Scientific Papers. Series A. Agronomy, Vol. LXIV, No. 2, 2021
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

# TRAP CROPPING: A USEFUL APPROACH IN FARMING SYSTEMS

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***Abstract***

*Trap crops are considered a useful strategy for insect pest control and offer several benefits in a pest management system. The principle of trap cropping relies on pest preference for certain plant species, cultivars or a certain stage of crop development. Farmers are motivated to utilize trap cropping because of the various difficulties in coping with the pest situation in other ways. Trap cropping, the use of alternative host plants to attract, intercept and/or retain targeted insect pests for the purpose of reducing damage to a main crop, is one such strategy. This paper aims at presenting various crops suitable for an insect trap, which may be used in farms, as for the organic ones a sweep net shall be used to collect insect pests instead of pesticides. When trap crops successfully attract pest populations, treatments are localized only in this area, thus limiting the damage to the main crops. The two main techniques used in choosing a trap crop will be considered. We will look at the different types of trap crop locations in the study area. The so-called 'push-pull' strategy shows very good results in Kenya. Whether using the same or different species, it is essential that the trap crop is more attractive than the main crop. Examples will be given of perimeter trap cropping, row and strip trap cropping, as well as their effectiveness in fiber, trench, cereals and vegetable crops in the USA, Thailand, Kenya, New Zealand and others. The advantages of trap crops in reduction of usage of insecticides are highlighted: reduction of pest incidence to manageable levels; conservation of indigenous natural enemies by providing shelter to be useful in the agrocenosis; growing harvested crops trap. The shortcomings mentioned by the farmers are reported in order to clarify their use.*

***Key words****: insect trap, push-pull' strategy, Trap crops.*

## INTRODUCTION

Interest in trap cropping, a traditional tool of pest management, has increased considerably in recent years (Shelton & Badenes-Pérez, 2006). Trap crops are considered a useful strategy for insect pest control (Sharma et al., 2019) and offer several benefits in a pest management system (Wszelaki & Broughton, 2013). For agricultural pest management, trap cropping potentially reduces crop damage, inexpensively and simultaneously reduces conventional pesticide applications (Cavanagh et al., 2009; Lu et al., 2009). Farmers are motivated to utilize trap cropping because of the various difficulties in coping with the pest situation in other ways (Hokkanen, 1991).

This paper aims at presenting various crops suitable for an insect trap, which may be used in farms, as for the organic ones a sweep net shall be used to collect insect pests instead of pesticides.

Sarkar et al. (2018) points out that according to Hokkanen (1991) since the 1930s there have been numerous reported cases of successful trap cropping for managing various insect pests, ultimately resulting in a substantial reduction in the use of pesticides in developing countries. Sharma et al. (2019) presents a large number of authors who cite successful examples of the use of trap crops since the late 1900s for insect pest management on cotton, soybeans, potato, rape, beans, rice, sorghum, vegetable crops and others. Tillman & Cottrell (2012) reports that according to Hokkanen (1991) the cultivation of a trap crop is a pest management strategy that uses an attractive plant species that retains pests and reduces the likelihood of them entering the main crop.

## RESULTS AND DISCUSSIONS

A trap crop, also known as a sacrificial crop, that attracts pests and keeps them away from the main crop, which is why these valuable organic techniques are regularly used in organic farms (Dore, 2010).

Organic producers can stagger upon trap crops and use these tactics to mechanically remove insects (Majumdar et al., 2012). Sarkar et al.

(2018) mention that according to Zehnder et al. (2007) in organic crop production pest management relies primarily on habitat manipulation through farm scaping and other biological control practices.

