plants had fruit sets and a total of 18 fruits, while selfing treatments had no fruit set at all (fig.7a). The fruit set distribution among the insect pollination treatment was heterogeneous. For instance, one plant had a total of 9 fruit sets while others had none or 1 fruit set (fig.7b). The average number of fruits observed in the insect-pollinated plants was ~2 (2.25) fruits per plant. Insect-pollinated plants had significantly higher fruit sets than selfing, which seems largely ineffective as it resulted in no fruit set.

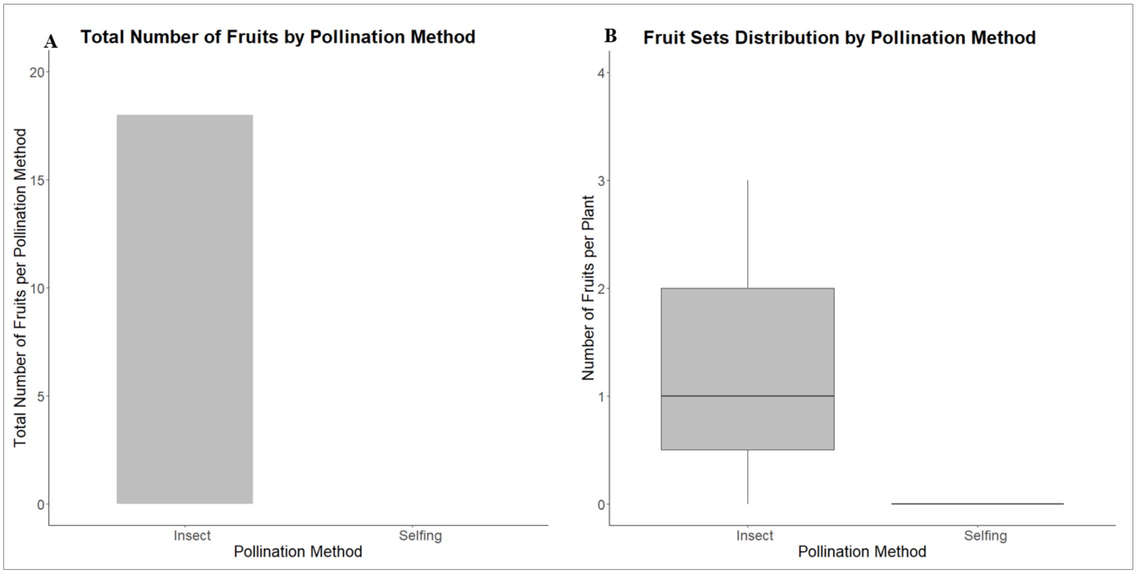

Figure 7: (A) Bar graphs comparing the total number of fruit production between two pollination methods (Insect and Selfing) and (B) Box plot comparing the number of fruit sets between two pollination methods (Insect and Selfing).

Task 3 Control approaches in young orchards

We conducted experiments in a young orchard in the Arava region that had a high swallow-wort infestation. Pre-emergence herbicide treatments were not performed as we haven't found a suitable location for this task. Herbicides were applied using a backpack sprayer with a nozzle delivering 20 L per dunam at 2 bars. For treatments after the weeds came up, glyphosate 2% (Roundup®, Bayer) (G), glyphosate + saflufenacil 0.1% (Hit®, BASF) + surfactant (Shatah 90®, ADAMA-Makhteshim, 0.05%) (G+H), and fluroxypyr 0.5% (Tomahawk®, ADAMA-Agan) (T) were used. We have chosen trees with a high swallow-wort infestation. Since the farmers treated the swallow-wort this year before our experiment, no trees covered with swallow-wort were found in the orchard. Treatments included an untreated control group without herbicide application.

Experiments were conducted in a fully randomized design with a single tree as a replicate. Based on previous studies, treatment efficacy was estimated 24 and 38 days after herbicide application. We have estimated the percentage of damage of swallow-wort for both soil and tree cover at each replicate, we furthermore estimated the percentage of coverage for tree and ground cover. Data was subjected to statistical analysis to determine the efficacy of different treatments.

