*Research Paper*
*Impact Factor: 4.164*
*Refereed Journal*

*IJMDRR*
*E- ISSN –2395-1885*
*ISSN -2395-1877*

# EFFECT OF INTERCROPPING ON INSECT PEST AND CROP YIELD: A REVIEW

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***Abstract***
*Intercropping is the planting of more than one crop in close proximity as part of the same farming system. The design of intercropping system can vary dramatically depending on the purpose of the intercrop for the depending on the purpose of the intercrop for the farming operation. Intercropping produces the benefits of in far diversity increased productivity, resource distribution balance; far risk reduction, weed and insect pest control. The various crop plants have the efficiency either by attracting or reflecting the insect pest. The plant morphology like thorns, hairs, excretory material helps the plant to defend from the crop pest. The intercropping is a tool of IPM system .The IPM now shifted to NPM .The intercropping concept of managing insect pest is eco friendly and sustainable in nature.*

***Key Words-Intercropping, Insect Pest, Management, Production, Crop.***

Growing of two or more crops simultaneously on the same field. Crop intensification is in both the time and space dimensions. There is intercrop competition during all or part of crop growth.(Reddy 2004).Intercropping of cotton with black gram, green gram, cowpea etc .in central and southern India is reported to divert the population of sucking pests and American bollworm from cotton .Intercropping of groundnut with pearl millet reduces the incidence of thrips, jassid and leaf minor. Tomato intercropped with cabbage has been reported to inhibit or reduce egg laying by diamondback moth. Intercropping of taramira in raya reduces the incidence of mustard aphid in the latter crop due to allelopathic influence of the former. Intercropping of chickpea with barley, wheat, linseed, mustard and sunflower is also known to reduce infestation of H.armigera in chickpea.( Atwal and Dhaliwal 2002).

The system of intercropping necessitates growing of different crops simultaneously on the same land. Such diverse community has fewer fluctuations in numbers of a given species and is stable. Several cultural practices are known to promote diversity and stability on the farm, including the Intercropping (Ouma and Jeruto 2010). This practice increased the distance between plants of the same species which leads to complicate migration of pests or transmission of diseases from one plant to another in the same field. In crop protection generally there is a base crop and one or more associated plants grown within, acting as repellent or attractant for certain pests. Attractant species are mainly used as trap plants to reduce pest infestation on the base crop. Once pests are lured from the main crop on to the trap plants, they can be controlled in limited area with minimum cost. Field intercropped fenugreek (Trigonella foenum greacum) with muskmelon decreased various pests (B. tabaci, Aphis gossypii and Aulacophora Africana) and suppressed oviposition of Epilachna elaterii and its subsequent numbers.( Mahmoud 2000 and Mahmoud and Abdelbagi 2004). Also, intercropping of millet with sorghum to disrupt egg laying of the millet head worm (Heliocheilus albipunctella), significantly minimized the pest infestation on millet compared to the sole crop(Bashir and Eisa 2004). Vegetable crops intercropped with Lablab purpureus, as a trap plant, significantly divert the population of Bemisia tabaci on to the latter crop. Because L. purpureus is a non host for the leaf curl virus, it contributes a lot in reducing the disease incidence when intercropped with some susceptible vegetables like tomatoes(Satti 2008). On the other hand, sowing of L. purpureus in alternating holes with sorghum on the same day, suppressed Striga weed population density by 88%, compared to sole sorghum crop.( Dawoud 2004). However, recently both of repellent and attractant plants are utilized in pest management, an approach known as “Push-Pull” strategy. This was applied in controlling whitefly on Phaseolus vulgaris when intercropped simultaneously with L. purpureus and Coriandrum sativum. The latter crop acted as a repellent, while L. purpureus diverted the whitefly away from the main crop (P. vulgaris)(Oji et al 2004).

Sekamatte et al., (2003) reported that intercropping of maize with soybean, groundnut and common beans reduced the termite attack, reduced loss in grains yield of maize and increased the nesting of predatory ants in maize field, in many instances termite attack was significantly lower in the maize soybean intercrop than in maize intercrop with groundnuts and beans.

Mochiah et al., (2011) observed the treatment with sole tomato, sole cabbage, two rows of cabbage to one row of tomato, three rows of cabbage to one row of tomato and four rows of cabbage to one row of tomato in organic production system. Result on the insect pest population showed significant differences, no significant differences observed between control cabbage and the cabbage-tomato intercrop. The study concluded that for better insect pest management and high productivity in organic cabbage production, two row of cabbage to one row tomato among the treatment was the most appropriate.

[The need to grow crop under non-pesticide management (NPM)of insect pest and crop cultivation cost to a minimum. Different category of intercropping used by gower to produce different crops for commercial and personal consumption. The same species crops ay not is best for intercrop. The causes behind it is that on one crop may invite same attack on the other, leading to total crop loss]

Asare-Bediake et al., (2010), said & Itilya (2003), studies significantly lower population of DBM in cabbage plants intercropped with other non-host plant due to the confusing alfactory and visual cues received.

