ISSN 2522-3488 Vol. 5, Issue 2: 45-50, DOI: 10.25236/IJNDES.2021.050207

Research and Development of a New Remote Control RIFA Trap

Yajuan Duan[1], Xiangshuai Li[1], Lishan Wang[1], Tao Yu[2], Changhua Liu[1,a,*], Shiliang Cao[2,b,*]

[1]College of Advanced Agriculture and Ecological Environment, Heilongjiang University, Harbin 150080, China
[2]Maize Research Institute, Heilongjiang Academy of Agricultural Sciences, Harbin 150086, China
[a]E-mail address: liuchanghua70@163.com(C.Liu)
[b]E-mail address: caoshiliang2003@126.com(S,Cao)
**Corresponding Author*

Abstract: *In order to prevent the further proliferation and spread of RIFA in our country, reduce the serious harm caused by RIFA populations to agricultural and forestry production, human health, public safety and the ecological environment. A new type of trap based on mobile function, obstacle clearance function, energy supply function, signal transmission function and trapping function has been developed. The new remote controlled RIFA trap is improved and upgraded on the basis of the existing traditional traps. The research and development of this trap not only advances the process of emergency trapping of RIFA in my country, but also provides a new way for artificial intelligence to prevent and control RIFA in the future.*

Keywords: *RIFA. Trap. Remote control. Artificial intelligence.*

1. Introduction

Solenopsis invicta Buren are called "invincible" ants due to their ferocious habits, omnivorous, strong competitiveness, and high fecundity [1]. After being bitten by a Solenopsis invicta Buren, there will be a strong burning sensation in the wound, and it will even cause swelling and shock all over the body, and even death in severe cases. They will eat a lot of crops, the seeds of plants and the roots, stems, leaves and fruits of crops [2]. The incidents of Solenopsis invicta Buren wounding people are frequently reported in the newspapers and threaten people's lives, Solenopsis invicta Buren compete with other species for limited resources, resulting in a decrease in the population of some species and destroying the food chain ecosystem [3].

RIFA poses great threats to agricultural economy, public safety and personal safety, so they need to be trapped [4]. General trapping devices have low recovery rates, high trapping costs, short working hours, require a large number of personnel to participate and observe, and cause a certain degree of harm to the ecological environment, most traps cannot find the RIFA nest accurately and are easy to lose. They are not suitable for no man's land or steep terrain and are not conducive to the trapping and killing of RIFA. Artificially placed RIFA traps will leave odors and reduce the trapping effect. Once bitten by RIFA, it will be extremely dangerous [5].

To this end, a new type of remotely controlled RIFA trap is proposed. The trapping work is carried out through remotely controlled release, which greatly improves the recovery rate of traps and reduces the participation of personnel. The use of mobile devices and obstacle removal devices to accurately locate the ant nests improves the trapping effect. The use of solar panels to provide a stable source of power and stored power, in order to achieve accurate, fast, high-efficiency, energy-saving, and environmentally-friendly trapping effects.

2. Structural of a New Type of Remote Control RIFA Trap

Whenever a RIFA epidemic occurs, the RIFA trap can be remotely released for epidemic prevention and control. During the remote delivery process, if obstacles are encountered, the 360 °camera (19) will optimize the recognition and pass it to the user to avoid obstacles. If wild weeds are encountered, the

ISSN 2522-3488 Vol. 5, Issue 2: 45-50, DOI: 10.25236/IJNDES.2021.050207

clearance device (2) will automatically activate and turn it on, Broken it up to the ground, used to fertilize the ground. A McNamee wheel (7) is installed under the trapping vehicle (6), which can ensure that the entire trapping vehicle (6) can move freely at 360 °without turning and turning, and any complex terrain is like flat ground. As shown in figure 1.