Comparing all treatments across time, significant statistical differences were found in the response of swallow-wort plants to all herbicides in comparison to the untreated control (fig. 8). In general, treatments with glyphosate + saflufenacil + surfactant and fluroxypyr, showed the highest efficacy in reducing soil cover. At the end of the experiment, 38 days from herbicide application, treatment with fluroxypyr excelled showing the lowest soil cover.

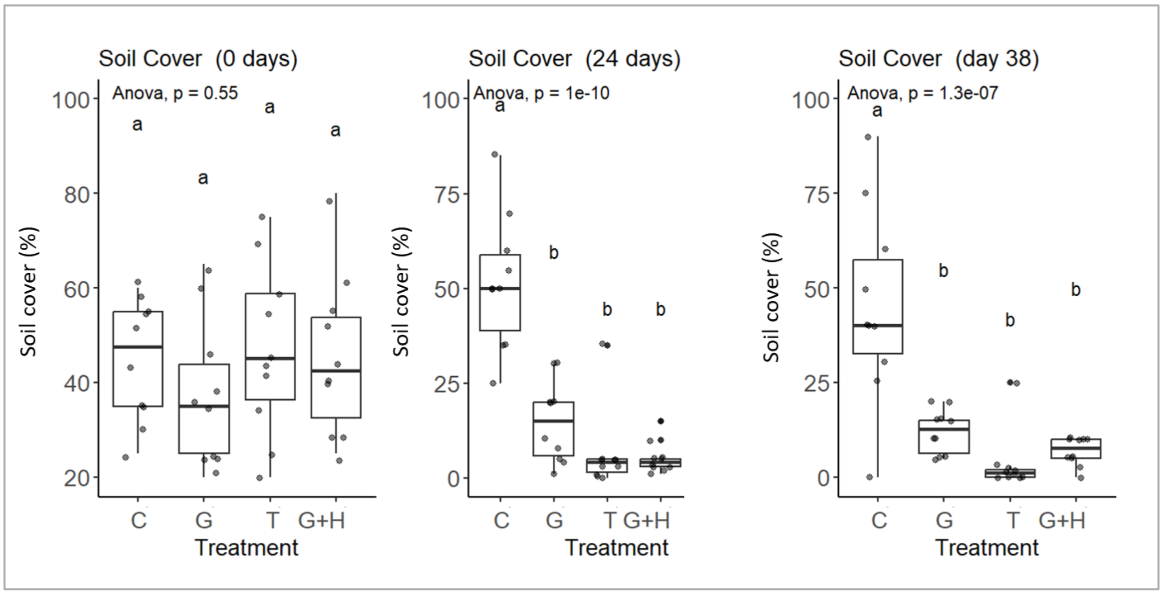

Figure 8. Soil cover percentage of swallow-wort plants (0-100%), 0, 24 and 38 days after herbicide application.

