PRECISE CONTROL OF RODENTS IN ALFALFA FIELDS USING DRONES

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ABSTRACT

Rodent control is a challenge to any alfalfa grower in the world. Many rodent species are attracted to alfalfa fields, their population in the field increases, and they can cause huge damages to the crop. The rodents' damage can reduce the alfalfa yield by up to 30-40% (accumulated) and can reduce the number of growing seasons. The rodent populations can also prevent the grower from using advanced irrigation methods, such as SDI (Subsoil Drip Irrigation systems) because of their damage to the subsoil irrigation pipes. In this study, we suggest a novel and innovative method to control the rodent populations in the field. It begins with monitoring the field by drone (with a high-resolution RGB camera), identifying the rodents' foraging areas in the field (through picture analysis), and precision poisoning by drone using a unique custom-made system - only where the rodents are active in the field. In our experiments, we show that we can control rodent populations using only 3-5% of the amount of poison that would have been used practicing broadcast poisoning.

Key Words: Rodent control, alfalfa, drip irrigation, drones

RODENT DAMAGE AND RODENT CONTROL

Since the soil is not cultivated for a few years in alfalfa crops, if winters are not severe, the rodent populations in the fields can thrive and cause huge damages to the crop [1,2]. Moreover, because alfalfa crops are harvested several times each year; the additive yield loss due to the rodents' damage can be very high.

The predominant methods used today for rodent control are poisoning (being either broadcast poisoning by aircraft or agromachinery, or precision poisoning by hand directly in the rodents` burrow openings); using traps; and flooding. Using the flood technique causes extensive water loss and soil erosion in the field. Poison types and amounts are limited by regulation in each area, and broadcast poisoning can cause secondary damage to other animals and can developed a stability of the rodents to the poison during the time.

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DRIP IRRIGATION IN ALFALFA FIELDS

It is well known that SDI (subsoil drip irrigation) has many advantages in agriculture – water conservation, precise distribution, decreasing fertilizer and crop protection products, reducing soil erosion, minimizing underground water pollution and more. In alfalfa growing, there could be more advantages, especially when you do not need to separate irrigation from the other agromachinery activities in the field (harvesting, drying and collecting the yield). The grower can irrigate the whole field at once (and not wait for days until the pivot center will end its cycle), and there is no need to wait until the harvested alfalfa will dry and the field will to be emptied of the hay to start irrigating. With SDI you can reduce the time between harvesting, and this may add another harvest or two in each growing season. The problem we face until now is that the rodent populations rise quickly if the soil is not cultivated between the harvests and the growing seasons. Besides the damage to the plants, rodents cause damage to the SDI systems. In such situations, it is very difficult to use SDI in alfalfa field in many places. [2,3]

We wish to solve these problems, in order to be able to use smart irrigation methods as well as to reduce the environmental effect of broadcast poisoning. We would like to present a new method that makes the poisoning more precise without reducing its effectiveness. A number of organizations cooperate in this project, each from its own incentive: Agricam (Benjamin Benzion) that came up with the monitoring and picture analysis idea; Alta Innovation (Ido Kogel and Tomer Regev) that came up with drone technologies for monitoring and precision poison scattering (Alta team have licenses to use drones for scattering plant protection and other materials in agriculture from the authorities in Israel); Netafim (Dekel Segev) that wishes to increase the use of SDI in alfalfa; Muller Professional Extermination (Yoav Muller) who has the knowledge in rodents and their control; and the Israeli Ministry of Agriculture (Dr. Yoav Motro) which aims to reduce the use of poison and to make rodent control more effective.

RODENT MONITORING IN ALFALFA FIELDS

Upon observing in alfalfa field, we notice that some raptors (such as Kestrels) hover above the fields when they search for signs of rodent. We know that they can identify the rodents` foraging areas in the field, and it is there they look for their meal. From analyzing alfalfa field pictures taken by drones, we notice that we can identify the rodents` paths in the alfalfa field.

