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## Impact of farmscaping on the abundance of natural enemies in maize

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### Abstract

Investigations on “Impact of farmscaping on the abundance of natural enemies in maize” were carried out in the Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, during the *kharif* in 2014 and 2015 with a Observations on the mean per plant population of the common natural enemies *viz.*, coccinellid beetles, syrphid fly and predatory wasps, clearly depict that their abundance was significantly more when marigold was planted for farmscaping in sole maize, maize + cowpea and maize + blackgram, both under seed treated and untreated conditions of sowing. The numerical abundance of the beneficial fauna was significantly more in the presence of marigold during the crop seasons in 2014 and 2015.

**Keywords:** marigold, farmscaping, natural enemies, maize

### Introduction

Maize (*Zea mays* L.) occupies an important place in world agriculture; in India, it ranks fifth in total area, third in total production and productivity and was grown over an area of 9.43 million hectares with a production of 24.35 million tonnes and productivity of 2.58 tonnes/ha (Anonymous, 2014) [5]. It has been estimated that by the year 2020, demand for maize in developing countries will surpass the demand for both wheat and rice. This level of production has to be substantially raised to meet the growing demand of maize as human food, animal and poultry feed, as well as industrial processing by the wet and dry millers to produce value added products. Despite the increase in acreage, maize production in India has remained almost stagnant. Biotic stress on maize is one of the major constraints to achieve the attainable yield. Maize is infested by 139 species of insect pests with varying degree of damage; There is considerable evidence of reduced populations of insect pests in polycultures (Andow, 1991; Altieri, 1994; Altieri and Letourneau, 1999) [4, 2, 3]. A decrease in the abundance of insect pests in diversified crop fields may be the result of: (i) increased parasitoid and predator populations due to higher availability of alternative prey, (ii) physical interference with pest colonization and movement, and/or (iii) chemical repellence or masking from non-host plants (Root, 1973; Risch *et al.*, 1983; Matteson *et al.*, 1984; Andow, 1991; Altieri, 1994; Khan *et al.*, 1997) [12, 4, 2, 9], which may be either other crops or weeds; however, from the view point of sustainable agriculture, the potential benefit of including other plant species within a cropping system must be balanced against the costs in terms of reduced productivity of the focal crop due to plant competition for resources. Although there are numerous cases of reduced pest density associated with polycultures, studies addressing the causes underlying such patterns are not equally common (Risch, 1981; Andow, 1991) [16, 4]. Likewise, pest-oriented studies on intercropping seldom include evaluations of its effect on crop yield (Letourneau, 1987; Power, 1987; Abate, 1991; Lal, 1991; Ramert and Ekbohm, 1996; Girma *et al.*, 2000; Karel, 1993 and Ogengalatio *et al.*, 1992) [11, 14, 1, 10, 15, 6, 8, 13]. Farmscaping is the holistic approach to pest control on farms that focus on increasing biodiversity in order to maintain healthy populations of beneficial insects, birds and other wildlife as part of an ecological pest management program. (Sreedhar, 2012). Ecological engineering or habitat manipulation, the key element of farmscaping, has emerged as paradigm for considering pest management approaches that are based on cultural practices informed by ecological knowledge of arthropod pest management (Gurr *et al.*, 2004) [7]. Farmscaping reduces the need of pesticides, lowering the cost and risks associated with indiscriminate application of pesticides. With these facts in view, the present study on the Impact of farmscaping on the abundance of natural enemies in maize under was carried out.