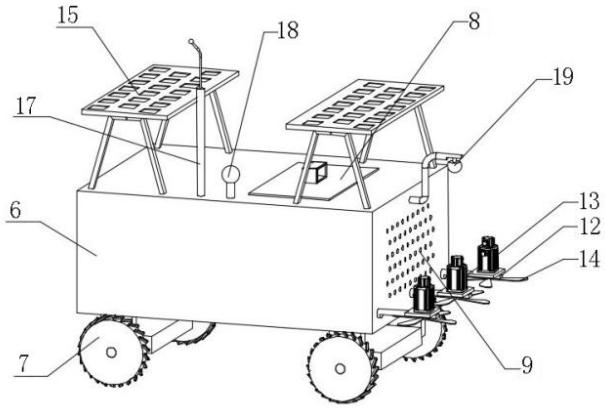

Figure 1: Side view of a new remote control RIFA trap.(6) Trapping vehicle, (7) McNamee wheel, (8) Protective cover, (9) Holes, (12) Support platform, (13) Speed reducing motor , (14) Cutting fan blades , (15) Solar photovoltaic panel, (17) Signal receiving and transmitting device, (18) GPS locator , (19) 360 °camera.

The RIFA trap is moved to the epidemic area, and the 360 °camera (19) is activated to transmit the epidemic image of the epidemic area to the remote control terminal in real time, the remote control terminal will automatically optimize the best operating area based on the image and start the operation, Move to the designated work location. The RIFA is tempted by the attractants (21), climbs into the trapping vehicle (6) through the holes (9), and touches the electricity grid (22) on both sides of the trap cages (20), and the RIFA touches the electricity grid (22), they will be electrocuted, and the corpse of the RIFA will fall into the insect collection box (23). When the operation is over, the remote control terminal sends instructions through the signal receiving and transmitting device (17), and the trapping vehicle (6) will move to the designated position through the McNamee wheel (7). After recovery, pull out the insect trap through the puller (24) the insect collection box (23) is taken out, and the RIFA are fumigated and destroyed. When the operation is over, the remote control terminal sends instructions through the signal receiving and transmitting device (17) and the trapping vehicle (6) will move to the designated position through the McNamee wheel (7). When the assignment is finished, pull out the insect trap through the puller (24) the insect collection box (23) is taken out, and the RIFA are fumigated and destroyed.

3. The Function of a New Type of Remote Control RIFA Trap

The new remote control RIFA trap includes five parts (as shown in figure 2): mobile device (1), Clearance device (2), Energy supply device (3), signal transmission device (4) and trapping device (5).

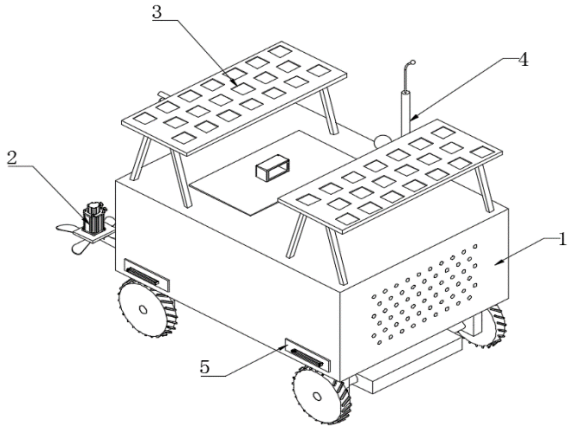

Figure 2: Functional diagram of a new remote control RIFA trap.(1) Mobile device (2) Clearance device (3) Energy supply device (4) Signal transmission device (5) Trapping device.

ISSN 2522-3488 Vol. 5, Issue 2: 45-50, DOI: 10.25236/IJNDES.2021.050207

3.1 Mobile Function

The mobile device (1) includes a trapping vehicle (6). Both sides of the trapping vehicle (6) are provided with holes (9). The top of the trapping vehicle (6) is provided with a mounting slot (10). The inside of the trapping vehicle (6), there are symmetrically arranged sliding slots (11). Two sets of McNamee wheels are fixed on the bottom side of the trapping vehicle, which can make the movement of the RIFA trap lighter, without turning, and can move in any direction 360 °freely without being blocked, The RIFA trap can be easily put into areas with complex terrain.

