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**Nadia Saeed**
Department of Agronomy Food Natural resources Animals and Environment (DAFNAE), University of Padova, Viale dell'Universita`, 16, 35020 Legnaro, PD, Italy.

**Nicola Mori**
Department of Agronomy Food Natural resources Animals and Environment (DAFNAE), University of Padova, Viale dell'Universita`, 16, 35020 Legnaro, PD, Italy.

**Andrea Battisti**
Department of Agronomy Food Natural resources Animals and Environment (DAFNAE), University of Padova, Viale dell'Universita`, 16, 35020 Legnaro, PD, Italy.

**Misbah Ashraf**
Entomological Research Institute, Ayub Agricultural Research Institute, Faisalabad, Pakistan.

**Correspondence**
**Nadia Saeed**
Department of Agronomy Food Natural resources Animals and Environment (DAFNAE), University of Padova, Viale dell'Universita`, 16, 35020 Legnaro, PD, Italy.

# Effect of *Brassica napus*, *Medicago sativa*, *Trifolium alexandrinum* and *Allium sativum* strips on the population dynamics of *Sitobean avenae* and predators in wheat ecosystem

**Nadia Saeed, Nicola Mori, Andrea Battisti, Misbah Ashraf**

**Abstract**
Exploitation of Brassica, Alfalfa, Berseem and Garlic as a predator cause and reducing aphid in strips comparable to wheat diversity Inqlab–91 were evaluated with wheat having no strips as trap crop for the period of 2015. Abundance of predators belong to family Coccinelidae, Chrysopidae and Syrphidae were counted from each plant of one square foot of wheat, and the great abundance of aphid dynamics was also taken into account. The highest population of Sitobean avenae was observed on plots not having a trap cropped area with four types of strips. The number of aphids on different intercrops was found positively correlated with the maximum and minimum temperature as well as with the rainfall, while relative humidity recorded negative with all intercrops except Wheat-Brassica intercrop. The exposure of useful insects on strip-feeding aphids helped to restrict the aphid to come in intercropped area of wheat plots and retained them less than economic injury level. This clears the task of trap cropping in wheat to diminish the insecticide claim chances on the main cereal crop of vast significance.

**Keywords:** *Brassica napus, Medicago sativa, Trifolium alexandrinum, Allium sativum, Sitobean avenae*.

## 1. Introduction
Wheat is a major crop of Pakistan and is cultivated in almost every part of the country. It contributes 12.5% to the value added in agriculture and 2.6% to GDP [1]. Polyculturing is a prehistoric and long-established agronomic practice which when applied correctly can help extensively to condense pest problems. Intercropping can be explored as a scheme where two or more crop species are developed in the same field at the same time during the wheat growing season [2]. It is a trouble-free and low-cost approach and has been documented as a potentially befitting way to raise crop production due to its considerable yield gain compared to sole crop [3]. The reason for intercropping is to create valuable biological connections among the crops. Increase habitats also help in creating a large abundance of natural enemies which successively diminish the rate of herbivorous pests [4-7]. The increased abundance of common predators such as Coccinelids, Syrphid fly and *Chrysoperla carnea* have the power to reduce the population of wheat aphids [8]. In addition, intercropping can enhance yields, more easily and efficiently by using available capitals, decrease weed, insect and disease pressures and offer better biological and economic stability [9 10, 31].
Different types of pests have been reported in which aphids come in hot issue nowadays in Pakistan [11, 12]. Aphids mostly cause two types of losses: one is direct in which they suck the plant, and the other is indirect in which they prefer to transmit their diseases from infected plant to healthy plant [13]. It was documented by Aheer *et al.* [10] that 7.19 aphids per tiller caused a 16.38%-yield reduction whereas 15 aphids per tiller led to a 30-40% loss [14].
Nevertheless, no study about four types of intercropping pattern has been conducted in Pakistan under the wheat cropping pattern up to now. In the present study, crops of *Brassica napus*, *Medicago sativa*, *Trifolium alexandrinum* and *Allium sativum* were assigned as intercrop and wheat as the major crop.