We tested this new monitoring method in fields in two areas in Israel - alfalfa field in Tzora (Beit Shemesh area, central Israel) and alfalfa fields in Sde Eliyahu (Beit Shean Valley, north eastern Israel). We took aerial photos of the field, aligned them to an orthophoto, identified the rodent's activity areas, marked them on GIS (Geographical Information System), and validated the results by monitoring the field by foot (walking in the field to the marked points and recognizing the rodents` burrows in the field) (see Fig 1). After 3 seasons of monitoring, we were able to identify about 70% of the rodent burrows in the field (30% false negatives), and about 70% of the

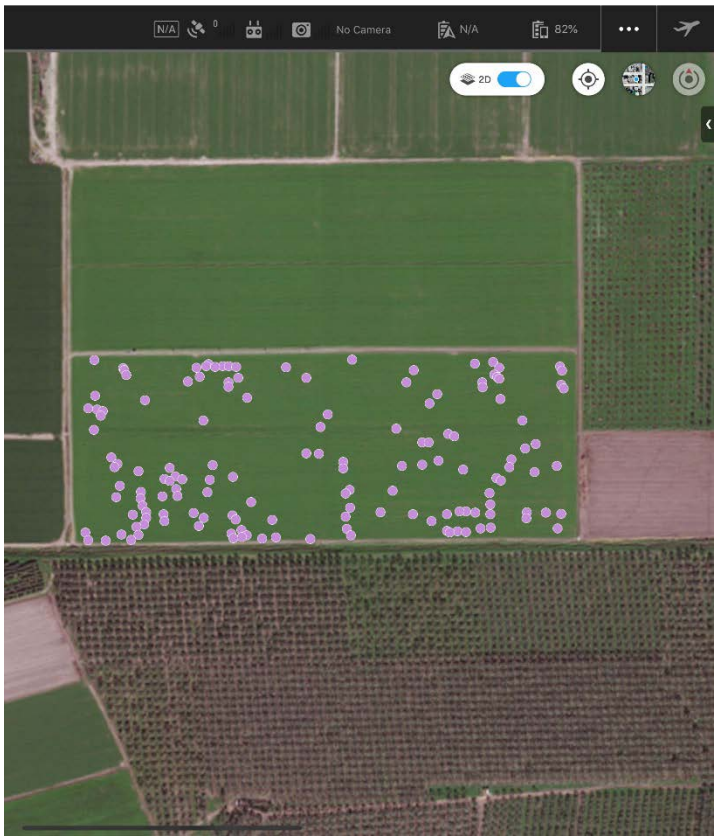
identifications were correct (30% false positives). Those performances are getting better while we extend the use in this monitoring technology.

Nowadays we develop an automatic analyzing system that automatically perform the visual analyses of the pictures from the drone to identify the rodents` activity areas. The analyzing system is based on big data that was uploaded to it, and with learning abilities it can ignore other signs in the field that cause by other animals (as dogs, pigs and birds).

In Israel we focused on the local rodents as Macedonian Mouse (*Mus macedonicus*) in Tzora, and Levant Voles (*Microtus* guentheri) and Tristran's Jirds (*Meriones tristrami*) in Sde Eliyahu. We saw that the signs of their pathways in the field are similar. Our software is learning based and we can use the automatic picture analysis to identify the mounds of the underground rodents (such as pocket gophers) in the field.

From this point we wanted to check if poison scattering only in the activity areas in the field can be effective to control rodents.

Fig. 1. An example of rodent activity areas on a ~ 50-acre field in Sde Eliyahu, Israel.



PRECISON POISONING BY DRONE

In the last two growing seasons (2018-2019) we focused on alfalfa fields in Sde Eliyahu. We tested whether poison (compound 1080, Sodium Fluoracetate 0.05% on