## Materials and Methods

The experiment was conducted at the Instructional Farm of Rajasthan College of Agriculture, Udaipur. The trial was laid out in uniformly sized plots measuring 4.8m x 3m (14.4 sq. m) in Randomized Block Design containing six treatments [Maize Sole with seed treatment, Maize Sole without seed treatment, Maize + Cowpea with seed treatment, Maize + Cowpea without seed treatment, maize + blackgram with seed treatment, maize + blackgram without seed treatment] with four replications of each; thus in all, there were 24 plots and also noted Relative Plant Effect (RPE) Indices. The row to row distance and plant to plant spacing for Maize were 30 cm and 25 cm and cowpea and blackgram 30 cm and 10 cm, respectively. Sowing of the recommended variety of Maize (Pratap Makka-5), Cowpea (RC-19) and Black gram (T-9) were done in the second week of July, 2014 and 2015 as a sole crop and farmscaping crop combination. The seeds of early flowering marigold variety Pusa Narangi were sown in well prepared, raised nursery beds. The usual floriculture operations were followed while raising the seedlings. The nursery was raised in the last week of June; mature seedlings of marigold were transplanted on the border of the experiment. The experiments were conducted in two sets. The associated natural enemies like Coccinellids, Syrphid flies and Wasps etc., were recorded by the visual count technique from the same 10 plants per replication randomly tagged, during early hours of the day and the Relative Plant Effect (RPE) indices worked for the numerical abundance of the common natural enemies in the presence of marigold.

## Statistical analysis

### Relative density (R.D. %)

$$RD\% = \frac{\text{Number of individuals of one species} \times 100}{\text{Total number of individuals of all species}}$$

The statistical analysis was carried out using t- test (Two tail test) to compare the superiority of two different treatments.

## Results

### I: Impact of marigold on the abundance of natural enemies in sole maize and the intercrops during *kharif*, 2014

The abundance of natural enemies especially coccinellids, syrphid fly and wasps was more in the farmscape treatments. The coccinellid population was significantly higher in the treatments farmscaped with marigold. Similarly, the syrphid fly population was significantly more when farmscaped with marigold except in maize + cowpea without seed treatment. The wasp population was significantly higher in the farmscape treatment with marigold except in maize sole with seed treatment and maize + blackgram with seed treatment. The mean per plant population of coccinellid beetles in maize sole, maize + cowpea and maize + blackgram ranged from 0.66 to 2.55, the maximum (2.55) being for maize + cowpea without seed treatment; the syrphid fly mean population in maize sole, maize + cowpea and maize + blackgram ranged from 0.61 to 1.76, the maximum (1.76) being for maize + cowpea without seed treatment; and the mean population of wasps in maize sole, maize + cowpea and maize + blackgram ranged from 0.61 to 0.92, the maximum (0.92) being for maize + cowpea without seed treatment in marigold

farmscaping.

In the set without marigold as a farmscape plant, the mean per plant population of coccinellid beetles in maize sole, maize + cowpea and maize + blackgram ranged from 0.38 to 1.86, the maximum (1.86) being for maize + cowpea without seed treatment; the syrphid fly mean population in maize sole, maize + cowpea and maize + blackgram ranged from 0.20 to 1.34, the maximum (1.34) being for maize + cowpea without seed treatment; and the wasps mean population in maize sole, maize + cowpea and maize + blackgram ranged from 0.46 to 0.72, the maximum (0.72) being for maize + cowpea with seed treatment (Table - 1).

The Relative Plant Effect (RPE) indices worked for the numerical abundance of the common natural enemies in the presence of marigold, the farmscape plant, was negative, which is indicative of the beneficial effect of the farmscape plant's presence, ranged from - 0.27 to - 0.42, - 0.23 to - 0.67 and - 0.13 to - 0.26 for coccinellids, syrphid fly and wasps, respectively during 2014 in sole maize and intercrops (with cowpea and blackgram) evaluated [Table 1 (A)]. The maximum RPE values were for syrphid fly population, followed by coccinellids both being specific aphid predators

### II: Impact of marigold on the abundance of natural enemies in sole maize and the intercrops during *kharif*, 2015

The abundance of natural enemies especially coccinellids, syrphid fly and wasps was more in significant in the farmscape treatments. The coccinellid population was significantly higher in farmscape treatments with marigold. Similarly, the syrphid fly population was significantly more when farmscaped with marigold and so also the population of wasps was significantly higher in the farmscape treatment with marigold. The mean per plant population of coccinellid beetles in maize sole, maize + cowpea and maize + blackgram ranged from 1.27 to 2.66, the maximum (2.66) being for maize + cowpea without seed treatment; the syrphid fly mean population in maize sole, maize + cowpea and maize + blackgram ranged from 1.00 to 2.50, the maximum (2.50) being for maize + cowpea without seed treatment; and the wasps mean population in maize sole, maize + cowpea and maize + blackgram ranged from 0.54 to 0.84, the maximum (0.84) being for maize + cowpea with seed treatment in with farmscape marigold.