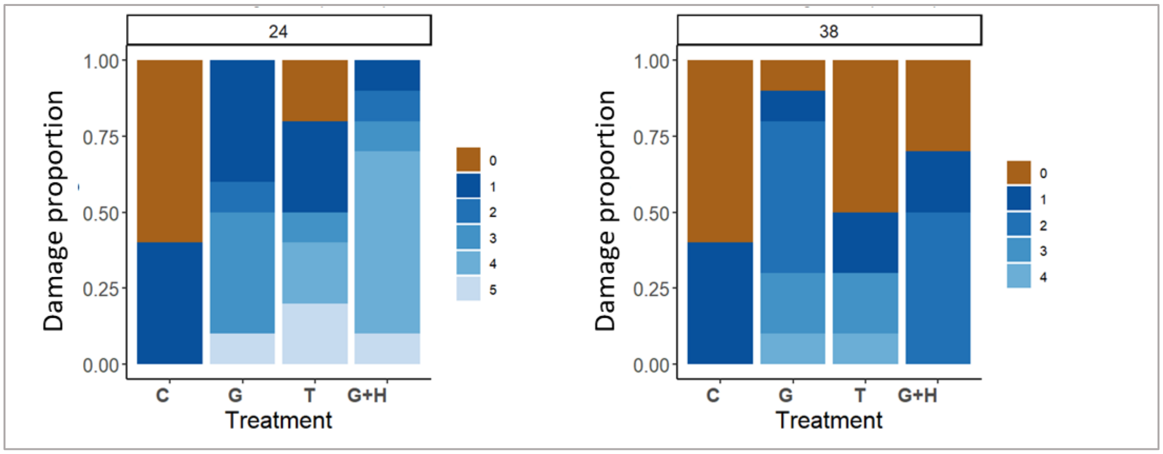

Figure 9. Ranking the damage of herbicide treatments on soil covering swallow-wort plants 24 and 38 days after application (ranking was 1-5).

Exploring the damage for soil cover by swallow-wort plants, a complementary image was detected as the damage for plants that were part of the soil coverage was higher than control over time for all three treatments (fig. 9). The highest damage to soil cover was recorded for the glyphosate + saflufenacil + surfactant treatment, 24 days after herbicide application. However, at 38 days after treatment, the damage for the glyphosate alone treatment was higher.

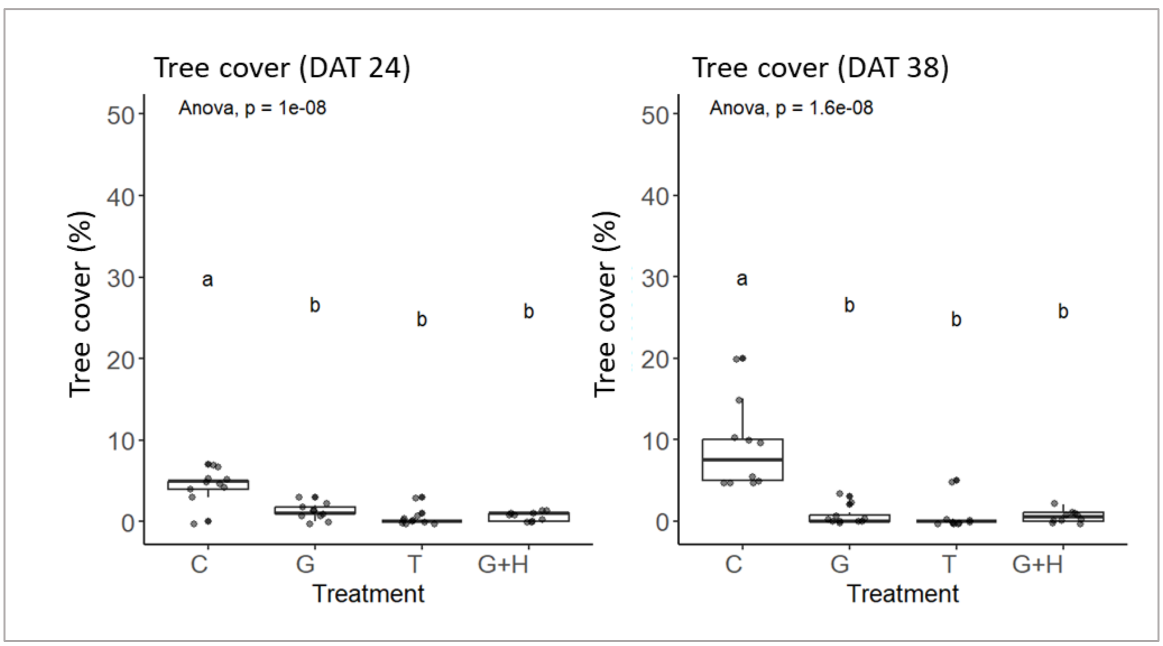

Figure 10. Tree cover percentage of swallow-wort plants (0-100%), 24 and 38 days after herbicide application.