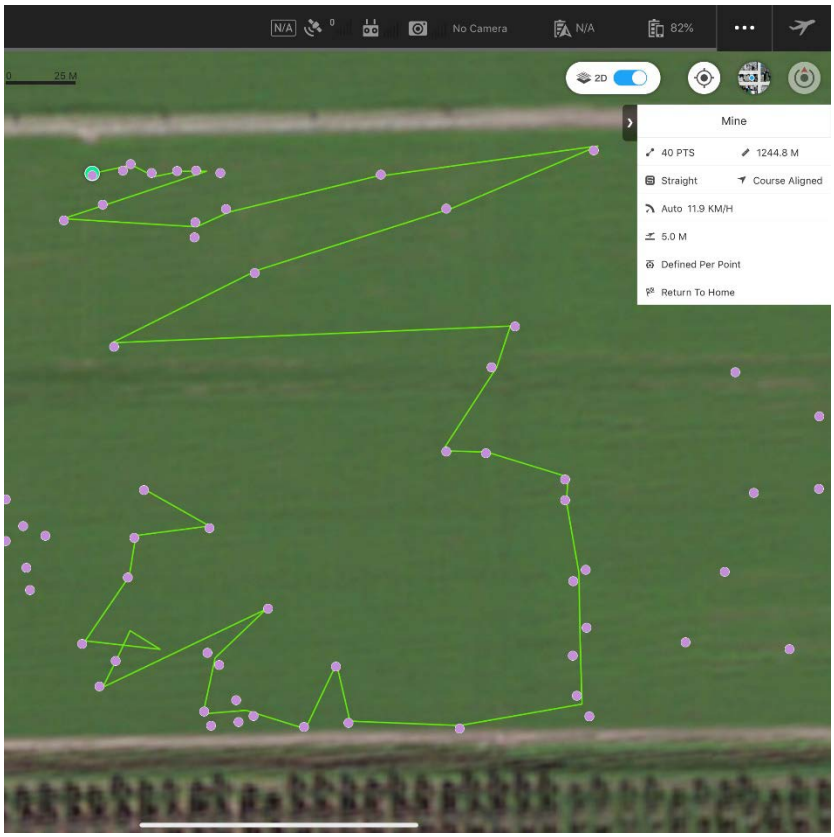
wheat grains - the only rodenticide registered for use in open areas in Israel), spread only in a ~7.50 meter (about 24.6 foot) radius around the points recognized as rodents activity areas in the picture analyses. On the first season we scattered the poison manually (the field was divided to 16 areas, half of them were treated, and the others were used as control), and we noticed that in spite of the fact that the field is located in an area with high rodent activity, the rodent populations in the field remained low. Comparing the rodents` activity in the treated field to a nearby alfalfa field that was flooded by an irrigation machine (similar to pivot center) – as a rodent counter-measure, we found that the activity in the field managed using precision poisoning field was lower. We did not find any difference between the treatments and control areas, but we did find a reduction in the rodents' activity in the whole field. It is importance to notice that the monitoring is happening before the harvest, when the alfalfa is high, while the poison scattering done after the collection of the dried harvested yield from the field (to prevent from the poison to reach to the animals how ate it).

In the last season (2019) we used a unique and novel drone scattering system developed especially for this project by Alta Innovation, called Gaya (see Fig 2). The Gaya system can scatter the granular poison autonomically above the identified areas in the field. It was designed to scatter to a radius of few meters in the same poison density allowed for broadcast use in Israel (300 grams per dunam = ~2.6 pounds per acre = 0.02 oz. AI/acre). A patent application was submitted.

Using this autonomic scattering system by drone was very fast (less than 45 minutes per 50-acre field) (Fig. 3), and resource efficient (only one employee and only 3-5% of poison compared to broadcast poisoning). For example, in a 200 dunams (50 acres) field, it is legal to scatter 60 Kg grams of compound 1080 by aircraft. With the drone, we are scattering about 50 gr per point. If we have (for example) 100 points in the field (a very reasonable figure), we use about 5 Kg per scattering. Moreover, because of its effectiveness, we can reduce the number of scatterings and further reduce the amount of poison used.

Fig. 2. Gaya - The novel scattering of granules in the field by drone.

Fig. 3. Example of an autonomic flight path, in each marked point, there is an automatic even scattering of 50 grams of poison in a ~7.50m radius.



CONCLUSIONS AND FURTHER RESEARCH

We showed in this article a novel and innovative rodent control method. The method includes an automatic monitoring method (automatic field scanning by drone and picture analysis) and automatic poison scattering using drones, this being done only in the areas with recorded rodent activity in the field. Using this rodent control method, we succeeded to maintain a 2 years old alfalfa field with very low rodent activity (compared to an adjacent field and other fields in the area).

We plan to continue developing the monitoring and the scattering technologies, in the same field and in other fields. On the next growing season (2020) we will test this method in an alfalfa field that will be irrigates with an SDI system. We will also try to expand the knowledge and the use of this method to other crops and other areas around the globe facing problems with other rodent species.

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