Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(5): 2244-2250

Received: 10-06-2020
Accepted: 18-07-2020

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Identification of the most conservative plant species for promising natural enemies of arthropods pests of Vegetable crops

Akhtar Ali Khan, Ajaz Ahmad Kundoo and Zakir Hussain Khan

Abstract
Conservative plants were identified from three different districts of Kashmir *viz*: Srinagar, Ganderbal and Budgam during 2016-2018. A total of 20 different plant species suitable for the important natural enemies were identified. Carrot family (caraway, coriander, wild carrot, dill, fennel), butter cup, buckwheat, dandelion, yarrow, Canada thistle, may weed act as attract for the predators. Marigold, dill, coriander and onion were act as repellent plants for insect pests of vegetables. Maize was act as barrier crop for aphids and flying insects and cowpea act as alternate host for egg laying of borer and cut worms that help in avoid damage in main crops. The conservative plants that attract beneficials against Cruciferous and Solanaceous insect Pests were identified. Maximum population of predators and parasitoids were recorded in the month of May in Dill, coriander, onion and wild carrot. While as maximum population of predators and parasitoids were recorded in the month of July-August in Marigold, fennel, dandelion, clover and cowpea. Flowering periods of conservative plants play important role in the activity of natural enemies. The visiting periods of different kinds of natural enemies for conservative plants ranges from February to November, whereas the majority of the natural enemies visit the flowers from the month of April to September during both years.

Keywords: Natural enemy conservative plants, predators, parasitoids, visitor insects, vegetable crops

Introduction
Diversity in vegetable ecosystem may favour reduced pest pressure and enhanced activity of natural enemies. However, several authors have noted that to selectively enhance natural enemies, the important elements of diversity should be identified and provided rather than encouraging diversity per se [1, 2]. Indeed, it has been shown that simply increasing diversity can exacerbate certain pest problems. Identifying the key elements of diversity may be a difficult process, but the process can be guided by an understanding of the resources needed by natural enemies [3, 4]. Potential mechanisms include improving the availability of alternative foods such as nectar, pollen, and honeydew; providing shelter or a moderated microclimate in which natural enemies may overwinter or seek refuge from factors such as environmental extremes or pesticides; and providing habitat in which alternative hosts or prey are present [5,6]. In addition, the temporal availability of such resources may be manipulated to encourage early season activity of natural enemies [7, 8, 9]. Finally, the spatial arrangement of such resources to enhance natural enemy activity within the crop must be considered. Ecological engineering is an alternative practicable solution that combats crop insect pests by increasing the biodiversity of natural enemies and plant species [10]. The important practices involve intercropping, trap cropping, mixed cropping, cover cropping and making availability of resources for natural enemies [11]. These are potential cultural practices for pest management, since these diversify crops in a given agro-ecosystem to reduce the population of insects and consequently their attack [12]. Several mechanisms could be responsible for the pest control such as physical obstruction, visual camouflage, masking of host plant odors, repellent chemicals, altering the profiles of the host plant odors, and reduced host plant quality [13]. The planting of conservative plants may reduce the pest population density in a various way [14]. First the conservative plants reduce the suitability of the main crop as a host due to changed morphology, the second they interfere directly with activities of the attacking insect and the third they change the environment favouring the natural enemies [15]. Besides, research findings demonstrate that non-host crops grown in intercropping can emit organic chemicals which attract the biocontrol agents (natural enemies) of insect pests or act as repellent against the insect pests [16].

Sometimes mixed crop acts a barrier crop which hinders the movements of insect pests and thus the susceptible plants will suffer less [17]. Cover crops are able to protect the natural enemies from the harmful living organisms by remaining under the same cop foliage. Wszelaki [18] stated that the practice of intercropping can make benefits in a crop production system by decreasing insect pest infestation, lowering external inputs, enhancing biodiversity increase yield and reduce economic risk. Intercropping is a potential cultural practice for pest management since it diversifies crops in a given agro-ecosystem to reduce the population of insects and consequently their attack [19]. The current study was carried out to identify the conservative plant species for intercropping with different vegetable crops for the management of insect pests.