3.2 Clearance Function

The clearance device (2) includes a supporting platform (12), one end of the supporting platform (12) is fixedly installed on one end of the trapping vehicle (6), and the other end of the supporting platform (12) is fixedly installed with speed reducing motor (13), The cutting fan blades (14) is fixedly installed on the drive shaft of the speed reducing motor (13), and the speed reducing motor (13) can drive the cutting fan blades (14) to rotate quickly, thereby clearing the obstacles at the front end of the trapping vehicle (6) and ensuring smooth deployment jobs.

3.3 Energy Supply Function

The energy supply device (3) includes solar photovoltaic panels (15) and batteries (16). The solar photovoltaic panels (15) are fixedly installed on the trapping vehicle (6), and the batteries (16) are fixedly installed in the mounting slot (10) to trap Two solar photovoltaic panels (15) are installed symmetrically on the top of the trapping vehicle (6), and the electricity generated by the two solar photovoltaic panels (15) is converted by an inverter, which can provide power energy for the entire trapping device, The excess current generated by the solar photovoltaic panel (15) is electrically connected to the battery (16), and the excess power is stored in the battery (16) for operation in cloudy or night. The battery (16) can also supply power for the McNamee wheel (7), the speed reducing motor (13), the signal receiving and transmitting device (17), the GPS locator (18) and the 360 °camera (19). By installing solar photovoltaic panels and batteries on the top of the trapping vehicle, it can provide a stable source of power and stored power for the RIFA trap. The power source generated by the solar photovoltaic panels will not pollute the environment and can Work on cloudy days or at night. As shown in figure 3 and figure 4.

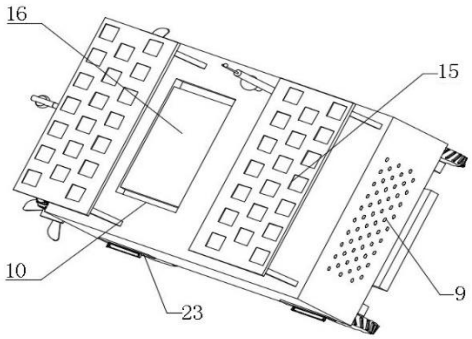

Figure 3: The top view of the new remote controlled RIFA trap.(9) Holes ,(10) Mounting slot, (15) Solar photovoltaic panel, (16) Battery, (23) Insect collection box.

Figure 4: Simulated operation diagram of a new type of remote control RIFA trap.

ISSN 2522-3488 Vol. 5, Issue 2: 45-50, DOI: 10.25236/IJNDES.2021.050207

3.4 Signal Transmission Function

The signal transmission device (4) includes a signal receiving and transmitting device (17) and a GPS locator (18). The signal receiving and transmitting device (17) and the GPS locator (18) are both fixedly installed on the trapping vehicle (6), and the signal is received and transmitted. The signal receiving and transmitting device (17) uses the Guangchangxing HDMI signal amplifier, and the GPS locator (18) Gumi love car GPS locator. A signal receiving and launching device is installed on the top of the trapping vehicle, which is powered by solar photovoltaic panels and batteries. The signal receiving and launching device is connected to the user's computer or mobile phone APP, which can not only receive the information of the RIFA trap in real time, but also can be remotely controlled The RIFA trap assists users to control and greatly avoids unnecessary damage to personnel.

3.5 Trapping Function

As shown in figure 5, the trapping device (5) includes trapping cages (20), an electricity grid (22) and an insect collection box (23). The trap cages (20) and the electricity grid (22) are both fixedly installed in the trapping vehicle (6). The RIFA is lured by the attractants (21) and can crawl through the holes (9) and enter the trapping vehicle (6). RIFA will be electrocuted when passing through the electricity grid (22) on both sides of the trapping cages (20). An attractants (21) is placed in the trapping cages (20). The attractants (21) has a slow-release effect and can be released slowly to improve the maintenance cycle of the entire trap and reduce the cost of use, the insect collection box (23) is slidably installed in the slot (11), and one side of the insect collection box (23) is provided with a puller (24). The mounting slot (10) is covered with a protective cover (8), The signal transmission device (4) also includes a 360 °camera (19), through which the 360 °camera (19) can scan the image to identify obstacles, and send the image to the remote control terminal through the signal receiving and transmitting device (17) for the operator to browse.