## 2. Material and Methods
The field experiment was conducted at the Research Area of Entomological Research Institute in Pakistan. The experimental field for this study was 198×15 m in size, which was divided into five treatment blocks: Wheat– Alfalfa strip cropping, Wheat-Brassica strip cropping,

Wheat-Berseem strip cropping and Wheat-Garlic strip cropping and wheat monoculture. Each block had three replicate plots that were arranged randomly within the field. All plots were 0.5 m apart and separated by bare ground. The strip cropping was planted 3.05 m wide whereas the monoculture plots were planted as 9.15 m wide strips but with only wheat.

In sequence to assemble aphids and their natural enemies, 10 tillers were selected randomly from each replication and for predators whole plant was checked for three minutes [24]. Sampling was done from approximately 1st Jan 2015 till 2nd April 2015. The sampling was carried out on a weekly basis. Meteorological data was also recorded for each sampling date (Temperature, Relative Humidity and Rainfall) from plant physiology section Ayub Agricultural Research Institute, Faisalabad to study their effect on the fluctuation of aphids and predators.

**Data Analysis**

Data collected were statistically analyzed by using analysis of variance technique, Randomized Complete Block Design-2 factor factorial. Treatment means were compared by using least significant difference (LSD) test at 5% probability level. Correlation between pest population and treatments, as well as weather factors was also determined.

## 3. Results

The weekly aphid populations of fifteen blocks for one year are shown in Figure 1; the aphid population in Brassica and Alfalfa intercropped blocks were significantly low ($P$<0.05) as compared to Berseem, Garlic and non-intercropped blocks for the whole period.

**Effect of intercrops on abundance of Aphids**

Aphid abundance was first observed on 14thJanuary 2015. However, the number of aphids increased more in wheat plots not trap cropped followed by trap cropped wheat plots with Brassica, Alfalfa, Berseem and garlic on 25thFebruary 2015. The aphid population showed almost the same trend on the next weekly observation but population decline occurred on 2ndApril 2015. Aphid numbers differed significantly among intercrops and under different meteorological conditions. Of the five intercrops, there were more aphids in wheat monoculture than Wheat-Alfalfa strip cropping, Wheat-Brassica strip cropping, Wheat-Berseem strip cropping and Wheat-Garlic strip cropping, but no significant difference was detected between wheat–alfalfa strip cropping, Wheat-Brassica strip cropping, Wheat-Berseem strip cropping and Wheat-Garlic strip cropping (Fig. 1; Wheat-Brassica strip cropping: F=13.12, $P$<0.01; Wheat-Alfalfa strip cropping: F=15.23, $P$<0.01; Wheat-Berseem strip cropping: F=17.01, $P$<0.01; Wheat-Garlic strip cropping: F=21.17, $P$<0.01; monoculture: F= 24.07, $P$<0.01).

