



E-ISSN: 2320-7078

P-ISSN: 2349-6800

JEZS 2017; 5(5): 682-686

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Received: 29-07-2017

Accepted: 30-08-2017

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Relative abundance and species composition of predatory coccinellids fauna in different seasons of Brinjal crop

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Abstract

A field experiment was conducted to study the arthropod biodiversity in the brinjal to document the total predatory fauna of coccinellids occurring in the brinjal crop at sprayed and unsprayed areas. Total ten species of coccinellids were recorded in study areas of brinjal ecosystem among them, the sub-family wise species composition was as follows: Coccinellidae: Coccinellinae (6 species), Chilocorinae (1 species) and Scymninae (3 species). Among the 10 species, seven species were more abundant viz., *Cheilomenes sexmaculata*, *Coccinella septempunctata*, *Coccinella transversalis*, *Propylea* sp., *Brumoides suturalis*, *Scymnus latemaculatus*, *Pseudaspidimerus trinotatus* recorded in Attur Farm (Unsprayed area) and in sprayed area, i.e., Chikkaballapur and Doddaballapur, five dominant species were recorded viz., *Cheilomenes sexmaculata*, *Coccinella septempunctata*, *Coccinella transversalis*, *Propylea* sp. and *Brumoides suturalis*. By observing the faunal composition of coccinellids, highest number of species was observed at unsprayed area compared with sprayed area. At Bengaluru (Attur Farm) unsprayed area, the relative abundance of *Cheilomenes sexmaculata* was highest 15.48 per cent in all the seasons and lowest abundance was recorded for *Scymnus latemaculatus* (9.91%), *Pseudaspidimerus trinotatus* (10.08%) and *Propylea* sp. (12.50%) during *Kharif*, *Rabi* and summer seasons, respectively. A similar trend was observed for sprayed areas, viz., Chikkaballapur and Doddaballapur, where *Cheilomenes sexmaculata* was recorded dominant species comprising of 21.43, 20.80 and 21.05 per cent of all species composition in different seasons.

Keywords: Brinjal, Sprayed areas, unsprayed area, Spiders, Seasons, Relative abundance, Species composition

1. Introduction

Brinjal (*Solanum melongena* Linn.) is the fourth most important vegetable grown after potato, onion, and tomato in India. This vegetable crop is primarily grown by small and marginal farmers and it is an important source of income for them. In the brinjal field, various arthropod species both pests and natural enemies prevail during seedling to harvesting stage. Twenty eight species of insect pests under seven different insect orders, coleopteran and ants as major predaceous insects from the brinjal ecosystem, while 53 species of insect pests were recorded [1]. Although, several researchers published reports on pest of brinjal elsewhere however, information about total arthropods community in the brinjal agroecosystem is limited. So, our objective was to observe the arthropod biodiversity in the brinjal agroecosystem [2].

Arthropods are important components of ecosystems occupying vital positions in food webs, dynamics of populations and communities. They play various roles in ecosystems acting as herbivores, predators, decomposers, parasitoids and pollinators. Arthropods possess several characteristics that make them suitable for environmental monitoring; high diversity, small body size, high reproductive capacity, acute sensitivity to environmental changes and ease of sampling [3]. Moreover, arthropods can be sampled quickly and reliably using various survey methods [4]. Thus, arthropods are often used as biological indicators of ecosystem integrity [5] and could be used reliably to infer ecosystem function and habitat condition [6, 7]. Population ecologists discussed the diversity of arthropods in two aspects, species richness (i.e. the number of species in a set of samples) and equitability e.g., the number of individuals of each species in a sample [8].

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2. Materials and Methods

Investigation to document the natural enemy diversity of coccinellids was carried out in two systems, one unsprayed for which crop was raised at the research farm of NBAIR, Bengaluru, at their Yelahanka Campus, Attur Farm and another at sprayed situation in a farmer's field at Doddaballapur and Chikkaballapur. The crop was raised/observed from June, 2013 to June, 2014, for one year at different seasons. At the NBAIR research farm, plot was prepared by ploughing and cross-ploughing followed by laddering. All the plots were prepared with proper proportions of manure and fertilizers. The plot size was prepared 8 × 8 m having 75 × 60 cm plant spacing as control plot. The variety which we have used for experimentation was MAHYCO-11 throughout the year. For comparison from control plot, farmer fields were selected at Doddaballapur and Chikkaballapur districts. At farmers' field, the crop stage selected was 35 days after transplanting of the crop and plot size was 8 × 8 m was selected irrespective of the plant spacing and variety grown by the farmers. The counting of predatory diversity, individuals were counted by using absolute methods like visual searching method by recording on plants as well as a collection of various stages of predators. After collection, specimens were identified with the help of specialists. The sampling was done once in 10 days in both unsprayed and sprayed fields, thus 36 observations were recorded in a year. The relative abundance of the dominant species of coccinellids was worked out by using the following formula after pooling all the data and expressed in percentage.