Bjorkma(2007) reported the intercropping of cabbage (Brassica oleracia) and red clover (Ttrifolium prates) affected the different life cycle stage of Delia florals. It was indicated that intercropping reduced turnip root fly, D.Floralis oviposition copared with manaculture Broad (2007) indicated that the insect pest population of broccoli, P. Xylostella was reduced by mixed cropping system.

Sharaby et al., (2015) evaluate the effect of intercropping of potato (Solanum tuberosuL.) with onion (Allium capa L.) on whitefly (Bemisia tabaci), aphid (myzus passcae and Aphis gossypi) infestation in potato fields. Intercroppinf significantly reduced potato plant infestation with whitefly by 42.7, 51.3% while it was 62.69% reduction with aphid during two successive winter season than when potato plant were cultivated alone.

Baidoo et al., (2012) reported that onion was used as an intercrop to manage the pests of cabbage.

Intercropping system for insect pest control includes the planting of a crop that has a repellent effect, or a combination of both, on a target pest in close proximity to a crop that has the potential to be attacked by it. (Degri et al., 2014). Ay spatial combination are possible for intercropping, including mixed intercropping, in which different crops are planted in the same row or at alternating rows. Crop rotation eans planting different crops on the same plot during different time of the year, and can include some of the benefits of intercropping, such as reducing insect pest population, increasing beneficial insects, and weed suppression. In addition, non crop plants such as in space and time to influence numbers of pest and beneficial arthropods on the main crop (smith and Liburd 2015). Some plant combinations, for instance , with non hosts reduce the spread of pest within crops (Degri et al., 2014). Non host plant in such mixture may emit chemical or odors that adversely affect the pests, thereby conferring some level of protection to the host plant (Reddy 2012)

Studies indicate that crop diversification through intercropping, such as cereals with legumes, is effective in reducing insect pest damage. The intercropping of groundnut with pearlmillet (Pennisetum glaucu L) increased the population of Gonizous sp, a parasitoid species that effectively manages leaf minor population in groundnut.

Chabi olaye et al., (2005) found a considerably reduced amount of noctuid eggs laid by Sesamia calamistis Hampson and Busseola fusca Fuller due to lack of the host found by the ovipositing adult moths in maize intercropped wit grain legumes or cassava than those in mono crop.

wszelaki (2014) reported that the use of intercropping can provide benefits to a management system, including decrease insect pest pressure, reduced need for external inputs, increase in biodiversity , enhanced production and lower economic risk. Separation susceptible plants with non host species provides a physical barrier to insect pest movement, limiting spread and decreasing livelihood of damage to susceptible varieties. Separation of tomato and potato that are susceptible to Colorado potato beetle with a non host crop such as a corn can reduce the movement of Colorado potato beetle from one solanaceous crop to another.

Vdinll & odebiyi (2011) intercropped okra and pepper & recorded five pests of okra which is podagrica uniforma, p. sjostedti, oxycarenus superstitiosus. The fruit damage in the sole crop okra.

Ganiger et al., (2009) intercropped the groundnut with cowpea, sesame, greengram, caster and redgram at early stage of the crop all redgram reduces pest population compared to that of in groundnut.

Sreekant et al., (2004) recorded that if greengram intercropped with pearlmillet then pulse crop minimum in thrips incidence followed by green gram-sorghum and green gram – maize comnination.

Abro et al., 2004 observed that, if cotton & okra raised as mixed crop then highest Earias spp. infestation in okra sole crop.

Chamuene et al., 2007 observed in case of cotton strip intercropped with sorghum, redgram, crotolaria or chraleuca population of H. armiger and other phytophagous insect was lower in the strip intercropped than in pure cotton crop and the total nuber of natural enemies was more abundant in the cotton strip intercropping.

Soundararajan and chitra carried out research to know the effect of intercrops viz.grouncnut, sorghum and pearl millet with black gram on whitefly Bemisia tabaci, leaf hopper Empoasca kerri, defaliator madurasia obscurella, pod borer maruca vitrata , lampides boeticus, helicoverpa atmigera. The sucking pest B. tabaci and E,kerri population low in intercropped compared to sole crop. The legume pod borer and other pod borer damage were low in the sorghum intercropped black gra. The non-leguminous cereals intercropped black gram plants had low pest incidence as well as higher coccinellid population.

Chabi-olaye et al., (2005) reported groundnut and pearl millet intercropping for management of stem borer pest. Degri and Samaila (2014) reported the result showed that fruit borer larvae holes per plant was found minimum when tomato was intercropped & maximum in sole tomato crop.

Intercropping has some suppressing effect in most of the insect pest through the changed cropping canopy and resultant change in micro-climate (jayaraj 2002 Ljoyah 2012, Degri et al., 2014).

Intercropping leads to the diversity of crop grown and reduction of plants of the same species is increased due to the planting of other crops between them, alteration of more beneficial insect pest especially when following crops are included in the cropping system (George and Jeruto 2010, Ram and singh 2010).

The use of intercropping system is one of alteration to insecticide. It is a non-chemical cultural practice that has the potential to reduce pest infestation because it increases crop diversity.(Sullivan 2003, woomer et al., 2004, Degri et al., 2012, Degri et al., 2014).