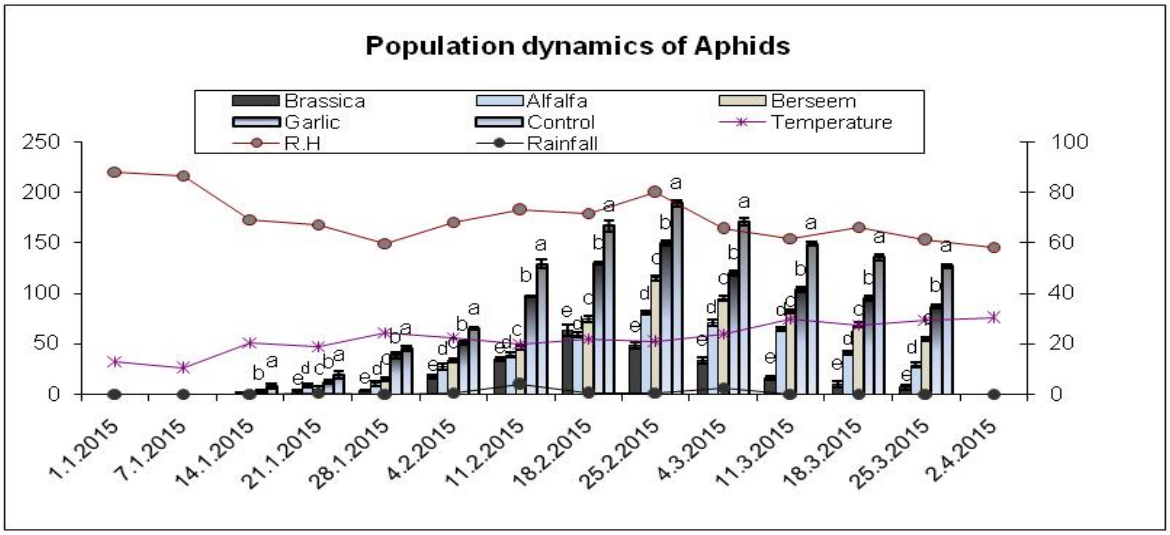


**Fig 1:** Mean (±SEM) abundance of Aphids in wheat fields with different intercropping patterns.

**Effect of intercrops on abundance of ladybird beetle, Syrphid fly and *Chrysoperla carnea***

Abundance of natural enemies was first observed on 4thFebruary 2015 with Wheat-Brassica intercrop. However, the number of predators increased more in trap cropped with brassica, alfalfa, berseem and garlic on 25th February 2015. The predator population showed almost the same trend on the next weekly observation taken on 2nd April 2015. Numbers of natural enemies on wheat plants were significantly different among five intercropping patterns (Fig. 2a, 2b and 2c). Of the five intercropping patterns, numbers of ladybird beetle, syrphid fly and *Chrysoperla carnea* were significantly greater in Wheat-Brassica intercrop than that in other intercrops and monoculture pattern in the whole period (For ladybird beetle: Fig. 2a; Wheat-Brassica strip cropping: F=23.45, $P$<0.01; Wheat-Alfalfa strip cropping: F=27.23, $P$<0.01; Wheat-Berseem strip cropping: F = 34.12, $P$<0.01; Wheat-Garlic strip cropping: F=39.17, $P$<0.01; monoculture: F= 42.93, $P$<0.01). (For Syrphid fly: Fig. 2b; Wheat-Brassica strip cropping: F=0.21, $P$<0.01; Wheat-Alfalfa strip cropping: F=0.66, P=0.52; Wheat-Berseem strip cropping: F=0.55, P=0.60; Wheat-Garlic strip cropping: F=0.73, P=0.501; monoculture: F=0.91, P=0.74) (For *Chrysoperla carnea*: Fig. 2c; Wheat-Brassica strip cropping: F=0.12, $P$<0.01; Wheat-Alfalfa strip cropping: F=0.17, P=0.53; Wheat-Berseem strip cropping: F=0.19, P=0.50; Wheat-Garlic strip cropping: F=0.21, P=0.66; monoculture: F=0.26, P=0.78).