Material and Methods

The study was carried out in the temperate vegetable growing areas of Kashmir located between 32.17 degree and 36.58-degree north latitude and 37.26 degree and 80.30-degree east longitude with altitude varying from 1500 to 2200 meters above mean sea level. In order to explore the most conservative plant species for natural enemies of arthropod pests of cabbage, tomato and brinjal. Surveys were conducted from three different districts of Kashmir *viz*: Srinagar, Ganderbal and Budgam during 2016-2017. During the year 2016 and 2017 the population of predators and parasitoids of vegetable pests were recorded from April to October against 9 different conservative plant species *viz*., dill, coriander, onion, wild carrot, Marigold, fennel, dandelion, clover and cowpea. Sweep net was used for the collection of natural enemies. Sweeping was done fortnightly on different conservative plants. In sweep net method, spiders were collected by making double stroke sweeps by insect collection hand sweeping net (diameter 32 cm and handle 92 cm). Each stroke of sweep-net was complete oscillation and was repeated five times randomly from five different places.

Result and Discussion

Most conservative Plants that Attract Beneficials

The conservative plants that attract natural enemies in three districts of Kashmir *viz*., Srinagar, Budgam and Ganderbal were studied during 2016-2017. A total of 20 different plant species suitable for the important natural enemies were identified. Out of which, Carrot family (Caraway, coriander, wild carrot, dill, fennel), butter cup, buckwheat, dandelion, yarrow, Canada thistle and may weed attract the predators (The population of predators depend on the aphids, so to maintain the cover crop or alternate host of aphids or alternate prey is necessary for maintaining the population of predators) and they will manage the Soft-bodied insects including aphids in vegetables, thrips, early instars caterpillar of cabbage butterfly. Marigold, dill, coriander and onion were act as repellent plants for insect pests of vegetables. Maize and cowpea act as alternate hosts for egg laying of borer and cut worms that help in avoiding damage in main crops and also to the report of Azouz [20]. The different kinds of conservative plants with Beneficial's (natural enemies) for Cruciferous and Solanaceous insect pests in Kashmir were shown in Table 1 and 2.

Table 1: Record of Plants that attract beneficials against Cruciferous and Solanaceous Insect Pests in Kashmir during 2016-2018

Plants that attract Beneficials against Cruciferous and Solanaceous Insect Pests		
Beneficial	**Against Insect Pests**	**Attractive /conservative plants**
Lacewing	Soft-bodied insects including aphids in vegetables, thrips, mealy bug, scale, early instars caterpillar of cabbage butterfly	Carrot family (Caraway, coriander, wild carrot, dill, fennel), Sunflower, buckwheat, dandelion, yarrow, Canada thistle, may weed.
Ladybird beetle	Cabbage Aphids Tomato aphids Brinjal Aphids	The population of ladybird beetles depend on the aphids, so maintain cover crop or alternate host of aphids or alternate prey to maintain the population. Carrot family (dill, coriander, wild carrot, fennel), Sunflower, dandelion, yarrow, buckwheat, may weed, Canada thistle, clover.
Syrphid fly	Aphids, early instar caterpillar of cabbage butterfly and diamond back moth.	Carrot family (wild carrot, dill, fennel, caraway, coriander), buckwheat, Sunflower, yarrow, Canada thistle, marigold, dandelion., may weed.
Spiders	Almost all insects that harm Cruciferous and Solanaceous crops.	Carrot family (Queen Ann's lace, caraway, dill, fennel, caraway, coriander), yarrow, sunflower, buckwheat, marigold, clover, cowpea, Canada thistle, mulching of paddy straw bundle
Damsel fly/ Dragon fly	Aphids, butter flies, caterpillars, flea beetles	Carrot family (Queen Ann's lace, caraway, dill, fennel, caraway, coriander) clover marigold, clover, dandelion, cowpea, yarrow, sunflower, buckwheat,
Braconid wasp (Bracnidae Family)	Aphid, cutworm, flea beetles cabbage butterfly caterpillar.	Nectar plants with small flowers (caraway, dill, wild carrot, fennel, mustard, clover, yarrow) buckwheat, dandelion, sunflower, cowpea.
Ground beetles (Carabidae Family)	Cutworm	Carrot family (Dill, fennel, caraway, wild carrot, coriander) clover, marigold, clover, cowpea, yarrow, sunflower, buckwheat, dandelion, Canada thistle.
Bigeyed Bugs	Flea beetles	Buildup in cool season cover crops such as clover; buckwheat, marigold, Carrot family (Dill, fennel, wild carrot, caraway), buckwheat, marigold, yarrow, dandelion, cowpea.
Tachinidae fly (Tachinidae Family)	Cutworms, cabbage semilooper	Carrot family (Caraway, coriander, dill, wild carrot, fennel), clover, buckwheat, marigold, sunflower, dandelion, cowpea, Canada thistle, may weed.
Chalcid wasps (many families, especially Trichogrammatidae)	Dimond back moth, cabbage semilooper	Maintaining of diversity of plants, that includes dill, caraway, wild carrot, buckwheat, yarrow, cowpea, clover, fennel.
Pirate bug (Anthocorid Family)	Cutworm	Carrot family (fennel, caraway, dill, coriander), sunflower, alfalfa, clover, cowpea, marigold.