Jankowska et al., (2009) observed the impact of intercropping white cabbage ‘Bently F1’ with French marigold (Tagetes patulanana ‘kalombina’ and pot marigold ( calendula officinalis ‘promyk’) on the occurrence of pest on plots where cabbage was intercropped the number of cabbage aphid Brevicoryne brassicae L and flea beetles phyllotreta was significantly lower. The lower number of eggs of the small white butterfly pieris rapae L, large white butterfly p. brassicae L, cabbage moth mamestra braddicae L and larvae and pupae of DBM were observed on plots whit calendula and Tagetes. Intercropping with pot marigold was the most effective pest control on cabbage.
Zhouhai-bo et al., 2013 reported increases in the abundance the aphid predator species, such as lady beetle, when wheat fields were intercropped with garlic.

Agriculture biodiversity is a fundamental feature of farming system around the world (thrupp 2000)
Maximizing survival and reproduction of beneficial arthropods requires ptovision of pollen and nectar resources that are often scare in modern agriculture land scapes (Isaacs et al., 2008).plant diversity can be beneficial to control pestvia “topdown” enhancement of natural enemy populations and by resource concentratia and other ‘bottom-up’ effects acting directly an pests (Gurr et al., 2003).

Sholes (2008) pointed that specialist herbivores became less abundant when non host species are mixed with their host plants and provided the evidence of associational resistance theory.
Push-pull strategy involves the behavioral manipulatia of insect pest and their natural enemies via the integratia of insect pest and their natural enemies via the integratia of instmuli that act to make the protected resource unattractive or suitable to the pest (push) while luring them toward an attractive source (pull) from where the pest are subsequently removed (cook et al., 2007).

Crop intercropping or mixing as a traditional agricultural technique for preventing crop yield decrease from plant disease and pest infestation in different world geographical areas(ma et al., 2007), can also increase biodiversity in field to encourage environmentally sustainable agriculture production with low inputs of pesticide (Ghaley et al., 2005).

Such naturally occurring predatory species have the potential to allow a reduction in inputs of chemical pesticide as they provide natural pest control. Both the direct impact of invertebrate predators on agriculture herbivores (symondson et al., 2002, Ives et al., 2005, snyder et al., 2005, Tscharntke et al.,. 3005) and the indirect effects that they have on other ecosystem

processes such as primary productivity and element cycling ( Downing and Leibold 2002, Paine 2002. Duffy 2003, Duffy et al., 2005, Fukami et al., 2006, Maron et al., 2006, Schmity 2006, Schmitz 2007).

One potential benefit associated with intercropping that has received increased attention over recent years has been its use as a strategy for crop protection against insects pests (Symondson et al., 2002, Aquilino et al., 2005, Ponti et al., 2007, Fiedler et al., 2008, Khan et al., 2008).
Tiwari et al., (2005) observed the effect of intercropping of mustard with potato, coriander, chickpea, wheat, linseed and fenugreek on the incidence of the major insect pest i.e. mustard aphid (Lipophis erysimi), flea beetle (Phyllotreta cruciferae) and sawfly (Athalia proxima). The lowest aphid population was recorded in mustard grown with coriander and maximum population on mustard as sole crop. Flea beetle incidence was minimum on mustard intercropped with linseed and maximum when sown with potato. While sawfly population was minimum on mustard sown with potato and maximum on mustard as sole crop.

Mishra et al., (2001) reported the lower incidence of L. erysimi on mustard +chickpea intercropping.
Lascar et al.,(2004) reported that intercropping of mustard with various other winter season crops (wheat, barley, radish, fenugreek, spinach, coriander, pea and fennel), sown at 2:1 ratio, resulted in lower incidence of the aphid except in mustard-radish combination in which the incidence was with sole crop of mustard; the minimum incidence was found in mustard-wheat, which was with mustard-barley combination.

Goel and Tiwari (2004) intercropped mustard with potato, wheat, gram(cicer arietinum), linseed, fenugreek and coriander or grown as a sole crop in pantnagar, Uttar Pradesh, India and counted L. erysimi & found lowest when mustard was intercropped with coriander, followed by linseed, fenugreek, gram, wheat and potato and the maximum aphid population was recorded when mustard was grown as a sole crop.
Meena and Lal (2004) reported the effect of cabbage intercropped with lucerne, garlic, mustard, marigold and tomato on mustard aphid, Lipaphis erysimi incidence and found that Lucerne was the most effective followed by garlic, while mustard was the least effective intercrop in reducing the aphid population.

Monika et al., (2005) determine the effect of intercropping Indian mustard with potato, coriander (coriandrum sativum), chickpea, wheat, linseed and fenugreek, on the incidence of the major insect pests, i.e. mustard aphid (Lipaphis erysimi), flea beetle (phyllotreta cruciferae) and saw fly (Athalia proxima) and on the yield of mustard as sole crop and with intercrops. The lowest aphid population was recorded in mustard grown with coriander and the maximum population was observed on mustard as sole crop. Flea beetle incidence was minimum on mustard intercropped with linseed and maximum when sown with potato, while saw fly population was minimum on mustard sown with potato and maximum on mustard as sole crop.

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