$$\text{Relative abundance of species A} = \frac{\text{Number of species}}{\text{Total number of species in the crop}} \times 100$$

3. Results

3.1 Diversity of predatory coccinellids occurring in brinjal crop

The results of the present investigation revealed that totally 10 species of coccinellids were recorded in the brinjal ecosystem (Table 1), among them the sub-family wise species composition was as follows: Coccinellidae: Coccinellinae (6 species), Chilocorinae (1 species) and Scymninae (3 species). Among the 10 species, seven species, which were most frequently recorded, were indicated as dominant species under unsprayed condition, i.e., Attur Farm (Table 2). The seven species which were relatively more abundant than the other were *Cheilomenes sexmaculata*, *Coccinella septempunctata*, *Coccinella transversalis*, *Propylea* sp., *Brumoides suturalis*, *Scymnus latemaculatus*, *Pseudaspidimerus trinotatus* and in sprayed conditions i.e., Chikkaballapur and Doddaballapur area, among the 10 species, only five species were recorded as dominant namely, *Cheilomenes sexmaculata*, *Coccinella septempunctata*, *Coccinella transversalis*, *Propylea* sp. and *Brumoides suturalis* (Table 3 and 4). By observing the faunal composition of the coccinellids highest number of species was observed in unsprayed area as compared to the sprayed areas.

3.2 Relative abundance of different predatory coccinellid fauna in brinjal

a) At Attur farm (Unsprayed area)

During *Kharif* season, maximum mean number of species recorded was *Cheilomenes sexmaculata* (7.42 coccinellids/10 plants), followed by *Coccinella septempunctata* (6.67 coccinellids/10 plants), *Coccinella transversalis* (6.33 coccinellids/10 plants), *Propylea* sp. (6.25 coccinellids/10

plants), while other minor coccinellid species population was 5.75 coccinellids/10 plants (Table 5). The relative abundance of *Cheilomenes sexmaculata* was highest (15.48%) of all the coccinellids recorded, followed by *Coccinella septempunctata* (13.91%), *Coccinella transversalis* (13.22%), *Propylea* sp. (13.04%), while the lowest species composition was recorded in case of *Scymnus latemaculatus* (9.91%) (Table 5).

Similarly, during *Rabi* season, maximum number of coccinellid species recorded was *Cheilomenes sexmaculata* (3.25 coccinellids/10 plants), followed by *Coccinella septempunctata* (3.00 coccinellids/10 plants), *Coccinella transversalis* (2.92 coccinellids/10 plants), *Propylea* sp. (2.83 coccinellids/10 plants) and lowest mean number of coccinellids was recorded in case of *Pseudaspidimerus trinotatus* (Table 5). Consequently, highest relative abundance was recorded in case of *Cheilomenes sexmaculata* (15.73%), followed by *Coccinella septempunctata* (14.52%), *Coccinella transversalis* (14.11%), *Propylea* sp. (13.71%) and *Pseudaspidimerus trinotatus*, other coccinellids were having less species composition (10.08%) (Table 5).

During summer season, maximum number of coccinellids were recorded again in case of *Cheilomenes sexmaculata* and *Coccinella transversalis* (3.67 coccinellids/10 plants), followed by *Coccinella septempunctata* (3.50 coccinellids/10 plants), *Propylea* sp. (3.08 coccinellids/10 plants), while the other coccinellid species were having lowest species composition (2.42 coccinellids/10 plants) (Table 5). Among the coccinellid species, maximum relative abundance was found in case of *Cheilomenes sexmaculata*, *Coccinella transversalis* (14.86%), followed by *Coccinella septempunctata* (14.19%), *Propylea* sp. (12.50%) while the other coccinellid species were having the lowest species composition (9.80%) (Table 5).

b) At Chikkaballapur (Sprayed area)

During *Kharif* season, maximum number of coccinellids were recorded in case of *Cheilomenes sexmaculata* (2.75 coccinellids/10 plants), followed by *Coccinella septempunctata* (2.42 coccinellids/10 plants) and minimum number of coccinellids were recorded in case of minor species (5.75 coccinellids/10 plants) (Table 6). Among the coccinellids species maximum relative abundance was found in case of *Cheilomenes sexmaculata* (21.43%), followed by *Coccinella septempunctata* (18.83%) and whereas the other coccinellid species showed the lowest species composition (12.34%) (Table 6).

Similarly, during *Rabi* season, maximum number of coccinellids were recorded in case of *Cheilomenes sexmaculata* (2.17 coccinellids/10 plants), followed by *Coccinella septempunctata* (2.00 coccinellids/10 plants) whereas other coccinellid species recorded lowest mean number of (1.17 coccinellids/10 plants) (Table 6). Among the coccinellid species maximum relative abundance was found in case of *Cheilomenes sexmaculata* (20.80%), followed by *Coccinella septempunctata* (19.20%) and others coccinellids contributed towards minimum species composition (11.20%) (Table 6).