Table 2: Most conservative (for natural enemy) plant species in Jammu and Kashmir during 2016 and 2018

S. No.	Natural enemies conservative/attractive plants		Family
	Common name	Scientific name	
1.	Wild carrot	*Daucus sp.*	Apiaceae
2.	Coriander	*Corandrumsativum*	Apiaceae
3.	Fennel	*Foeniculum*sp.	Apiaceae
4.	Dandelion	*Taraxacumofficinale*	Asteraceae
5.	Caraway	*Carum*sp.	Apiaceae
6.	Yarrow	*Achilleamillefolium*	Asteraceae
7.	Dill	*Anethum sp.*	Apiaceae
8.	Marigold	*Tagetes* sp.	Asteraceae
9.	Sunflower	*Helianthus* sp.	Asteraceae
10.	Clover	Trifolium sp.	Fabaceae
11.	Canada thistle	*Sirsium sp.*	Asteraceae
12.	Cow pea	*Vigna sp.*	Fabaceae
13.	May feed	*Anthermis sp.*	Asteraceae
15.	Mustard	*Brassica* sp.	Cruciferae
16.	Onion	*Alium sp.*	Amaryllidaceae
17.	Wild Black Berry	-	-
18.	Alfa alfa	Medicagosp	Fabiceae
19.	Butter cup	Ranunculus sp.	Ranunculaceae
20	Maize	*Zea mays*	Poaceae

Flowering period of Insectary plants

Flowering periods of conservative plants play important role in the activity of natural enemies because natural enemies get attracted and visit the flowers for pollen and nectars. The visiting periods of different kinds of natural enemies for above mentioned conservative plants starting from February to November, whereas the majority of the natural enemies visit the flowers from the month of April to September during 2016-2017. Besides the visiting period of each natural enemy with respect to conservative plants were shown in Table 3**.** Sarkar *et al.* [21] and Shrestha *et al.* [22] also reported the visiting periods on trap and companion crops flowers it attracts the natural enemies.

Table 3: Flowering period of Insectary plants grown in J&K 2016-2018

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dill				■	■	■	■					
Coriander				■	■	■	■					
Buckwheat					■	■	■	■	■			
Onion				■	■	■						
Marigold							■	■	■	■	■	
Fennel			■	■	■	■	■	■	■			
Dandelion					■	■	■	■				
Carrot				■	■	■	■	■	■			
Clover		■	■	■	■	■	■	■	■	■	■	
Yarrow							■	■	■			
Caraway					■	■						
Mint					■	■	■					
Sunflower						■	■					
Cowpea					■	■	■	■				
Canada thistle			■	■	■	■	■	■	■			
May weed			■	■	■	■	■	■	■	■	■	
Butter cup				■	■	■	■					
Wild Black berry				■	■	■	■	■				