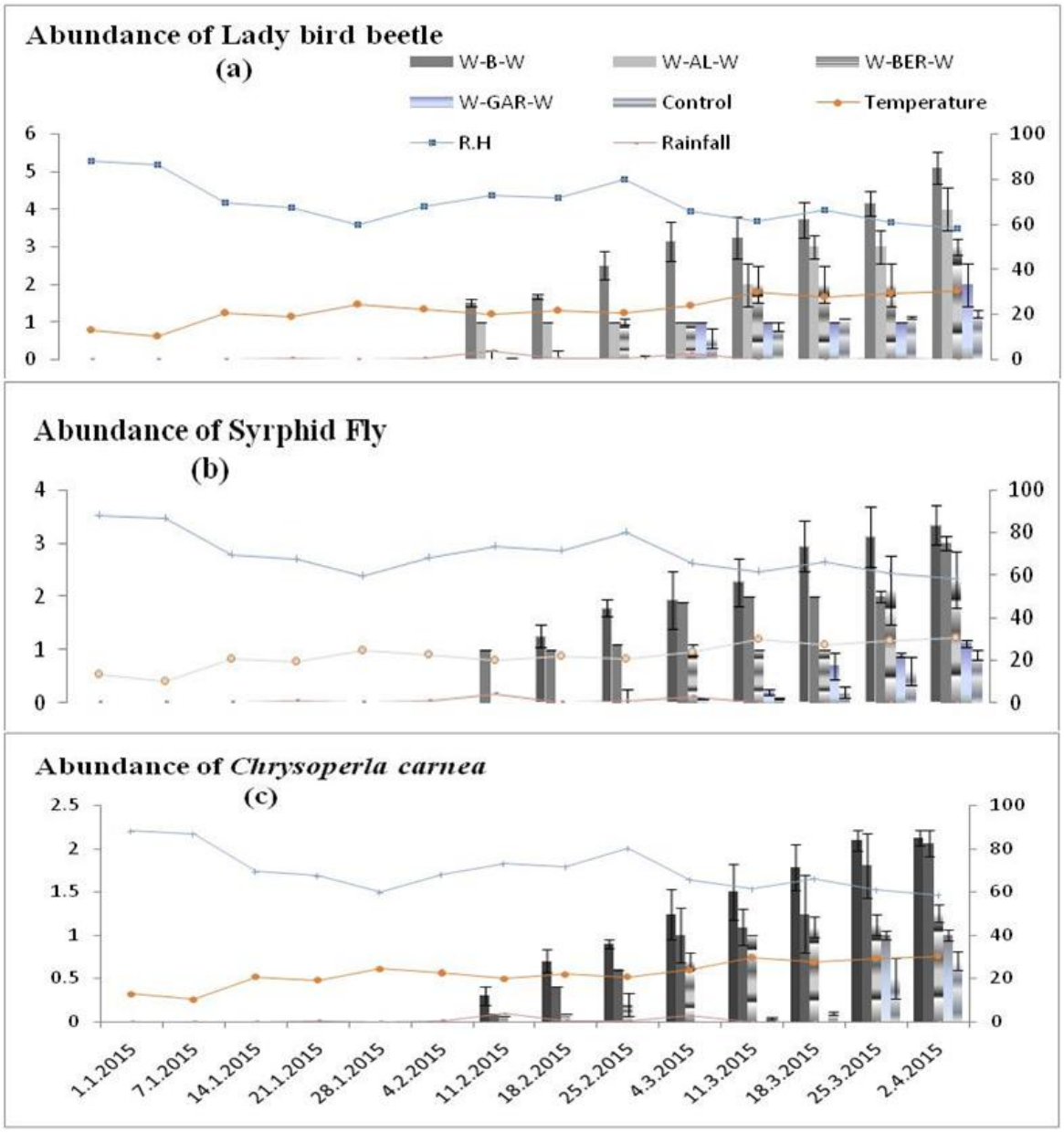


**Fig 2:** (a, b, c): Mean (±SEM) abundance of Ladybird beetle, Syrphid fly and *Chrysoperla carnea* in wheat fields with different intercropping patterns.

**Table 1**: Correlation coefficient of Aphid abundance and Natural enemies with Weather parameters

| Species | Intercrops | Temperature $^0$C | | R.H % | Rainfall |
|---|---|---|---|---|---|
| | | Max | Min | | |
| Aphids | Wheat-Brassica-Wheat | 0.05 | 0.2 | 0.11 | 0.45 |
| | Wheat-Alfalfa-Wheat | 0.33 | 0.48 | -0.09 | 0.37 |
| | Wheat-Berseem-Wheat | 0.37 | 0.54 | -0.1 | 0.31 |
| | Wheat-Garlic-Wheat | 0.36 | 0.48 | -0.12 | 0.39 |
| Ladybird beetle | Wheat-Brassica-Wheat | 0.76** | 0.94 | -0.50 | 0.06 |
| | Wheat-Alfalfa-Wheat | 0.76* | 0.89 | -0.52* | -0.08 |
| | Wheat-Berseem-Wheat | 0.77* | 0.89 | -0.53 | -0.19 |
| | Wheat-Garlic-Wheat | 0.73* | 0.79 | -0.59* | -0.08 |
| Syrphid Fly | Wheat-Brassica-Wheat | 0.76* | 0.94 | -0.49 | -0.14 |
| | Wheat-Alfalfa-Wheat | 0.76* | 0.91 | -0.52* | 0.11 |
| | Wheat-Berseem-Wheat | 0.73* | 0.82 | -0.59* | -0.11 |
| | Wheat-Garlic-Wheat | 0.67* | 0.76 | -0.52* | -0.23 |
| *C. carnea* | Wheat-Brassica-Wheat | 0.78* | 0.94 | -0.53* | -0.06 |
| | Wheat-Alfalfa-Wheat | 0.77* | 0.91 | -0.55* | -0.1 |
| | Wheat-Berseem-Wheat | 0.79* | 0.89 | -0.58* | -0.1 |
| | Wheat-Garlic-Wheat | 0.53* | 0.62 | -0.45 | -0.18 |