There are two primary techniques used in the selection of trap cropping: selection of a more preferred plant species or cultivar grown at the same time as the main crop; planting of the same species and cultivar as the main crop timed to be at the most preferred stage of development before the main crop (Wszelaki & Broughton, 2013). The principle of trap cropping relies on pest preference for certain plant species, cultivars or a certain stage of crop development (Hokkanen, 1991; Fenoglio et al., 2017). In order for a crop to function successfully as a trap crop, there are two main processes of attracting the pest to the trap plant and retention of pests that arrive (Holden et al., 2012). Because insect invasions happen at specific times of the year, trap crops need to be sown in time to well established by the time pests arrive (Dore, 2010). Trap crops are generally attractive to pests during their reproductive stages; hence, trap crops are planted earlier than the main crops (Majumdar et al., 2012; Khan, 2015). Majumdar et al., (2012) cite Shelton & Badenes-Pérez (2006) and Wszelaki & Broughton (2010), who point out that trap crops are grown to lure pests away from the main crop by providing an alternative place for insects to feed and lay eggs. The supply of attractive host plants at the critical time in the pest's and/or the crop's phenology leads to the concentration of pests at the desired site, the trap crop (Hokkanen, 1991). Whether the same or different species are used, it is essential that the trap crop is more attractive than the main crop (Wszelaki & Broughton, 2013). Techniques of manipulation range from establishing an early or a late trap crop of the same cultivar as the main crop to planting a completely different plant species (Hokkanen, 1991). The amount of trap crops depends on the insect, which must be limited, as Parker and Snyder (2014) recommends that the trap crop is 10% of the crop used. According to Dore (2010) farmers usually set aside about 20% of the main crop area for the trap crop, which also may lessen dispersal out of the trap crop (Michaud et al., 2007). Sarkar et al. (2018) report the indication of Holden et al. (2012) that the trap crop should cover not more than 2-10% of the total crop area.

When trap crops successfully attract pest populations, the treatments are localized only in this area and the pests do not reach the main crop, thus limiting the damage to the crop (Wszelaki & Broughton, 2013). There are a number of publications that state that applying a pesticide directly to the trap crop is the most common method of controlling pests. This has worked in systems ranging from Lepidopteran pests of *Brassica oleracea* to *Acalymma vittata* and *Anasa tristis* on cucurbit crops (Dogramaci et al., 2004; Holden et al., 2012). Treating trap crops with insecticides at peak activity is an effective strategy to reduce pest populations (Majumdar et al., 2012). Plants produce chemicals, or volatiles, that attract insects for pollination and repel pest insects. Different species and cultivars produce varying degrees of unique volatiles substances that repel insect pests more strongly than others and this makes them suitable for trap crops (Wszelaki & Broughton, 2013). The different types of used trap crop 'complement' each other by providing a mixture of chemical profiles (different primary glucosinolates and concentrations of them); different physical structures (glossy leaves vs. hairy leaves) and different phenologies (rape matures later in the season) (Parker & Snyder, 2014).

Trap cropping, the use of alternative host plants to attract, intercept and/or retain targeted insect pests for the purpose of reducing damage to a main crop, is one such strategy (Holden et al., 2012). Since there is no single trap crop that can attract all pest species, the selection of trap crops depends on the target insect pest, while design or layout depends on the available field space, insect migration, and grower's preference (Majumdar et al., 2012). The layout of the trap crop should be according to the specific pest, as for some insects it is sufficient to plant the trap crop around the border, and for insects that are harder to stop, a different arrangement is used (Dore, 2010). In a presentation Majumdar (2011) points out that when the method of planting - border crop is used, a successful control of *Heliotis* sp. carried out through a castor trap crop, in the main cotton crop. An Internet source (PAN