Population density of natural enemies on different conservative plants

Maximum pooled mean population of predators and parasitoids were recorded in the month of May in Dill, coriander, onion, wild carrot which were ranged from 3.7 to 4.0 predators/sweep and 2.0 to 3.7 parasitoids/ sweep in Srinagar; 3.4 to 3.8 predators/sweep and 2.2 to 4.0 parasitoids/ sweep in Budgam while as it ranged 2.9 to 4.0 predators/sweep and 2.1 to 4.1 parasitoids/ sweep in Ganderbal. Maximum pooled mean population of predators and parasitoids were recorded in the month of July-August in Marigold, fennel, dandelion, clover and cowpea which were ranged from 1.8 to 3.9 predators/sweep and 1.9 to 4.0 parasitoids/ sweep in Srinagar; 2.6 to 3.6 predators/sweep and 1.9 to 3.6 parasitoids/ sweep in Budgam while as it ranged 2.1 to 3.4 predators/sweep and 1.5 to 3.7 parasitoids/ sweep in

Ganderbal as shown in Table 4-9. Besides, the important aspects of biology and ecology of Natural enemies were also recorded for conservation biological control of vegetable insect pests that helped us in synchronized plantation of trap crops, cover crops, and as attractive and alternate crops in pest management. In detail, the density of natural enemies is discussed below as district wise as well as on the basis of conservative plants during 2016-2017. Similarly, Ben-Issa *et al*. [23] report that many factors need to be taken into account for a successful companion plant strategy. For the best long-term results, companion plant strategies have to be combined with other alternative approaches against aphids.

Population density of Predators on different conservative plants

The population density of predators/sweep was recorded from Srinagar district during 2016 and 2017 is presented in Table 4. The pooled mean population of predators/sweep were recorded as 3.01 in Dill, 2.84 in Coriander, 2.89 in Onion, 1.17 in Marigold, 1.87 in Fennel, 2.19 in Dendelion, 2.24 in Wild carrot, 1.88 in Clover and 2.66 in Cowpea.The population density of predators/sweep was recorded from Budgam district during 2016 and 2017 is presented in Table 5. The pooled mean population of predators/sweep was recorded as 2.78 in Dill, 2.86 in Coriander, 1.81 in Onion, 1.79 in Marigold, 1.98 in Fennel, 2.35 in Dendelion, 2.40 in Wild carrot, 2.06 in Clover and 2.48 in Cowpea.The population density of predators/sweep recorded from Ganderbal district during 2016 and 2017 is presented in Table 6. The mean population of predators/sweep was recorded as 3.10 in Dill, 3.18 in Coriander, 2.90 in Onion, 1.52 in Marigold, 2.16 in Fennel, 1.86 in Dendelion, 2.11 in Wild carrot, 2.31 in Clover and 2.55 in Cowpea. Similarly, McCabe *et al*. [24] report that flower borders may support the control of some pest insects; however, if the pest is a generalist and can utilize the resources of the wildflower patch, their populations of natural enemies may increase within the crop.

Table 4: Population mean of predators on different conservative plants in Srinagar during 2016 and 2017

Date of Observation	Pooled mean Population of predators*/Sweep								
	Dill	Coriander	Onion	Marigold	Fennel	Dandelion	Wild carrot	Clover	Cowpea
1st April	1.5	1.45	1.3	0	1.0	1.3	0.9	0.85	0
15th April	1.8	1.75	1.9	0	1.4	1.55	1.5	1.0	0
1st May	3.7	2.75	3.3	0	1.95	1.65	3.35	2.2	3.4
16th May	4.0	3.9	3.8	0	1.95	2.3	3.7	2.1	3.45
1st June	3.3	3.05	3.1	1.6	1.75	2.55	2.65	2.25	2.75
16th June	3.5	2.95	3.6	1.35	1.55	2.55	2.5	2.4	2.3
1st July	3.3	3.7	3.15	1.1	2.55	2.9	1.95	3.15	3.4
16th July	3.0	3.2	2.6	1.85	2.85	2.95	2.0	2.7	3.9
1st August	-	-	-	1.85	2.65	2.5	2.7	2.7	2.9
16th August	-	-	-	1.55	2.45	2.9	2.25	1.95	2.85
1st Sept.	-	-	-	0.75	2.2	2.05	2.1	1.45	2.5
16th Sept.	-	-	-	0.9	2.0	1.1	1.3	1.6	1.95
1st Oct.	-	-	-	0.7	1.1	0	0	1.15	1.65
16th Oct.	-	-	-	0.1	0.9	0	0	0.85	0.95
Mean	3.01	2.84	2.83	1.17	2.61	2.19	2.24	1.88	2.66