The ranking for tree coverage among treatments and across the time of the experiment showed a clear trend of reduction compared to the control throughout the experiment (fig. 10). tree cover was significantly low for all treatments, with very low coverage for the fluroxypyr treatment.

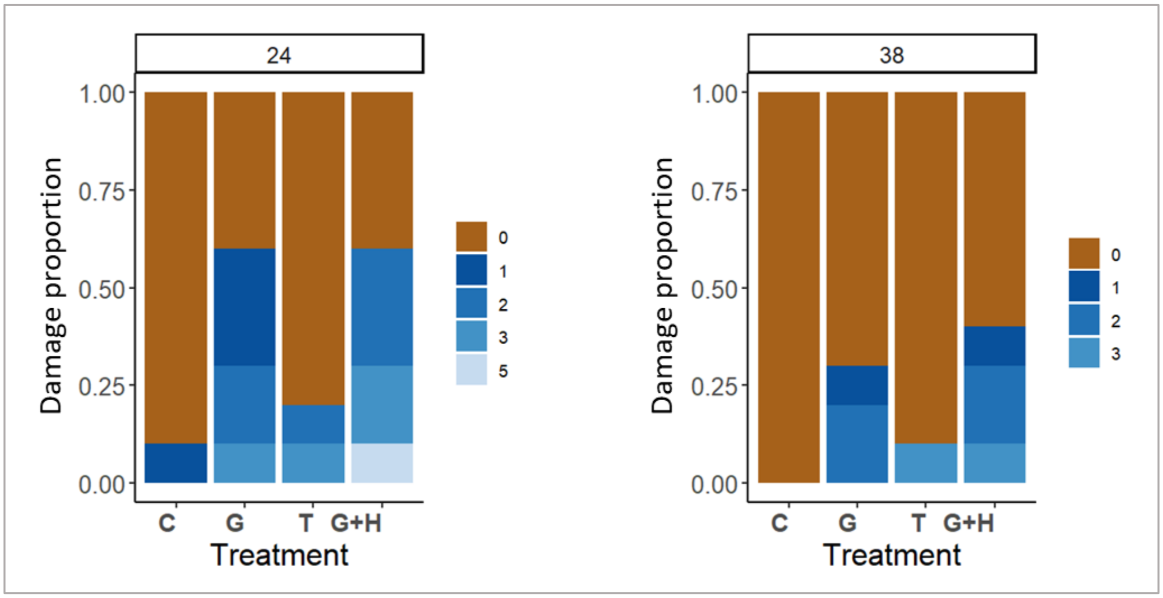

Figure 11. Ranking the damage of herbicide treatments on palm tree covering swallow-wort plants (ranking was 1-5), 24 and 38 days after herbicide application.

For the tree cover damage, it seems that swallow-wort plants were suppressed at all treatments, and coverage damage was higher for the glyphosate treatments for both 24 and 38 days after treatment (fig. 11). However, the damage reduced over time and was no more than 3, on a scale of 0-5, at 38 days after herbicide application.

Task 4 Experiments about rhizome development dependent on pollination efficiency and seed pod development

Biotic Pollination Effects on Swallow-Wort Biology

Insect-pollinated plants had significantly lower shoot weight at the end of the experiment season than selfing and hand-pollinated plants. Also in dry root weight measurement, insect-pollinated plants had significantly lower dry root weight at the end of the experiment season than selfing and hand-pollinated plants (fig.12).