Germany, 2005) lists trap crops that are used in the cultivation of cotton, with a suitable border crop okra as a trap crop against *Flower cotton weevil* (Hasse, 1987). When growing corn, the ICIPE (2003) recommends growing a border crop of Napier grass and Sudan grass to control stemborer. In a publication Sharma et al. (2019) indicates that the earliest successful examples of trap crops for insect pests management include management of boll weevil and *Helicoverpa armigera* on cotton; and the European corn borer and *Helicoverpa zea* (Boddie) on maize. As specified in all these examples, early planting of the same crop was used as trap crops. Shelton & Badenes-Pérez (2006) cites authors (Hunt & Whitfield, 1996; Hoy et al., 2000) who point out that early-planted potatoes were used as a border trap crop for the Colorado potato beetle moving from overwintering sites to crops attacked by it and concentrating in the outer rows, where it could be treated with insecticides, cultural practices, or even propane flamers. Sharma, (2013) quotes Thiery & Visser (1987), according to who the Colorado potato beetles are attracted to volatiles from potato, but are repelled or not attracted by mixtures of potato and tomato. Majumdar (2011) and Dore (2010) report that it is recommended against slugs in vegetables to form a border crop of chervil. Nettle attracts aphids and Nasturtiums are also very attractive to aphids (blackfly, greenfly, whitefly), while radish attracts *Flea beetle* and Root fly away from cabbages (Dore, 2010). For effective control of thrips it is recommended to use basil and marigold as a border crop in the main crop of garlic (Majumdar, 2011), and in the crop of pepper successfully results are achieved by the formation of a border crop with corn (Vlahova, 2013). Parker et al. (2013) presents an example of pacific gold mustard as a crop trap, which is flanked on both sides by the main crop of broccoli. The main mechanism of operation of the trap crop shows that the trap crop is more attractive than the main crop. The mustard crop is often used to attract pests away from broccoli. Sharma et al., (2019) cite Criddle (1922), according to who Rye grass was used as the trap crop in ditches and headlands of wheat fields to provide a place for laying eggs of *C. cinctus* and were later destroyed crop. The same study reports that brome grass can also be a superior trap crop because the survival rate of *C. cinctus* larvae is considerably lower on this plant and also the parasitism rates are greater on this grass. Another crop - fall rye, has also been found to be an effective trap crop for *C. cinctus* management.

Parker and Snyder (2014) presents two specific ways of arranging a perimeter trap crop-as a boundary surrounding the main crop and a strip trap crop on one side of the crop. Boucher et al. (2003) points out that perimeter trap crops can be defined as a planted crop around the border of the main crop. Shelton & Badenes-Pérez (2006) specifies that more attractive plants are used for insect control. Boucher & Durgy (2004) cite many authors who determine that perimeter trap cropping has led to a dramatic increase in trap crop efficacy over the past decade on a variety of pests and crops. But they clarify that perimeter trap cropping does not work on every pest or for every crop. The authors report that perimeter trap cropping functions by intercepting pest migration, concentrating the pest population in the border area, where they can be controlled, thus preserving natural enemies in the main crop. Boucher & Durgy (2004) recommend applying foliar insecticides to the perimeter crop as soon as beetles are found or their feeding begins on the trap crop, without waiting for a threshold level to be exceeded. A perimeter trap crop system incorporating sorghum (NK300) and Peredovik sunflower in Clanton, Alabama provides significant reduction in pesticide usage on tomatoes as a main crop. Insecticide treatment of sorghum at peak leaffooted bug activity provides 78 to 100% control of the pest without the need to treat the main crop. Only 12 to 15% production area under trap crops can be adequate for significant pest management; this characteristic makes the sorghum and sunflower mixed trap crop system very economical (Majumdar et al., 2012). In a presentation indicates that Zonosemata electa attacks many types of pepper, but has a preference for cherry pepper (Shelton & Badenes-Pérez, 2006). Shelton & Badenes-Pérez (2006) adds that Boucher et al. (2003) has reported the use of hot cherry peppers as a perimeter trap crop in bell peppers for control of pepper maggot. Rea et al. (2002) report that in New Zealand the density of green stink bug (*Nezara viridula*) is reduced, the timing of their colonization is delayed, and cob damage to sweet corn is reduced after growing black mustard (*Brassica nigra*) around the perimeter of fields as a perimeter trap crop. Hormchan et al. (2009) report two interesting experiments conducted in Thailand, using perimeter trap cropping and row intercropping with okra and castor bean, as well as sunflower and castor bean, to track the populations of leafhopper.