*Major predators (Coccinellids, Chrysoperla larvae, Syrphid flies, Spiders)

Table 5: Population mean of predators on different conservative plants in Budgam during 2016 and 2017

Date of Observation	Pooled mean Population of predators*/Sweep								
	Dill	Coriander	Onion	Marigold	Fennel	Dandelion	Wild carrot	Clover	Cowpea
1st April	1.2	2.05	1.6	0	1.1	1.7	2	1.3	0
15th April	1.9	1.8	2.05	0	1.55	2.05	2.05	1.55	0
1st May	3.6	3.85	2.5	0	2.3	2.25	3.4	2.75	2.2
16th May	3.5	3.6	3.15	0	2.25	2.75	2.8	2.35	2.35
1st June	2.9	2.95	3.35	2	2	2.75	2.7	2.4	2.85
16th June	2.7	2.3	2.95	2.55	2.15	2.6	2.45	2.6	2.85
1st July	3.1	3	2.8	2.65	2.6	2.1	2.05	2.95	3.0
16th July	3.35	3.4	2.45	2.65	3.05	3.2	2.65	2.25	2.85
1st August	0	0	0.75	2.5	1.85	2.75	2.3	2.7	3.65
16th August	0	0	1.4	1.6	2.25	2.25	2.1	2.0	2.4
1st Sept.	0	0	0.7	1.4	2.35	2.25	2.55	2	2.4
16th Sept.	0	0	0.8	1.4	1.55	1.55	1.75	1.65	2.3
1st Oct.	0	0	0.55	0.35	1.7	0	0	1.55	1.25
16th Oct.	0	0	0.4	0.8	1.1	0	0	0.85	1.75
Mean	2.78	2.86	1.81	1.79	1.98	2.35	2.40	2.06	2.48

*Major predators (Coccinellids, Chrysoperla larvae, Syrphid flies, Spiders)

Table 6: Population mean of predators on different conservative plants in Ganderbal during 2016 and 2017

Date of Observation	Pooled mean Population of predators*/Sweep								
	Dill	Coriander	Onion	Marigold	Fennel	Dandelion	Wild carrot	Clover	Cowpea
1st April	3.2	2.45	2.3	0	2.4	2.55	2.15	1.5	0
15th April	3.15	2.85	2.9	0	2.3	2	1.65	2.15	0
1st May	3	3.2	3.55	0	2.15	1.3	2.5	2.4	3.35
16th May	3.05	4.0	3.45	0	2.05	1.5	2.95	2.4	3.6
1st June	3.2	3.95	3.1	0.8	2.9	1.95	3.4	2.9	2.7
16th June	4	3.25	3.05	1.7	2.05	2	3.2	2.5	2.75
1st July	2.65	2.8	1.75	1.4	3.1	2.3	2.4	3.4	3.1
16th July	2.6	2.95	3.1	2.0	3.4	2.6	2.15	3.2	3.3
1st August	0	0	0	2.1	1.9	2.5	1.1	2.3	2.5
16th August	0	0	0	1.1	1.3	1.2	1.35	2.6	2.6
1st Sept.	0	0	0	1.85	1.2	1.75	1.95	2.9	2.25
16th Sept.	0	0	0	1.75	0.7	0.75	0.6	1.85	2.2
1st Oct.	0	0	0	1.4	2.55	0	0	1.05	1.5
16th Oct.	0	0	0	1.15	2.35	0	0	1.25	0.8
Mean	3.10	3.18	2.90	1.52	2.16	1.86	2.11	2.31	2.55

*Major predators (Coccinellids, Chrysoperla larvae, Syrphid flies, Spiders)