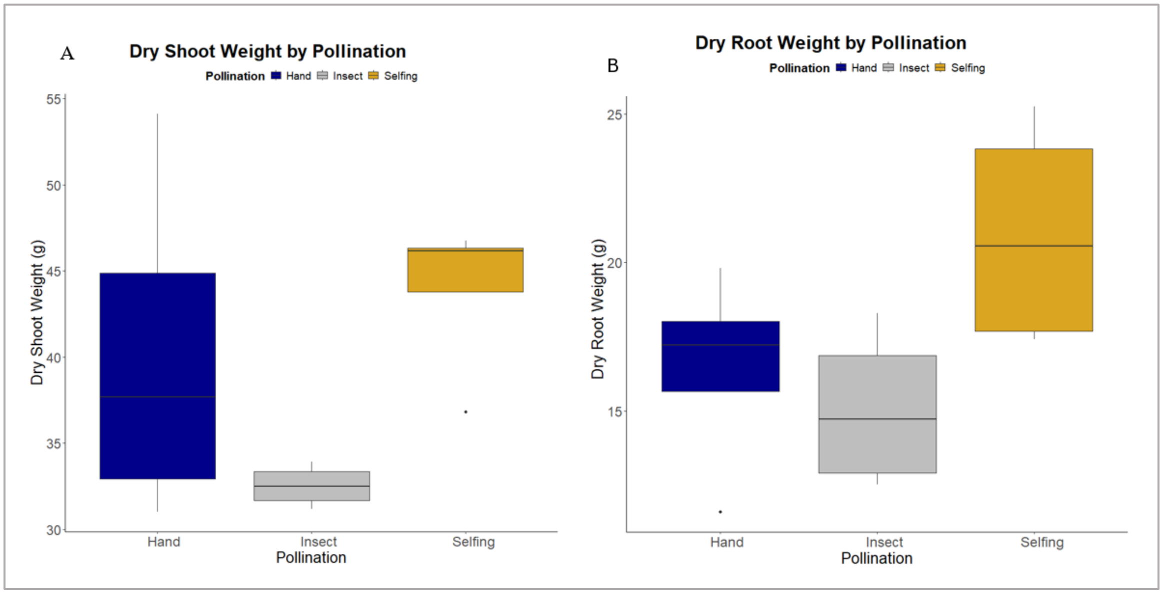

Figure 12: Box plots comparing (A) dry shoot weight by pollination method (hand, insect and selfing) and (B) dry root weight by pollination method (hand, insect and selfing).

Discussion (conclusions and implications for the continuation of the research)

Our data demonstrate a continuous spread of swallow-wort in the studied plantations, despite the farmers' control efforts, which include herbicide applications and manual weeding. This highlights the urgent need for a new, sustainable control protocol that not only enables effective management of the weed's spread but also accounts for the other tasks farmers must attend to throughout the year in date plantations. The proposed protocol should be based on an understanding of the weed's phenology, reproductive strategies, and life cycles, while also incorporating the most effective herbicides and their optimal application stages.

Our investigations revealed that various insects, potentially including pollinators, were attracted to the flowers of swallow-wort. Both our net-house and field experiments indicate that seed set and seed production are contingent on successful insect pollination, which cannot be replicated through hand pollination. This underscores the reliance of the plant on insect pollinators for reproduction.

One of the primary challenges in controlling swallow-wort is its ability to spread not only through seeds but also primarily through rhizomes. We examined the effects of successful pollination, seed set, and seed development on the plant's root and rhizome growth. Our results show that insect-pollinated plants had significantly lower shoot biomass compared to non-pollinated or self-pollinated plants. Additionally, insect-pollinated plants exhibited significantly lower dry root weight compared to the other treatments. These findings suggest that the plant prioritizes seed production over the development of its root system and rhizomes when adequately pollinated, allowing seeds to mature. This insight is crucial for developing control strategies. Previous studies have shown that seed emergence is very low, and seedling control is more effective than rhizome control. Therefore, excessive seed production is unlikely to hinder management efforts for swallow-wort in date orchards.

As in previous years, we observed significant differences in the response of swallow-wort plants to all herbicide treatments when compared to the untreated control. Overall, treatments involving glyphosate + saflufenacil + surfactant, as well as fluroxypyr, proved to be the most effective in reducing soil cover. These findings were communicated to farmers through the distribution of a flyer via relevant channels.