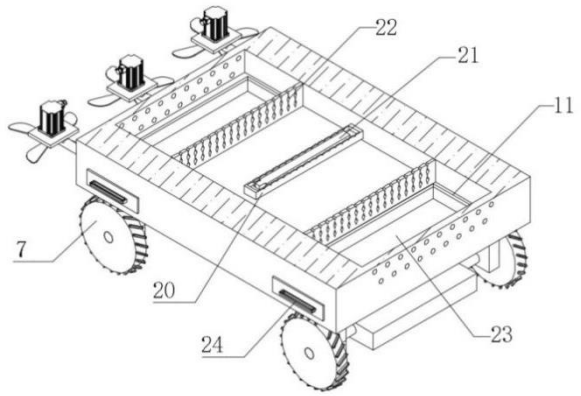

Figure 5: Cross-sectional view of the chassis of the new remote controlled RIFA trap, (7) McNamee wheel, (11) Slot, (20)Trap cages, (21)Attractants,(22) Electricity grid, (23) Insect collection box, (24) Puller.

One end of the 360 °camera (19) is fixedly connected to one end of the trapping vehicle (6). The signal output end of the GPS locator (18) and the image information output end of the 360 °camera (19) are connected to the signal receiving and transmitting device (17) The signal receiving end connection, The signal receiving and transmitting device (17) is provided with at least one of a Bluetooth module, a Lora communication module, an NB-iot communication module, a 4G communication module and a 5G communication module, and the signal receiving and transmitting device (17) can be connected to the user's computer Or the mobile phone APP, not only can receive the information of the RIFA trap in real time, but also can remotely control the RIFA trap to assist the user to control it. Two electricity grids (22) are arranged symmetrically, and the electricity grids (22) are respectively located on both sides of the trapping cages (20), and the dead bodies of the RIFA are collected through the two electricity grids (22). As shown in figure 6.

ISSN 2522-3488 Vol. 5, Issue 2: 45-50, DOI: 10.25236/IJNDES.2021.050207

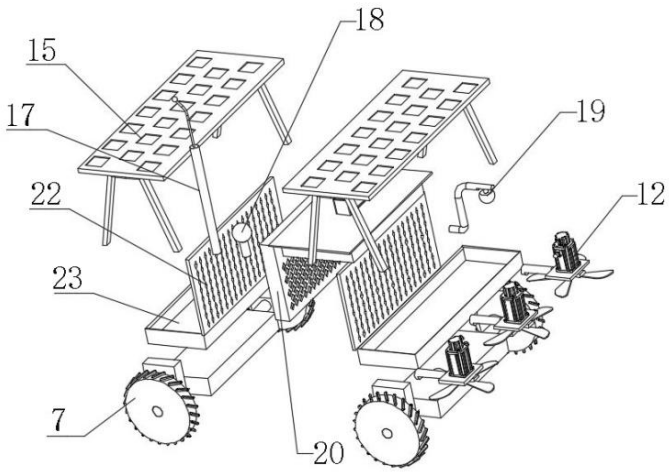

Figure 6: Exploded view of a new type of remote control RIFA trap. (7) McNamee wheel, (12) Support platform, (15) Solar photovoltaic panel, (17) Signal receiving and transmitting device, (18) GPS locator, (19) 360 °camera, (20) Trap cages, (22) Electricity grid, (23) Insect collection box.

4. Discussion and Conclusion

At present, the areas invaded by RIFA include rice fields, vegetable fields, farmhouses, urban green areas, street trees, grasslands and other areas. The situation is very serious. It is imminent to launch RIFA trapping work immediately. Tsutsui, N.D. [6] and other studies have found that RIFA will survive in areas where there are no animals, and it is very difficult to control RIFA. Therefore, the research and development of a new type of remotely controlled RIFA trap has designed a function that can be manually controlled and moved remotely, which can more accurately locate the ant nest for trapping work.