When the crops were cultivated without marigold as the farmscape plant the mean per plant population of coccinellid beetles in maize sole, maize + cowpea and maize + blackgram ranged from 0.64 to 1.34, the maximum (1.34) being for maize + cowpea without seed treatment; the syrphid fly mean population in maize sole, maize + cowpea and maize + blackgram ranged from 0.40 to 1.10, the maximum (1.10) being for maize + cowpea without seed treatment; and the wasps mean population in maize sole, maize + cowpea and maize + blackgram ranged from 0.26 to 0.46, the maximum (0.46) being for maize + cowpea with seed treatment (Table - 2).

During the crop season in 2015, the Relative Plant Effect (RPE) indices worked for the numerical abundance of the common natural enemies in the presence of marigold, the farmscape plant, was also negative and relatively more than that in the previous crop season (2014), again indicative of the beneficial effect of the farmscape plant's presence, and ranged from - 0.41 to - 0.53, - 0.56 to - 0.70 and - 0.41 to - 0.57 for coccinellids, syrphid fly and wasps, respectively in

sole maize and intercrops (with cowpea and blackgram) evaluated [Table 2 (A)]. This year also the maximum RPE values were for syrphid fly population, followed by coccinellids both being specific aphid predators.

**Discussion**

The impact of marigold on the abundance of natural enemies in maize sole, maize + cowpea and maize + blackgram with and without seed treatment showed that coccinellid, syrphid fly and wasp populations were significantly higher in marigold farmscaping as compared to their populations under cultivation without marigold during *kharif*, 2014 and 2015. the years; however, an exception was notable for the wasp population in maize sole and maize + blackgram with seed treatment during *kharif*, 2014 when it was lower in the marigold farmscaping treatment. In similar studies earlier, Silveira (2009) recorded higher numbers of arthropod pests on onion plants 30 metres from the marigold strip, while higher

numbers of predators and parasitoids were found at 5-metre distance. Species richness and Shannon's diversity index were higher on onions at 5 m from marigold; therefore, marigold rows next to onion fields resulted in higher number of entomophagous species, potentially enhancing the natural control of onion pests. He opined that marigold strips may be an alternative to crop sprays for organic control of onion pests. Rekha *et al.* (2009) reported 9 species of predatory coccinellids, of which 3 common species [*Coccinella transversalis* (Fabricius); *Menochilus sexmaculatus* (Fabricius) and *Brumoides suturalis* (Mulsant)] were found in cereals, pulses and vegetable crops. Helenius (1990) reported that the barriers and egress trenches significantly reduced the pitfall catches of carabids, staphylinids and spiders. Distinctly more syrphids were observed in the weed strips than in the adjacent fields. The weed strips contained a high density of flowering plants and, therefore, proved to be very attractive feeding places for all syrphids (Frank, 1999).

**Table 1:** Impact of marigold on the abundance of natural enemies under farmscaping with or without marigold during *kharif*, 2014