Farmers could potentially delay control measures until later in the growing season when seeds have developed but have not yet dispersed. Weeding efforts conducted shortly before seed dispersal, when the plant has directed much of its energy into seed production rather than rhizome growth, may be more effective. This approach would help limit both seed and rhizome-based spread.

In the final year of the project, we will continue analyzing the data set and compare findings across all project components. The goal is to develop a best-practice guide for farmers, outlining the most effective strategies to control swallow-wort spread. To further refine our recommendations, we plan to conduct an additional field trial testing herbicide and weeding control approaches (Task 3), replacing the monitoring of distribution (Task 1). We aim to provide farmers with the most effective control options available.

Aside from this adjustment, all tasks for the final year will proceed as planned, including outreach activities and publications.

Appendix

1. flyer for farmers

משרד החקלאות וביטחון המזון
שירות ההדרכה והמקצוע (שה"מ)
דצמבר 2024

התמודדות משולבת עם חנק מחודד במטעים במשך השנה

כרמית סופר ארד, מדריכת הגנת הצומח במטעים, שה"מ, מחוז גליל-גולן
ד"ר מאור מצרפי, חוקר במחלקה לפתולוגיה של צמחים וחקר העשבים, מרכז מחקר נווה יער, מינהל המחקר החקלאי - מכון וולקני

המידע בדפון זה מורכב ממחקר שבוצע במעבדה של ד"ר מצרפי ודיונים מקצועיים שהתנהלו בקבוצת וואטסאפ, שכותרתה: "איך חונקים את החנק".

רקע

חנק מחודד - *Cynanchum acutum* L., הוא צמח מטפס רב-שנתי ממשפחת האסקלפיים, אשר הפך ברבות השנים לעשב מזיק בגידולים חקלאיים שונים. החנק המחודד מתרבה בצורה מינית בעזרת זרעים הנישאים למרחק ברוח, ובאופן א-מיני באמצעות מקטעי קני שורש. הצמח מאופיין בקנה שורש מעמיק, דבר המקשה על הדברתו.

חנק מחודד נפוץ באזורי אקלים ממוזגים סביב הים התיכון, המזרח התיכון ומרכז אסיה. החנק מחודד הוא מין מקומי במדינת ישראל ונפוץ במרבית האזורים, מהגולן והגליל בצפון, דרך משור החוף ובקעת הירדן ועד לאזור צפון הנגב. בתי הגידול בהם ניתן בדרך כלל למצוא את הצמח הם גדות נחלים, צדי דרכים, תעלות מים ושטחים חקלאיים מושקים. בשנים האחרונות מתועדים תהליכי פלישה והתפרצות לאזורים חדשים שכוללים אזורים חקלאיים רבים מהגליל העליון בצפון ועד לנגב המערבי והערבה הדרומית. בתמונה, חנק מחודד על עץ תמר צעיר במטעים בערבה הדרומית (צילום: מאור מצרפי).

פנולוגיה

מחזור החיים של חנק מחודד כולל נביטה מזרעים והתעוררות מקני השורש בעונת האביב; צימוח מהיר, פריחה בקיץ; ויצירת פירות והתייבשות העלווה בסתיו. כאמור, אמצעי הריבוי העיקרי של חנק מחודד הוא קני שורש, ולכן עיבודי קרקע בחקלאות ועבודות תשתית בשטחים ציבוריים במקומות שבהם קיים חנק, עלולים לגרום להתפשטותו על ידי הפצת מקטעי קני השורש.

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Publications as project outcomes:

- See attached flyer in Appendix,
- Bar, O., Lati, R. N., Schäckermann, J., Kapiluto, O., Spodek, M., Gamliel, A., & Matzrafi, M. (2024). Biology and chemical weed management of Cynanchum acutum L. *Frontiers in Agronomy*, *6*, 1448556.
- Further publications are in preparation.