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Ecological engineering in cauliflower for aphid management

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Cole crops are the major winter crops, among which cauliflower, *Brassica oleracea* var. *botrytis* L is one of the widely cultivated vegetable crops of India. Insect pest attack is one of the major factors responsible for the reduction of yield in cole crops. Among the various pests, sucking pests, *viz.* aphids (*Brevicoryne brassicae* (L.) and *Lipaphis erysimi* (Kalt.)) cause significant yield loss to the crop. Besides, aphids also act as a vector for a number of viral diseases like Cauliflower mosaic virus, Turnip mosaic virus *etc* (Martinière *et al.* 2009, Singh *et al.* 2012, Guerret *et al.* 2017). Aphid infestation on cole crops was noticed throughout the year with a peak from December to February coinciding with cole crop maturity (Mandal 2008).

Agricultural ecosystems are simplified and their habitats are divided and replaced altogether by long stretch of monoculture fields (Pfiffner and Luka 2000) leading to a decline in species diversity and abundance of natural enemies and also downgrading conservation and augmentation functions (McCabe *et al.* 2017). Therefore, diversification of farm through habitat manipulation is essential to create an appropriate ecological infrastructure offering suitable food (pollen and nectar), alternative prey and shelter for adult natural enemies (Landis *et al.* 2000, Hertzog *et al.* 2017). With this background, studies were conducted at ICAR-Indian Agricultural Research Institute, Pusa, New Delhi during *rabi*, 2017 to evaluate the potential of ornamental flower strips to increase the role of predators in cauliflower ecosystem as a preventive means of pest regulation for organic protection.

Cauliflower and selected flower crops (candytuft, *Iberis* sp, calendula, *Calendula officinalis*, marigold, *Tagetes erecta*, daisy, *Bellis perennis* and cineraria, *Cineraria* sp) seeds were sown in a raised nursery bed. The date of the sowing of flower crops and cauliflower was adjusted to synchronize the peak flowering of flower strips with the aphid incidence in cauliflower. The experiment was laid out in randomized complete block design (RCBD) with seven treatments (T1- Candytuft, T2- Calendula, T3- Marigold, T4- Daisy, and T5- Cineraria, T6- a mix of flower and T7- Sole cauliflower) in three replications. The flower strips were planted in a plot size of 4 × 1 m between two cauliflower plots measuring 4 × 4m (Fig 1). One month old seedlings were transplanted into the experimental plots with a plant spacing of 60 × 45 cm. All the recommended agronomical practices for raising a good crop were followed except insecticide application.

Fig 1 Layout of the ecologically engineered cauliflower plot at ICAR-IARI, New Delhi.

The aphid population (both *B. brassicae* and *L. erysimi*) was recorded from 10 randomly tagged cauliflower plants in each plot at weekly intervals from the 6th standard meteorological week (SWM) to 10th SMW. Three leaves, *viz*. upper, middle and lower from each plant were selected for the population count and damage incidence, more than 30 aphids/plant will be taken as a benchmark. Predators were grouped into coccinellids, spiders and syrphids and their abundance were recorded in all flower strip cropping systems.

The incidence of aphids on cauliflower noticed from the first week of February. It was observed that in all the selected intercrop aphids colonized at the same time, but the number of aphids landing on plants differed. An almost a similar number of aphids colonized on cauliflower during 6th and 7th SMW, except in cineraria intercropping system, where the number of aphids (22.67) was significantly lower compared to all other intercropping systems (Table 1).

During 8th to 10th SMW all the flower intercrops reported having a significant influence on the aphid

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Table 1 Population of aphids, syrphids and coccinellid in ecologically engineered cauliflower crop

