

Intercropping of African marigold with tomato for better productivity, pest control and economic returns in Arunachal Pradesh

ABSTRACT

This study was carried out during Rabi season of 2017-18 and 2018-19 respectively in Tirap district of Arunachal Pradesh to find out the best line combination of marigold with tomato. Total three treatments (T1- 3 rows of Tomato with 1 row of marigold, T2- 3 rows of Tomato with 1 row of marigold and T3- Control (tomato sole crop) were planted with three replications under Randomized block design. T1 recorded minimum infestation of tomato fruit borer (5.47 %), maximum fruit yield (16.32 t/ha), maximum net return (Rs. 1,53,000), Best B:C ratio (3:1) while T3/control recorded least (18.32%, 14.27 t/ha, rs.1,17,780 and 2:43 respectively).

INTRODUCTION

The tomato fruit borer (*Helicoverpa armigera*) is most destructive pests of field crops worldwide. It is widely disseminated in different agroclimatic conditions, high mobility, having good survival rate under adverse conditions too and have capacity to complete several generations in a year. It's also having ability to develop resistance against insecticides, polyphagy in nature; by which it survives in better way during lacking of major food instead of mortality. The several studies have reported that its outbreak leded the development of insecticide resistance due to heavy spray of insecticides, which are known to have detrimental effect on populations of its natural enemies and bioclimatic factors in host plants (Fitt *et al.*, 1995; Naseri *et al.*, 2009). The several studies have proven that light trap can also use to control of *Helicoverpa armigera* (Kumar *et al.*, 2012). Being the movement from one crop to others, these insects exposed to many applications of pesticides and as the result; they became pesticide resistant. According to Puri, 1995, the 55% spray of insecticides consumed by *Helicoverpa armigera*. The residual effect of insecticides in human health are the discussion points in present era due to occurrence of so many disease and health issues in human kind. Thus, the minimization of chemical spray for better health as well as reduction the production cost is the demand of moment. Thus, the significance of trap plants increases. Utilizing plants in a cropping area to draw oviposition away from the primary crop is known as trap cropping. Trap crops protect the main crop from pests that would otherwise wipe it off. To keep the field safe, trap crops might be sown all the way around it or sporadically, like every ninth row. Plant alfalfa and mustard next to strawberries to draw lygus bugs and place Pelargonium geranium among rose bushes to deter Japanese beetles from eating the geranium, which is poisonous to them.

In order to keep pests from getting to the main crop, trap crops divert them away or concentrate them in specific field products where they may be readily stopped or managed. Trap

crops serve an additional purpose for natural enemies and have an important property that makes them noticeably more attractive to pests (Pats *et al.*, 1997). Gaurav sharma *et al.* (2022) has wrote the following uses of marigold-

Natural Herbicide-

The marigold oil obtained from leaves have antifungal properties against soil borne diseases. Its major constituents are - piperitone (33.77 %), trans-ocymene (14.83 %), terpinolene (13.87 %) and β -caryophyllene (9.56 %).

Insecticidal properties -

The foliage, root and flowers parts are the good sources of insecticidal compounds. In different studies proven that flowers having the best active ingredients regarding insecticidal properties. The β -caryophyllene, piperitenone, tetracontane, C botryococcane and decane are the major compounds (Ravikumar, 2009). The alpha-pinene, limonene and borneol are the compounds which are responsible for antifeeding characteristics of marigold. Borneol is also a component of many essential oils and is a natural insect repellent. He further added that alpha-terpineol is also responsible for the insecticidal and pesticidal properties of the plant. Green *et al.* (1991) suggested some potential of *T. minuta* oil or its components for the control of *A. aegypti* and other mosquitoes.

Trap crop-

The crop grown for attracting the pest and protecting the main crop is known as trap crop. The Successful use of marigold as trap crop for management of tomato fruit borer on tomato is on record (Srinivasan and Moorthy, 1991) with marigold in 3:1 combination without using any type of insecticide (Hussain and Bilal, 2007).