Perimeter trap cropping and row intercropping of okra, and castor bean and sunflower respectively in the cotton plots have given lower numbers of cotton leafhopper and higher yields than those in the sole cotton. Shelton & Badenes-Pérez (2006) cites Pair (1997) giving an example of conventional trap cropping by using highly attractive varieties of squash to manage squash bugs and cucumber beetles in several cucurbitaceous crops. This example as perimeter trap cropping is also cited by Majumdar (2010) who points out that the squash is a suitable perimeter trap crop for the main crop-watermelon, cantaloupe and cucumber, and it is important to plant the squash earlier and apply insecticide on borders, as squash lure 66% cucumber beetles and 90% squash bugs. In a presentation Majumdar (2011), reports an example by Cook et al. (2006) for turnip rape (*Brassica rapa*) as perimeter trap crop in the main crop-oilseed rape (*B. napus*) against pollen beetles. Majumdar (2011) reports that Cook et al. (2007) call this the 'push-pull' strategy. Shelton & Badenes-Pérez (2006) explains that push-pull trap cropping is based on a combination of a trap crop (pull component), which attracts insects, with a repellent intercrop (push component) that diverts the pest away from the main crop. The so-called 'push-pull' strategy has shown very good results in Kenya. Sharma (2013) cites Linker et al. (2009), for example, Row trap crops are another option for successful control of *Heliotis* sp., as they are placed in a number of rows in the cotton, for example, every 5 rows of cotton, 1 row of sunflower or cowpea (CIKS, 2000); for every 20 rows of cotton 1 row of tobacco or corn (Hasse, 1987).

Row intercropping is the planting of a trap crop in alternating rows within the main crop with a push-pull approach, where a trap crop is used to pull the pest species away while the protected cash crop is intercropped with a plant that repels pests. This approach has been used successfully to protect maize in Kenya. Sharma et al. (2019) cites Farstad & Jacobson (1945) with another strategy to grow wheat plants around the perimeter of a fallow field adjacent to a wheat field, with an empty space in between the fallow and wheat field, which attracts *C. cinctus* adults emerging from the previous year crop.

A strip trap crop is a specific way of arranging on one side of the crop (Parker & Snyder, 2014). Tillman (2006) points out that strip planting of trap crops is the formation along one common border between two or more crops. A well-known example of a strip trap crop is alfalfa grown to a main cotton crop to limit the development of *Lygus bug* (Majumdar, 2010; Majumdar, 2011; Meyer, 2003; PAN Germany, 2005; Rana, 2018). Shelton & Badenes-Pérez (2006) cites the authors Stern (1969) and Godfrey & Leigh (1994) who report the most widely cited example of alfalfa as a successful crop trap in conventional cotton cultivation in the central valley of California in the 1960s to control the lygus bugs. Majumdar (2011) points out that cotton, sorghum and peanuts can be effectively grown by strip trap cropping, relying on pheromone traps with high levels of parasitism reported from the tachinid fly in sorghum. Saeed et al. (2013) uses alfalfa as a strip crop, in which predators multiply, as this strip is parallel to wheat. They have found that the role of fodder crops as a trap crop in wheat is significant, as they decrease the insecticide application on the main crop. It is reported that the maximum population of aphids has been observed on plots not trap cropped with lucern, as the highest population of lice has been observed in the area without alfalfa. (Hormchan et al., 2009). In sunflower, marigold is grown to successfully control *Helicoverpa armigera*; against *Spodoptera litura* castor is grown (Sharma, 2013). Majumdar (2010) points out that alfalfa is a very suitable trap crop, which is planted in rows, and the main crop is strawberry, as it regularly vacuums an alfalfa trap crop to reduce the damage to organic strawberries by *Lygus* *hesperus* (Swezey et al., 2007; Hagler et al., 2018). An example of the successful infestations of diamondback moth in cabbage in Florida is the use of collard greens (*Brassica oleracea* var. *acephala* L.) as a trap crop (Mitchell et al., 2000). Sarkar et al., (2018) cites Bender et al. (1999), according to who sorghum (*Sorghum bicolor* L.) has been successfully used as a trap crop in cotton fields, and according to Bukovinsky et al., (2005) black mustard reduces the kernel injury in sweet corn caused by *Nezara viridula* L.