	6th SMW			7th SMW			8th SMW			9th SMW			10th SMW		
	Mean Aphid population	Mean Syrphid population	Mean coccinellid population	Mean Aphid population	Mean Syrphid population	Mean coccinellid population	Mean Aphid population	Mean Syrphid population	Mean coccinellid population	Mean Aphid population	Mean Syrphid population	Mean coccinellid population	Mean Aphid population	Mean Syrphid population	Mean coccinellid population
T1	44.67b (6.76)	0.00	0.00	215.67b (14.68)	0.00	0.00	438.67ab (20.94)	0.00	0.00	872.67a (29.56)	4.33a (2.31)	6.33d (2.71)	4571.67a (67.61)	7.00c (2.83)	8.33cd (3.05)
T2	40.00b (6.40)	0.00	0.00	174.33ab (13.23)	0.00	0.00	440.67ab (20.93)	0.00	0.00	931.33ab (30.53)	5.00ab (2.44)	7.33d (2.89)	3716.33a (60.94)	5.67bc (2.58)	6.00bc (2.64)
T3	46.00b (6.84)	0.67	0.67	131.00a (11.48)	0.00	0.00	383.33ab (19.59)	0.00	0.00	1107.33bc (33.29)	6.33bc (2.71)	4.33ab (2.31)	3952.33a (62.86)	4.33ab (2.31)	9.00d (3.16)
T4	48.33b (6.98)	0.33	0.33	181.00ab (13.49)	0.00	0.00	416.67ab (20.38)	0.00	0.00	1144.00c (33.83)	3.33a (2.08)	3.00a (2.00)	5473.33b (73.90)	9.67d (3.26)	5.00b (2.44)
T5	22.67a (4.86)	0.00	0.00	138.33a (11.80)	0.67	0.67	308.33a (17.56)	0.00	0.00	944.33ab (30.73)	7.33cd (2.52)	6.00cd (2.64)	3750.00a (61.23)	12.00e (3.60)	9.33d (3.21)
T6	54.33b (7.43)	0.00	0.00	139.67a (11.85)	0.00	0.00	355.33a (18.87)	0.33	0.33	851.33a (29.17)	8.33d (2.31)	4.67bc (2.38)	3783.33a (61.49)	9.33d (2.31)	6.67bcd (2.76)
T7	42.00b (6.55)	0.00	0.00	129.33a (11.40)	0.00	0.00	555.00b (23.49)	0.00	0.00	1165.00c (34.11)	3.33a (2.08)	3.67ab (2.16)	4954.33a (67.74)	2.33a (1.82)	2.33a (1.82)
C D	0.96	*	*	1.29	*	*	2.51	*	*	2.03	0.28	0.22	5.02	0.26	0.21
SE(m)	0.31	*	*	0.41	*	*	0.81	*	*	0.65	0.09	0.07	1.61	0.08	0.07
CV	8.14	*	*	5.69	*	*	6.90	*	*	3.57	6.17	5.09	4.28	5.22	4.27

Figures in parenthesis are square root transformation value). *ANOVA was not performed due to low population

Fig 2 Pupae of coccinellid beetle resting on flower strip.

population. Among the flower intercrops (8th SMW) the lowest population of aphid recorded with *Cineraria* flower intercropping (308.33) compares to control (555.00) (Table 1). At 9th SMW of intercropping with candytuft (872.67), calendula (931.33), cineraria (944.33) and flower mix (851.33) resulted in a lower aphid population compared to control (1165.00) (Table 1). At 10th SMW the aphid population in calendula (3716.33), cineraria (3750) and flower mix (3783.33) was significantly lower over the control (4954.33) (Table 1).

During 6th, 7th and 8th SMW not much population of syrphids and coccinellids was observed. During the 9th SMW, more number of syrphid adults were observed around flower mix (8.33) intercrop. Similarly, more of coccinellid beetle was observed in calendula (7.33) intercrop. During 10th SMW, significantly more number of syrphids and coccinellid population was observed in all the flower intercrop system over the control. Cineraria flower as an intercrop witnessed more number of syrphids (12.00) and coccinellids (9.33) population. It might be due to ample amount of nectar and pollen in cineraria flower compared to others. Besides the defender population takes shelter on the foliage of flower crops (Fig 2).

The total numbers of aphids observed on the marked plants in treated and control plots increased steadily during the experimental period, whereas the proportionate decrease in the aphid count was noticed in later stages of flower intercropping except in daisy intercropping system. Earlier studies have also favored the intercropping of cabbage with other plants reduce cabbage aphid infestation (Bukovinszky *et al.* 2003, Beata *et al.* 2009). No other invertebrate predator was noticed on the cauliflower during routine sampling, which indicated the predation by syrphids and coccinellids may be a main cause of the differences in aphid population (Pfiffner and Luka 2000, Nelson *et al.* 2004). The effect of predation was noticed in the later part of the crop growth stage, because both the predators might have taken an initial period for the establishment on flower crops. More number of aphids in daisy flower intercropping might be due to more green foliage which attracts aphids rather than predators.

SUMMARY

Because of high-value, the crops like *Brassica* have very low pest-damage thresholds, natural enemies alone are unlikely to replace use of high cost insecticides. However, conservation of natural enemy population is possible by avoiding or applying insecticides at reduced rates and use of habitat manipulation techniques such as ecological engineering, used in the present research work. The selected flower crops apart from hosting natural enemy it is also an alternate source of income to farmers. Among the intercrops, cineraria flower crop reported with less number of aphids and even attracted more number of syrphids as well as coccinellids can be exploited to use as intercrop.

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