Allelopathic effect

Allelo-chemicals can be defined as plant metabolites or their products that are released into the microenvironment and are toxic to other organisms (Halbrendt, 1996).

The marigold produces different kind of compounds that are biologically active including α -T compounds and polyacetylenes. Of these, α -T compounds are strongly photoactivated and phytoinhibitory and can be exploited to control nematodes and other plant pathogens such as *A. solani* (Gómez-Rodríguez *et al.*, 2003) as well as biological control of weeds (Lambert *et al.*, 1991).

Nematode management

It has been proven that marigold suppress plant-parasitic nematodes *Meloidogyne* spp. and *Pratylenchus* spp. (Hooks *et al.*, 2010). Literature also indicates that marigolds could prevent the population increase of 14 genera of plant parasitic nematodes. The allelopathic effect of marigold responsible for nematode suppression is mainly attributed to α -terthienyl (Gommers and Bakker, 1988). Marigold has been reported to kill plant parasitic nematodes as a standing cover crop and is ineffective after soil incorporation. It is found that the nematicidal activity of marigold is only detected in the root exudates (roots of the growing plant) but not in the homogenized extracts of roots and leaves. Marahatta *et al.* (2010) reported that

root-knot nematodes infestation can be suppressed more efficiently by planting marigold.

Thus, in view of a numerous benefit of marigold intercropping with different crops, KVK Tirap had decided to conduct a trial of tomato with marigold with following objectives-

- To know the best line combination in between tomato crops
- To encourage chemical free farming
- To disseminate this technology among farming community
- To minimizes the cost of cultivation

MATERIALS AND METHODS

Krishi Vigyan Kendra - Tirap, Arunachal Pradesh conducted On Farm Trials on” Intercropping of African marigold with tomato” to assess the scale of insect control in tomato plant; in Rabi season, 2017-18 and 2018-19 respectively in Noitong, Soha, Doidum villages. Tomato; variety- Pusa Sadabahar and African Marigold, variety- Pusa Narangi were planted. The trials were conducted under Randomized block design (RBD) with three treatments -

T1- 3 rows of Tomato with 1row of marigold

T2- 3 rows of Tomato with 1row of marigold

T3- Control (tomato sole crop) and all these three treatments were replicated thrice.

The selected farmers were well educated through village level training about scientific cultivation practices of tomato with marigold as an intercrop. The total three (03) farmers were selected from these villages. The total area of the trial was 0.10 ha (0.033 ha size plot of each farmer). The seeds of Pusa narangi variety of African marigold were sown in Nursery at KVK Tirap on 10th October, 2017 and 2018 respectively. And seeds of tomato; variety- Pusa sadabahar were sown in nursery of KVK on 25th October, 2017 and 2018 respectively. All the cultural practices were followed scientifically. The 25 days old tomato seedlings were transplanted at the spacing of 90 cm (row to row) x 45 cm (plant to plant) and 35 days old seedlings of marigold planted.

In Arunachal Pradesh three types of Agro-climatic zones are prevails. the Tirap district falls under Eastern Himalayan Region (Zone II), Sub region-: Per Humid Hyper Thermic Foothills; where hot and humidity is very common characteristics. The rains start from End of February and continue up to September. The intermediary dry spells are often occurs which are very heat and humid.