Population density of Parasitoids on different conservative plants

The population density of parasitoids/sweep was recorded from Srinagar district during 2016 and 2017 is presented in Table 7. The mean population of parasitoids/sweep were recorded as 2.85 in Dill, 2.40 in Coriander, 1.60 in Onion, 1.30 in Marigold, 1.97 in Fennel, 2.07 in Dendelion, 1.59 in Wild carrot, 2.03 in Clover and 2.04 in Cowpea.The population density of parasitoids/sweep was recorded from Budgam district during 2016 and 2017 is presented in Table 8. The mean population of parasitoids/sweep were recorded as 2.78 in Dill, 2.69 in Coriander, 1.53 in Onion, 1.35 in Marigold, 1.85 in Fennel, 1.95 in Dendelion, 1.74 in Wild carrot, 2.00 in Clover and 2.08 in Cowpea.The population density of parasitoids/sweep was recorded from Ganderbal district during 2016 and 2017 is presented in Table 9. The mean population of parasitoids/sweep were recorded as 2.78 in Dill, 2.50 in Coriander, 1.50 in Onion, 1.45 in Marigold, 1.96 in Fennel, 1.95 in Dendelion, 1.79 in Wild carrot, 2.04 in Clover and 2.18 in Cowpea. Khan and Shah [25] reported in the support of finding with relation of parasitoids with pest management of aphids and Amoabeng *et al*. [26] supported as non-crop plants to promote conservation biological control of crop pests and serve as sources of botanical insecticides.

Table 7: Population mean of parasitoids on different conservative plant in Srinagar during 2016 and 2017.

Date of Observation	Pooled mean Population of parasitoids*/Sweep								
	Dill	Coriander	Onion	Marigold	Fennel	Dandelion	Wild carrot	Clover	Cowpea
1st April	2.75	2.35	1.75	0	0.55	0.55	1	1.85	0
15th April	2.7	3.05	1.7	0	1.1	0.9	1.45	1.7	0
1st May	3.75	3.75	2.05	0	2.15	2.3	3.05	1.8	1.4
16th May	3.45	3.45	2.05	0	2.1	2.2	2.9	2.6	1.85
1st June	2.8	1.9	1.95	0.55	2.45	3.45	2.3	2.35	2.8
16th June	2.55	1.7	1.45	0.7	2.7	3.6	1.95	3.75	3.4
1st July	2.2	1.6	1.1	1.25	3.2	3.1	1.5	2.95	4.05
16th July	2.65	1.45	0.8	1.85	3.0	2.7	1.2	3.4	3.7
1st August	0	0	0	1.9	2.85	2.2	1.2	2.9	1.9
16th August	0	0	0	1.45	2.45	1.95	1.05	1.7	1.25
1st Sept.	0	0	0	1.95	1.75	1.2	1	1.2	1.55
16th Sept.	0	0	0	1.25	1.9	0.7	0.55	1.65	1
1st Oct.	0	0	0	1.35	0.65	0	0	0.65	1.05
16th Oct.	0	0	0	0.75	0.8	0	0	0.95	0.55
Mean	2.85	2.40	1.60	1.30	1.97	2.07	1.59	2.03	2.04

*Major parasitoids (Braconid wasp, Chalcid wasp, Ichneumonid wasp).

Table 8: Population mean of parasitoids on different conservative plant in Budgam during 2016 and 2017.

Date of Observation	Pooled mean Population of parasitoids*/Sweep								
	Dill	Coriander	Onion	Marigold	Fennel	Dandelion	Wild carrot	Clover	Cowpea
1st April	2.65	2.05	1.25	2.4	1.45	1.25	1.65	1.15	0
15th April	2.85	2.7	1.35	0	1.3	1.35	1.6	1.3	0
1st May	4.1	3.1	1.85	0	2.4	2.45	3.15	1.95	2.05
16th May	3.7	3.8	2.15	0	2.2	2.45	3.55	2.05	2.7
1st June	2.55	2.8	1.55	1.3	2.2	3.75	2.5	1.8	3.05
16th June	2.15	1.85	1.9	1.05	2	2.85	1.6	2.45	3.55
1st July	2.25	2	0.85	1.25	2.55	2.3	1.55	3.6	3.7
16th July	2.05	1.7	1.15	2	3.4	2.3	1.45	3.6	3
1st August	0	0	0	2	3.4	1.5	1.35	3.2	2.45
16th August	0	0	0	1.5	2.65	1.2	1.9	1.6	1.6

1st Sept.	0	0	0	1.6	1.7	1.2	0.8	1.75	1.75
16th Sept.	0	0	0	1.2	1.5	0.9	0.4	1.8	1.35
1st Oct.	0	0	0	1.3	0.6	0	0	1.45	0.75
16th Oct.	0	0	0	0.45	0.1	0	0	0.95	0.3
Mean	2.78	2.5	1.50	1.45	1.96	1.95	1.79	2.04	2.18

*Major parasitoids (Braconid wasp, Chalcid wasp, Ichneumonid wasp).