Treatments	Mean population of natural enemies					
	Coccinellid		Syrphid fly		Wasps	
	With marigold	Without marigold	With marigold	Without marigold	With marigold	Without marigold
Maize sole with seed treatment	0.66 (35.03)	0.38 (36.33)	0.61 (32.38)	0.20 (18.74)	0.61 (32.59)	0.47 (49.93)
	5.11*		6.15*		1.64	
Maize sole without seed treatment	0.83 (36.09)	0.53 (40.31)	0.84 (36.45)	0.33 (24.84)	0.63 (27.47)	0.46 (34.84)
	5.56*		6.83*		3.71*	
Maize + Cowpea with seed treatment	1.52 (50.01)	0.92 (45.98)	0.69 (22.62)	0.37 (18.20)	0.83 (27.37)	0.72 (35.81)
	3.50*		3.44*		1.30	
Maize + Cowpea without seed treatment	2.55 (48.74)	1.86 (47.85)	1.76 (33.68)	1.34 (34.40)	0.92 (17.58)	0.69 (17.74)
	7.74*		1.49		3.46*	
Maize + Blackgram with seed treatment	1.17 (43.10)	0.70 (39.18)	0.74 (27.34)	0.45 (25.18)	0.80 (29.56)	0.64 (35.65)
	12.93*		3.06*		1.32	
Maize + Blackgram without seed treatment	1.43 (38.20)	0.92 (39.70)	1.44 (38.53)	0.74 (31.95)	0.87 (23.28)	0.66 (28.35)
	5.88*		4.66*		2.46*	

Figures in parentheses are Relative Density (%) values. \* Value of 't'- statistically significant at 5%

**Table 1a:** Relative effect of marigold on the occurrence of natural enemies during *kharif*, 2014

Treatments	Relative Plant Effect (RPE) Indices		
	Coccinellids	Syrphid fly	Wasps
Maize sole with seed treatment	-0.42	-0.67	-0.22
Maize sole without seed treatment	-0.36	-0.60	-0.26
Maize + Cowpea with seed treatment	-0.39	-0.46	-0.13
Maize + Cowpea without seed treatment	-0.27	-0.23	-0.25
Maize + Blackgram with seed treatment	-0.40	-0.39	-0.20
Maize + Blackgram without seed treatment	-0.35	-0.48	-0.24

**Table 2a:** Relative effect of marigold on the occurrence of natural enemies during *kharif*, 2015

Treatments	Relative Plant Effect (RPE) Indices		
	Coccinellids	Syrphid fly	Wasps
Maize sole with seed treatment	-0.48	-0.60	-0.57
Maize sole without seed treatment	-0.50	-0.58	-0.46
Maize + Cowpea with seed treatment	-0.41	-0.65	-0.41
Maize + Cowpea without seed treatment	-0.49	-0.56	-0.53
Maize + Blackgram with seed treatment	-0.51	-0.59	-0.53
Maize + Blackgram without seed treatment	-0.53	-0.70	-0.53

**Table 2:** Impact of marigold on the abundance of natural enemies under farmscaping with or without marigold during *kharif*, 2015

Treatments	Mean population of natural enemies					
	Coccinellid		Syrphid fly		Wasps	
	With marigold	Without marigold	With marigold	Without marigold	With marigold	Without marigold
Maize sole with seed treatment	1.27 (44.11)	0.66 (49.48)	1.00 (34.69)	0.40 (30.46)	0.61 (21.20)	0.26 (19.70)
	4.85*		15.48*		3.63*	

Maize sole without seed treatment	1.78 (50.58)	0.89 (53.07)	1.20 (34.06)	0.50(29.70)	0.54(15.35)	0.29(17.23)
	6.23*		10.40*		3.36*	
Maize + Cowpea with seed treatment	1.39(40.00)	0.65(41.71)	1.30(37.34)	0.45(28.83)	0.79(22.66)	0.46 (29.47)
	10.72*		9.93*		6.53*	
Maize + Cowpea without seed treatment	2.66(44.32)	1.34(47.30)	2.50(41.69)	1.10(38.93)	0.84(14.00)	0.39(13.77)
	7.37*		2.55*		5.78*	
Maize + Blackgram with seed treatment	1.31(41.76)	0.64(44.88)	1.10(35.04)	0.45(31.32)	0.73(23.20)	0.34(23.80)
	6.63*		6.19*		3.81*	
Maize + Blackgram without seed treatment	1.94(49.34)	0.91(49.86)	1.30(33.10)	0.60(32.65)	0.69(17.57)	0.32(17.49)
	15.03*		3.99*		7.88*	

Figures in parentheses are Relative Density (%) values. \* Value of 't'- statistically significant at 5%

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