The weather during the research period has given in Table No- 1

| Month | Rainfall(mm) | | Temperature °C | | | | Relative Humidity (%) | | | |
|----------------|--------------|-------|----------------|------|------|------|-----------------------|----|------|----|
| | 2017 | 2018 | 2017 | | 2018 | | 2017 | | 2018 | |
| | | | Max. | Min. | Max. | Min. | M | E | M | E |
| April- 2017 | 247 | 186.0 | 34.4 | 12.2 | 35.2 | 13.2 | 82 | 67 | 81 | 65 |
| May- 2017 | 327 | 117.5 | 35.6 | 14.6 | 36.7 | 15.1 | 86 | 73 | 89 | 75 |
| June-2017 | 241 | 433.4 | 36.8 | 16.5 | 37.7 | 17.2 | 91 | 80 | 93 | 82 |
| July-2017 | 347 | 336.6 | 34.2 | 18.4 | 35.4 | 18.9 | 93 | 83 | 95 | 81 |
| August-2017 | 493 | 277.3 | 33 | 19.1 | 34.2 | 20.1 | 87 | 85 | 89 | 87 |
| September-2017 | 371 | 186.2 | 32.3 | 18.8 | 33.6 | 20.1 | 88 | 84 | 91 | 86 |
| October-2017 | 162 | 118.0 | 26.5 | 17.2 | 27.4 | 18.4 | 89 | 90 | 92 | 92 |
| November-2017 | 7.6 | 15.4 | 25.1 | 12.3 | 25.9 | 14.1 | 87 | 82 | 89 | 88 |
| December-2017 | 0 | 0 | 25.8 | 9.4 | 26.2 | 10.2 | 85 | 83 | 86 | 87 |
| January-2018 | 12.2 | 12.7 | 25.4 | 8.6 | 26.2 | 9.1 | 85.7 | 88 | 84.9 | 88 |
| February-2018 | 69.6 | 69.0 | 26.1 | 7.9 | 26.9 | 8.3 | 88 | 90 | 83 | 92 |
| March-2018 | 138.2 | 123.0 | 28.7 | 8.8 | 29.1 | 9.2 | 85 | 81 | 82 | 83 |

Where Max. denotes maximum, min. denotes minimum, M denotes Morning, E denotes evening

The Observation on population of tomato fruit borerplant⁻¹ was recorded from the selected plants on both tomato and marigold at 40, 60 and 85 days after transplanting. The percentage of fruit damage was also calculated at 40, 60 and 85 days after transplanting.

The fruit damage percentage was calculated by the following formula:

$$\text{Percent fruit damage} = \frac{\text{No. of Fruit damage}}{\text{No. of fruit damage}}$$

Results and Discussions-

The pooled data on effect of marigold on infestation on tomato fruit borer during 2017-18 and 2018-19 clearly indicating that the closer spacing was resulted positively on tomato yield. The average fruit damage was 5.47 to 18.32 in different treatments. The T1 yielded minimum damage 7.99, 4.94 and 3.48 % respectively after 50 days, 65 days and 80 days after transplanting. While the T2 damage level were 9.11, 6.28 and 3.49 % respectively after 50 days, 65 days and 80 days after transplanting. And T3 was the

recorded poorest: 16.87, 18.42 and 19.68 % respectively after 50 days, 65 days and 80 days after transplanting.

The uses of marigold as a trap crop in different ratios has proven its utility. According to Shrinivasan *et al.* (1994), marigold produces huge number of green leaves and flowers; which feeder by fruit borers during the cropping season of tomato. The larvae feed quickly and has no option to move towards tomato crops. In this result, the fruit damage was significantly recorded lesser over control. The T1 had maximum density of marigold yielded 5.47% fruit damage while T2 had medium density of marigold; yielded 6.29% of fruit damage. And Control resulted 18.32 % fruit damage; due to lack of marigold crop. Shrinivasan *et al.* (1994) and Virk *et al.* (2004) have also mentioned that marigold crop is a good natural repellent of tomato fruit borers in different agroclimatic conditions and this study has also proved that marigold can uses as natural repellent in climatic conditions of Arunachal Pradesh.