Ants are one of the most destructive species. We need to comprehensively consider the living habits, living environment, trapping cost and ecological balance of RIFA. Allen, C. R, et al. [7] believes that the traps are less intelligent at this stage and will consume a lot of workforce and time during use. On the basis of ensuring the trapping effect, the new type of remote control RIFA trap adopts the effective combination of environmental factor detection function, compound slow release function and other technologies, and realizes the perfect integration with modern cutting-edge science and technology.

With the continuous improvement of my country's green crop prevention and control system, trapping technology has become one of the core technologies for ecological pest control [8]. Therefore, the research and development of the new type of remote control RIFA trap adheres to the concept of green, environmental protection and sustainability, and develops functions such as solar power supply function, replaceable lure core function and remote control recycling function, which promotes the sustainable development of pest control.

In summary, the research and development of a new type of remotely controlled RIFA trap can quickly and effectively trap and kill RIFA pests. It has the advantages of high sensitivity, no pollution to the environment, safety to non-target organisms, time-saving and labor-saving, etc. played a high role in green prevention and control, on the basis of traditional traps combined with modern technology, it aims to provide strong technical guidance and theoretical basis for the direction of RIFA pest traps.

Acknowledgments

Outstanding Youth Fund Project of Heilongjiang Academy of Agricultural Sciences" Research on Maize Germplasm Base Analysis and Hybrid Combination Prediction Based on Sequencing Typing SNP" (2019JCQN004), National Postdoctoral Program" Discovery and Screening of Molecular Markers Related to Cold Tolerance in Maize Germination" (2017M621318), Agricultural Science and Technology Innovation Leapfrog Project of Heilongjiang Academy of Agricultural and Industrial Sciences" Research on Comprehensive Processing and Utilization of Whole Corn Plant" (HNK2019CX22-13).

ISSN 2522-3488 Vol. 5, Issue 2: 45-50, DOI: 10.25236/IJNDES.2021.050207

References

[1] Zhang, R.Z., Li, R. and Liu, N. (2005) An introduction and strict precautions against red imported fire ant, solenopsis invicta, for its potential invasion to the mainland of china. Entomological Knowledge, (01), 6-10.
[2] Zeng, L., Yong Yue, L.U., Xiao Fang, H.E., Zhang, W.Q. and Liang, G.W. (2005) Identification of red imported fire ant solenopsis invicta to invade mainland china and infestation in wuchuan, guangdong. Entomological Knowledge, (02), 144-148+230-231.
[3] Forys, E.A., Allen, C.R. and Wojcik, D.P. (2002) Influence of the proximity and amount of human development and roads on the occurrence of the red imported fire ant in the lower florida keys. Biological Conservation, 108(1), 27-33.
[4] Fernando, A., Zanuncio, T.V., Cola Zanuncio, J., Patr Cia, M., Fialho, M.Q. and Bernardino, A.S. (2005) Effect of plant age, temperature and rainfall on lepidoptera insect pests collected with light traps in a eucalyptus grandis plantation in brazil. Annals of Forest Science, 62(1), 85-90.
[5] Okl, A.A. and Millar, J.G. (2009) Manipulation of insect signaling for monitoring and control of pest insects. Springer Netherlands, doi: 10.1007/978-90-481-2316-2_11.
[6] Tsutsui, N.D. and Suarez, A.V. (2010) The colony structure and population biology of invasive ants. Conservation Biology, 17(1), 48-58.
[7] Allen, C.R.,Epperson, D.M. and Garmestani, A.S.A (2009) Red imported fire ant impacts on wildlife: a decade of research. American Midland Naturalist, 152(Jul 2004), 88-103.
[8] Allen, C.R., Lutz, R.S. and Demarais, S. (1995) Red imported fire ant impacts on northern bobwhite populations. Ecological Applications, 5(3).