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Intercropping of African Marigold with Tomato for Better Productivity, Pest Control and Economic Returns in Arunachal Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study highlights about intercropping of African marigold with tomato for better productivity, pest control and economic returns in Arunachal Pradesh, India. 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 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

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ratio (3:1) while T3/control recorded least (18.32%, 14.27 t/ha, rs.1,17,780 and 2:43 respectively). 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.

Keywords: Fruit yield; tomato farming; agroclimatic conditions; insecticides.

1. 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 leaded 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 [1,2]. The several studies have proven that light trap can also use to control of *Helicoverpa armigera* [3]. 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., [4], Gaurav sharma et al. [5] has wrote the following uses of marigold.

1.1 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 %).

1.2 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 [6]. 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. [7] suggested some potential of *T. minuta* oil or its components for the control of *A. aegypti* and other mosquitoes.

1.3 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, [8] with marigold in 3:1 combination without using any type of insecticide [9].

1.4 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 [10].

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., [11] as well as biological control of weeds [12].

1.5 Nematode Management

It has been proven that marigold suppress plant-parasitic nematodes Meloidogyne spp. and *Pratylenchus* spp. Hooks et al., [13]. 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 [14]. 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. [15] 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

2. 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.

Table 1. The weather during the research period

Month	Rainfall(mm)		Temperature ^{0}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

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 intermediatory dry spells are often occurs which are very heat and humid.

The Observation on population of tomato fruit borer plant-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:

Percent fruit damage = No. of Fruit damage / No. of fruit damage

3. RESULTS AND DISCUSSION

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. [16], 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. [16] and Virk et al. [17] 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.

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 [18]. 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).

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. Results 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

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 photo synthetically active radiation resulting better solar radiation use efficiency [9,19]. 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 finding has also reported by Wondimkun et al [20].

The T1 (3 rows of Tomato with 1row 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).

4. 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.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Fitt GP, Dillon ML, Hamilton JG. Spatial dynamics of Helicoverpa populations in Australia: simulation modeling and empirical studies of adult movement. Computers and Electronics in Agriculture. 1995;13:177-192.
2. Naseri B, Fathipour Y, Moharramipour S, Hosseiniaveh V. Comparative life history and fecundity of *Helicoverpa armigera* (*Lepidoptera: Noctuidae*) on different Soyabean varieties. Entomological Science. 2009; 12(2):147-154.
3. Kumar A, Mishra M, Prakash S. monitoring of *Helicoverpa armigera* (Hubner) through light and effect of weather on its larval development in the Tarai region of Balramour. Bioherald. 2012; 2(1):73-75.
4. Pats P, Ekbom B, Shovgard M. Influence of intercropping on the abundance, distribution and parasitism of *chilo* spp. (*Lepidoptera: Pyralidae*). Bull. Entomol. Res. 1997;87: 507-513.
5. Gaurav sharma et al. Marigold: A diverse crop with multipurpose value for health and environment: A review. Agricultural Review. 2022;2:1-9.
6. Ravikumar P. Chemical examination and insecticidal properties of *Tagetes erecta* and *Tagetes patula*. Asian Journal of Biological Sciences. 2009;5(1): 29-31.
7. Green MM, Singer JM, Sutherland DJ, Hibben CR. Larvicidal activity of *Tagetes minuta* (marigold) toward *Aedes aegypti*. Journal of the American Mosquito Control Association. 1991;7(2):282-286.
8. Srinivasan K, Moorthy PNK. Indian mustard as a trap crop for management of major lepidopterous pests on cabbage. Tropical Pest Management. 1991;37:26-32.
9. Hussain B, Bilal S. Marigold as a trap crop against tomato fruit borer (*Lepidoptera: Noctuidae*). Ind. J. Agri. Res. 2007;2(2): 185-188.
10. Halbrendt JM. Allelopathy in the management of plant- parasitic nematodes. Journal of Nematology. 1996 ;28:8-14.
11. Gómez-Rodríguez O, Zavaleta-Mejía E, González-Hernández VA, Livera-Munoz ME, Cárdenas-Soriano E. Allelopathy and microclimatic modiûcation of intercropping with marigold on tomato early blight disease development. Field Crop Research. 2003; 83:27-34
12. Lambert JDH, Campbell G, Arnason JT, Majak W. Herbicidal properties of alpha-terthienyl, a naturally occurring phytotoxin.

Canadian Journal of Plant Science. 1991; 71:215-218.

13. Hooks CRR, Wang KH, Ploeg A, McSorley R. Using marigold (*Tagetes* spp.) as a cover crop to protect crops from plant-parasitic nematodes. Applied Soil Ecology. 2010;46:307-320.
14. Gommers FJ, Bakker J. 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. 1988;1: 3-22.
15. Marahatta SP, Wang KH, Sipes BS, Hooks CRR. Effects of *Tagetes patula* on active and inactive stages of root-knot nematodes. Journal of Nematology. 2010;44(1): 26-30.
16. Srinivasan K, Krishna Moorthy PN, Raviprasad TN. African marigold as a trap crop for the management of the fruit borer *Helicoverpa armigera* on tomato. International Journal of Pest Management. 1994;40:56-63.
17. Virk JS, Brar KS, Sohi AS. Role of trap crops in increasing parasitaation efficiency of *Trichoderma chilonts* ishui in cotton. J. Biol. Control. 2004;18:61-64.
18. Kakar KL, Nath A, Dogra GS. Control of tomato fruit borer, *Helicoverpa armigera* (Hubner) (*Noctuidae: Lepidoptera*). Pesticides. 1980;14:11-13.
19. Sarate PJ, Tamhane VA, Kotkar HM, Ratnakaran N, Susan N, Gupta VS, Giri AP. Developmental and digestive flexibilities in the midgut of polyphagous pest, the cotton bollworm, Helicoverpa armigera. Journal of Insect Science. 2012; 12:42-49.
20. Wondimkun et al. Intercropping of marigold with tomato on yield related traits and yield of tomato in South Ethiopia conditions. Journal of Biology, Agriculture and Healthcare. 2021;11(6):1-18.

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