Table -2: Effect of marigold on infestation on tomato fruit borer (during 2017-18 and 2018-19 : pooled data)

| Parameters | 50 days | 65 days | 80 days | Average |
|------------|---------|---------|---------|---------|
| T1 | 7.99 | 4.94 | 3.48 | 5.47 |
| T2 | 9.11 | 6.28 | 3.49 | 6.29 |
| T3 | 16.87 | 18.42 | 19.68 | 18.32 |
| CD (5%) | 1.51 | 1.29 | 0.76 | |

Table-3: Result of marigold intercropping with tomato (pooled data of 2017-18 and 2018-19)

| Parameters | T1 | T2 | T3 |
|---------------------------------|----------|----------|----------|
| Plant height (cm) | 60.23 | 58.26 | 57.44 |
| No of fruits/plant | 37.89 | 31.65 | 29.76 |
| Total fruit yield(t/ha) | 19.64 | 17.81 | 14.27 |
| Marketable fruit yield (t/ha) | 16.32 | 14.18 | 11.28 |
| Unmarketable fruit yield (t/ha) | 3.32 | 5.70 | 8.19 |
| Net return (Rs/ha) | 1,53,000 | 1,38,000 | 1,12,780 |
| B:C ratio | 3:11 | 2:84 | 2.43 |

The plant height of T1, T2 & T3 (60.23, 58.26 and 57.44 cm respectively) were closely

similar, very minor different were reported. The total number of fruits per plant of tomato was higher with T1 (37.89) followed by T2 (31.65). T while T3 was least. This showed that the positive effect of marigold intercropping with tomato (Kakar *et al.* 1980). This might be due to protection of different external factors like frost, insect pest and other environmental factors that resulted more no of fruits were produced. The total fruit yield was also reported higher with T1 (19.64 t/ha), followed by T2 (17.81) and control (14.27 t/ha).

Because intercropping of marigold served as trap crop and act as a barrier against insect pests. Regarding total marketable fruit yield(t/ha) T1 reported significantly better (16.32 t/ha) followed by T2 (14.18 t/ha) and control was the least (11.28 t/ha). This might be due to the better use of solar radiation attributed to increased interception of photosynthetically active radiation resulting better solar radiation use efficiency (Hussain and Billan, 2007, Sarate *et al.* 2012). The unmarketable fruit yield recorded higher with control (5.70 t/ha) over T1 (3.32t/ha). This proved that the marigolds protect to tomato crop in better way against insects and root knot nematodes; which resulted in maximum number of good quality fruits. Hence the economics was also higher with T1 followed by T2 and minimum with T3 (Rs. 1,53,000, 1,38,000 and 1,12,00 and 3:1, 2.84 and 2.43 respectively). Similar findings has also reported by Wondimkun *et al.* (2021).

The T1 (3 rows of Tomato with 1 row of marigold) resulted best in all parameters- minimum infestation of tomato (5.47 %), maximum no of fruits/plant (37.89), maximum fruit yield (19.64 t/ha), maximum marketable fruit yield (16.32 t/ha), maximum net return (Rs. 1,53,000/ha) and Best B:C ratio (3:11).

Conclusion

Plant alfalfa and mustard next to strawberries to draw lygus bugs and place Pelargonium geranium among rose bushes to deter Japanese beetles from eating the geranium, which is poisonous to them. Thus, it can be suggested to farmers of Arunachal Pradesh that marigold can be used as a trap crop in tomato farming for better production, yield and economics.

References:

- Fitt, G.P.; Dillon, M. L. and Hamilton, J. G. (1995). Spatial dynamics of *Helicoverpa* populations in Australia: simulation modeling and empirical studies of adult movement. *Computers and Electronics in Agriculture*, **13**: 177-192.
- Gaurav sharma *et al.* (2022). Marigold: A diverse crop with multipurpose value for health and environment : a review. *Agricultural review*, **2**: 1-9.
- Gómez-Rodríguez, O., Zavaleta-Mejía, E., González-Hernández, V.A., Livera-Munoz, M.E. and Cárdenas-Soriano, E. (2003). Allelopathy and microclimatic modification of intercropping with marigold on tomato early blight disease development. *Field Crop Research*. **83**: 27-34
- Gommers, F.J. and Bakker, J. (1988). Physiological diseases induced by plant responses or products. In: *Diseases of Nematodes*, [Poinar Jr., G.O., Jansson, H.B. (Eds.)], CRC Press, Boca Raton FL. 1: 3-22.
- Green, M.M., Singer, J.M., Sutherland, D.J. and Hibben, C.R. (1991). Larvicidal activity of *Tagetes minuta* (marigold) toward *Aedes aegypti*. *Journal of the American Mosquito Control Association*. **7**(2): 282-286.
- Halbrendt, J.M. (1996). Allelopathy in the management of plant-parasitic nematodes. *Journal of nematology*. **28**: 8-14.
- Hooks, C.R.R., Wang, K.H., Ploeg, A. and McSorley, R. (2010). Using marigold (*Tagetes* spp.) as a cover crop to protect crops from plant-parasitic nematodes. *Applied Soil Ecology*. **46**: 307-320.
- Hussain, B. and Bilal, S. (2007). Marigold as a trap crop against tomato fruit borer (Lepidoptera: Noctuidae). *Ind. J. Agri. Res.*, **2**(2): 185-188.
- Kakar, K. L.; Nath, A. and Dogra, G. S. (1980). Control of tomato fruit borer, *Helicoverpa armigera* (Hubner) (Noctuidae: Lepidoptera). *Pesticides*, **14**: 11-13.
- Kumar, A., Mishra, M. and Prakash, S. (2012). monitoring of *Helicoverpa armigera* (Hubner) through light and effect of weather on its larval development in the Tarai region of Balramour . *Bioherald*, **2**(1): 73-75.
- Lambert, J.D.H., Campbell, G., Arnason, J.T. and Majak, W. (1991). Herbicidal properties of alpha-terthienyl, a naturally occurring phytotoxin. *Canadian Journal of Plant Science*. **71**: 215-218.
- Marahatta, S.P., Wang, K.H., Sipes, B.S. and Hooks, C.R.R. (2010). Effects of *Tagetes patula* on active and inactive stages of root-knot nematodes. *Journal of Nematology*. **44**(1): 26-30.

- Naseri, B.; Fathipour, Y.; Moharramipour, S.; Hosseiniaveh, V. (2009). Comparative life history and fecundity of *Helicoverpa armigera* (Lepidoptera: Noctuidae) on different Soyabean varieties. *Entomological Science*, **12(2)**: 147-154.
- Pats, P.; Ekbom, B. and Shovgard, M. (1997). Influence of intercropping on the abundance, distribution and parasitism of *chilo* spp. (Lepidoptera: Pyralidae). *Bull. Entomol. Res.*, **87**: 507-513.
- Ravikumar, P. (2009). Chemical examination and insecticidal properties of *Tagetes erecta* and *Tagetes patula*. *Asian Journal of Biological Sciences*. 5(1): 29-31.
- Sarate, P. J.; Tamhane, V. A.; Kotkar, H. M.; Ratnakaran, N.; Susan, N.; Gupta, V. S.; Giri, A. P. (2012). Developmental and digestive flexibilities in the midgut of polyphagous pest, the cotton bollworm, *Helicoverpa armigera*. *Journal of Insect Science*, 12: 42-49.
- Srinivasan, K. and Moorthy, P.N.K. (1991). Indian mustard as a trap crop for management of major lepidopterous pests on cabbage. *Tropical Pest Management*. 37: 26-32.
- Srinivasan, K.; Krishna Moorthy, P. N. and Raviprasad, T. N. (1994). African marigold as a trap crop for the management of the fruit borer *Helicoverpa armigera* on tomato. *International Journal of Pest Management*, **40**: 56-63.
- Virk.J.S.,K.S. Brar and AS Sohi, 2004. Role of trap crops in increasing parasitaation efficiency of *Trichoderma chilonts* ishui in cotton . *J.Biol.Control*, 18:61-64.
- Wondimkun *et al.* (2021). Intercropping of marigold with tomato on yield related traits and yield of tomato in South Ethiopia conditions. *Journal of biology, agriculture and healthcare*, **11(6)**: 1-18.