Table 9: Population mean of parasitoids on different conservative plants in Ganderbal during 2016 and 2017.

Date of Observation	Pooled mean Population of parasitoids*/Sweep								
	Dill	Coriander	Onion	Marigold	Fennel	Dandelion	Wild carrot	Clover	Cowpea
1st April	2.6	2.1	1.35	0	1.35	1.15	1.3	1.25	0
15th April	2.75	3.2	1.45	0	1.4	1.3	1.45	1.35	0
1st May	4.05	3.9	2.1	0	2.3	2.15	3.35	1.85	2.05
16th May	3.7	3.8	2.2	0	1.6	2.5	3.85	2.15	2.6
1st June	2.6	2.9	1.45	1.35	2.3	2.5	2.35	1.65	2.85
16th June	2.15	1.9	1.85	1.2	1.95	3	1.35	2.35	2.85
1st July	2.3	1.95	0.75	1.3	2.6	3.8	2.1	3.5	3.6
16th July	2.1	1.8	1.1	1.8	3.2	2.5	1.4	3.5	3.6
1st August	0	0	0	1.9	3.3	1.5	0.8	3.2	2
16th August	0	0	0	1.6	2.6	1.1	1.5	1.6	1.4
1st Sept.	0	0	0	1.6	1.5	1.25	0.85	1.7	1.75
16th Sept.	0	0	0	1	1.25	0.75	0.6	1.75	1.3
1st Oct.	0	0	0	1.35	0.6	0	0	1.25	0.75
16th Oct.	0	0	0	0.45	0.05	0	0	0.95	0.25
Mean	2.78	2.69	1.53	1.25	1.85	1.95	1.74	2.00	2.08

*Major parasitoids (Braconid wasp, Chalcid wasp, Ichneumonid wasp)

Conclusion

A total of 20 different plant species suitable for the important natural enemies were identified for the insect pests of Cabbage, Tomato and Brinjal crop. The maximum population of predators and parasitoids were recorded in the month of May during 2016-2017 in Dill, coriander, onion and wild carrot. Therefore, these conservative plants can be grown as companion crops with Cruciferous crop (Cabbage). Similarly, the maximum population of predators and parasitoids were recorded in the month of August during 2016-2017 in Marigold, fennel, dandelion, clover and cowpea. Therefore, these conservative plants can be grown as companion crops with Solanaceous crops (Tomato and Brinjal). Flowering periods of conservative plants play an important role in the activity of natural enemies. Flowering plants grown in and around crop fields proposed as a means of supporting beneficial insects to increase their abundance and increase biological control. They provide many essential resources for beneficial arthropods including nectar, pollen, alternate prey, and shelter. Besides, the major population of predators depends on the aphid populations, so growing of the cover crop (Buckwheat) or alternate host or alternate prey of aphids is necessary for maintaining the population of predators, so that they will manage the Soft-bodied insects including aphids, thrips and early instar caterpillars of cabbage butterfly in vegetables. Nine species of conservative plants *viz*., dill, coriander, onion, buckwheat, Marigold, maize and cowpea rated as highly attractive to beneficial insects and with different periods of peak bloom. Whereas Marigold, dill, coriander and onion were act as repellent plants for insect pests of vegetables. Maize also act as barrier crop for aphids and flying insects and cowpea act as alternate host for egg laying of borer and cut- worms that help in avoiding damage in main crops.

Acknowledgements

This research has been funded by Department of Science and Technology (DST), Ministry of Science; New Delhi, India entitled "Ecological Engineering for conservation biological control of insect pests in vegetable ecosystem of Kashmir". The authors are thankful to DST for their valuable support and financial assistance.

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