Another effective method of planting a trap can be applied to a main cabbage crop, every 15 rows with Chinese cabbage to effectively control the cabbage webworm; mustard to effectively control the *Flea hopper*, and radishes to effectively control mustard aphid (Majumdar, 2011). Studies by Vernon et al., (2000) report that wheat planted 1 week in advance of planting strawberries is a successful trap crop because it effectively reduces wireworms *(Agriotes obscurus* L.), plant mortality and can be used as an inexpensive pest management method. Shelton & Badenes-Pérez (2006) mentions sequential trap cropping and cites the authors Pawar & Lawande (1995), who suggest that Indian mustard is suitable as a trap crop for diamondback moth, but requires planting mustard two or three times through the cabbage season because it has a shorter crop cycle than the cabbage and other cruciferous crops. According to Klopatek & Gardner (1999) a trap crop should be viewed in the larger context of landscape ecology (Shelton & Badenes- Pérez, 2006; Reddy, 2018). A trap crop is alternative IPM tactics being under investigation in New England (Boucher & Durgy, 2004; Bucher & Cheng, 2012), Tennessee (Wszelaki & Broughton, 2010), and Alabama (Majumdar et al., 2012). Tillman & Benefits of trap crops include the reduced cash crop damage, the reduction in pesticide dependence, and enhanced biodiversity (Majumdar, 2011; Majumdar et al., 2012). The advantages of trap crops in reducing the use of insecticides are highlighted: reduction of pest incidence to manageable levels (Balusu et al., 2012); conservation of indigenous natural enemies by providing shelter to be useful in the agrocenosis; growing harvested crops trap (alfalfa, squach); can be integrated with Cottrell (2012) report scientific papers focusing on trap crops that effectively control stink bugs (Todd & Schumann, 1988) in soybean and sweet corn (Rea et al., 2002) in conventional and organic production systems. Tillman & Cottrell (2012) report that according to Wiseman & McMillian (1971) and Tillman, (2006) sorghum (*Sorghum bicolor* (L.) Moench spp. *bicolor*) is an important host plant feeding on its panicle to the stink bugs, thus suppressing *N. viridula* populations in the agricultural land in Georgia. In his publication Mertz (2018) presents the idea of the researcher Anne Nielsen's group from the Rutgers University, who has tested a combination sunflower - sorghum as a trap crop located around the perimeter of a vegetable plot to learn whether the trap crop would reduce the brown marmorted stink bug (BMSB) pressure in the vegetables. Mertz (2018) reports that according to Nielsen the Brown marmorated stink bugs are a particular problem for organic growers who cannot apply the insecticides used by traditional growers, so the use of trap crops have proven to be a solution to entice the invasive pests away from fruits. For three years Nielsen has conducted field tests on 11 organic farms in the United States to study the effectiveness of the sunflower/ sorghum trap crop, as he has indicated that BMSB could be successfully controlled. The author reports that insecticides are used once or twice per season in the trap crop to knock down BMSB; the use of pheromones increases the time the stink bugs spend on the trap crop; and the use of trap crop boost populations of samurai wasps, which would in turn reduce BMSB numbers. Another researcher, Szűcs (2019), reports that BMSB are successfully controlled in Asia by samurai wasps, and already in Michigan, samurai wasps can help control BMSB. existing farming practices (Majumdar, 2010). The shortcomings mentioned by the farmers are reported in order to clarify their use. The disadvantages of trap cropping are the need for additional planting and resources; growers need knowledge of insect behavior and migration; timely management of insects in a trap crop: otherwise you have a 'pest nursery'; and the proportion of cash crop to trap crop (Rao, 2001).

## CONCLUSIONS

Trap cropping a useful approach in farming systems. The advantages of trap crops definitely can be used in both commercial (cash crop) and non-commercial crop production. The ability to limit a pest on the farm is essential. The application of the insect trap approach has proven its efficiency in farming systems characterized with the application of pesticide treatment, but it may be also used in organic farming by using those insecticides permitted according to Regulation (EC) No 889/2008 in combination with sweep net sampling.

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