*Significant

The number of aphids on different intercrops was found positively correlated with the maximum and minimum temperature as well as with rainfall, while relative humidity recorded negative with all intercrops except Wheat-Brassica intercrop (Table 1). The beneficial insect data showed the significantly positive correlation with temperature in all the intercrops, while the negative correlation was found with relative humidity and rainfall.

## 4. Discussion

Wheat with different intercropping patterns can suppress the population of aphids in wheat fields. Meanwhile, the fluctuation of aphid population may affect abundance of natural enemies. Increasing agro biodiversity can lead to greater insect herbivore suppression by natural enemies [14, 15]. The addition of floral resources can enhance the survival, fecundity, longevity and behavior of natural enemies in order to increase their effectiveness [4, 16, 17]. It is possible to control wheat aphids by using floral plants to design an ideal intercropping system. Present results suggested that wheat with different intercropping patterns have a significant effect on the abundance of aphids, ladybird beetles, Syrphid fly and *Chrysoperla carnea*. Wheat alone and intercropped with garlic had more densities of aphids compared to other intercrops, and the population rates of aphids on wheat intercrop with Brassica and Alfalfa were significantly lower than sole and intercrop with garlic and Berseem [18]. There were more predators in Wheat-Brassica and wheat alfalfa intercropping fields compare to wheat monoculture, wheat –garlic and Wheat-Berseem intercropping pattern. The same results have been reported in literature, and are also in agreement with the natural enemies hypothesis which suggest that natural enemies are more abundant in diversity habitats where they can impose higher mortality on herbivores than in monocultures [14, 19, 20, 21]. In diversified habitats, the presence of floral resources could benefit natural enemies in a number of ways by providing shelter, as a source of alternative hosts or prey, or by providing non-host foods such as nectar and pollen [4, 22; 23]. Brassica crop is taller than wheat and also has different color and smell producing ability which affects the herbivores [24]. This disruptive hypothesis is equivalent to Root's [20] resource concentration hypothesis and stipulates that herbivores in polycultures will have more difficulties finding crop plants associated with one or more taxonomically or genetically different plants than finding crop plants in monoculture [9]. Simonds *et al.* [25] also examined that *Allium sativum* are a very effective antifeedant and Kirtikar and Basu [25]also reported that *Allium sativum* has very strong pungent repelling action. In the current study, wheat garlic intercropping also had lower aphids population than monoculture crop due to its repelling action. Uvah and Coaker [27] studied that non-host plants emit odors that repel herbivores. Plant diversity tends to intensify the impact of natural enemies, thus contributing to the relevant infrequent pest outbreaks often related with natural communities and mixed crop ecosystems [29]. Moreover, intercropping patterns with different crops provide floral nectar for natural enemies to increase the biological control of wheat aphids [29]. In these intercropping fields, there were significant differences among the densities of predators except for *Chrysoperla carnea*. There were a higher number of predators in the Wheat-Brassica and Alfalfa intercropping compared to other intercropping patterns. This may be attributable to the fact that there were more strips of brassica intercropping which can provide floral nectar for predators [30].

## 5. Conclusion

In general, intercropping with different crops could provide flower nectar and alternative hosts or preys which can enhance predator fitness. Wheat-Brassica and alfalfa intercropping systems could obtain better effects in conserving and enhancing populations of natural enemies, and consequently reducing the chemical dependency in agro-ecosystems. In designing an effective intercropping system, we should take into account the selection of main crop cultivars and intercropping crops. Given the inherent complexity of the effects of vegetation diversity, it is necessary to understand and evaluate the effects of vegetation diversity on population dynamics of pests and natural enemies. Further research needs to be done to evaluate the net effect of additional floral resources in a complex natural agro ecosystem and to investigate the mechanisms of how additional floral resources affect wheat aphid population dynamics.

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