Maximum number of coccinellid species were recorded during summer season, was for *Cheilomenes sexmaculata* (2.33 coccinellids/10 plants), followed by *Coccinella septempunctata* (2.17 coccinellids/10 plants) and lowest mean number was recorded in case of *Brumoides suturalis* and others minor coccinellids (1.33 coccinellids/10 plants) (Table 6). The maximum relative abundance was recorded in case of *Cheilomenes sexmaculata* (21.05%), followed by *Coccinella*

septempunctata (19.55%) and *Brumoides suturalis* and other coccinellid which had minimum species composition (12.03%) (Table 6).

c) Doddaballapur (Sprayed area)

During *Kharif* season, maximum number of coccinellid species recorded was *Cheilomenes sexmaculata* (3.00 coccinellids/10 plants), followed by *Coccinella septempunctata* (2.75 coccinellids/10 plants) and other which showed coccinellid species shows lowest mean number as compared to others (1.33 coccinellids/10 plants) (Table 7). Among the coccinellids species maximum relative abundance was recorded in case of *Cheilomenes sexmaculata* (21.30%), followed by *Coccinella septempunctata* (19.53%) and other coccinellids showed the least species composition (9.47%) (Table 7).

Similarly, during *Rabi* season, maximum number of coccinellid species recorded were *Cheilomenes sexmaculata* (3.00 coccinellids/10 plants), followed by *Coccinella*

transversalis (2.08 coccinellids/10 plants) and lowest mean number of coccinellids was observed in case of other coccinellid species (1.00 coccinellid/10 plants) (Table 7). Among the coccinellids species maximum relative abundance was recorded in case of *Cheilomenes sexmaculata* (26.67%), followed by *Coccinella transversalis* (18.52%) and the other coccinellid species recorded lowest species composition of 8.89 per cent (Table 7).

During summer crop, maximum number of coccinellids were recorded in case of *Cheilomenes sexmaculata* (2.92 coccinellids/10 plants), followed by *Coccinella septempunctata* (2.50 coccinellids/10 plants) and other coccinellid species showed the lowest mean number of coccinellids (1.42 coccinellids/10 plants) (Table 7). Among the different coccinellids species maximum relative abundance was recorded in case of *Cheilomenes sexmaculata* (23.65%), followed by *Coccinella septempunctata* (20.27%) and other coccinellid which showed the lowest species composition (11.49%) (Table 7).

Table 1: Predatory coccinellid fauna recorded during the investigation at both unsprayed and sprayed areas

Sl. No.	Species	Family and subfamily
1	<i>Coccinella septempunctata</i> (Linnaeus, 1758)	Coccinellidae: Coccinellinae (6)*
2	<i>Coccinella transversalis</i> (Fabricius, 1781)	
3	<i>Harmonia octomaculata</i> (Fabricius, 1781)	
4	<i>Illeis cincta</i> (Fabricius, 1850)	
5	<i>Cheilomenes sexmaculata</i> (Fabricius, 1781)	
6	<i>Propylea</i> sp.	
7	<i>Brumoides suturalis</i> (Fabricius, 1798)	Coccinellidae: Chilocorinae (1)*
8	<i>Pseudaspidimerus trinotatus</i> (Thunberg, 1781)	Coccinellidae: Scymninae (3)*
9	<i>Scymnus castaneus</i> (Sicard, 1929)	
10	<i>Scymnus latemaculatus</i> (Motschulsky, 1858)	

Note: *Values in parentheses are total number of species in that group

Table 2: Predatory coccinellid fauna recorded during the investigation and their status in the unsprayed - Attur Farm area

Sl. No.	Family and subfamily	Species	Status of coccinellids
1	Coccinellidae: Coccinellinae (6)*	<i>Cheilomenes sexmaculata</i> (Fabricius, 1781)	Major
2		<i>Coccinella septempunctata</i> (Linnaeus, 1758)	Major
3		<i>Coccinella transversalis</i> (Fabricius, 1781)	Major
4		<i>Propylea</i> sp.	Major
5		<i>Illeis cincta</i> (Fabricius, 1850)	Minor
6		<i>Harmonia octomaculata</i> (Fabricius, 1781)	Minor
7	Coccinellidae: Chilocorinae (1)*	<i>Brumoides suturalis</i> (Fabricius, 1798)	Major
8	Coccinellidae: Scymninae (3)*	<i>Scymnus latemaculatus</i> (Motschulsky, 1858)	Major
9		<i>Pseudaspidimerus trinotatus</i> (Thunberg, 1781)	Major
10		<i>Scymnus castaneus</i> (Sicard, 1929)	Minor

Note: Major= > 1.00 coccinellids per plant per observation

Minor= < 1.00 coccinellids per plant per observation

*Values in parentheses are total number of species in that group

Table 3: Predatory coccinellid fauna recorded during the investigation and their status in the sprayed - Chikkaballapur area

Sl. No.	Family and subfamily	Species	Status of coccinellids
1	Coccinellidae: Coccinellinae (4)*	<i>Cheilomenes sexmaculata</i> (Fabricius, 1781)	Major
2		<i>Coccinella septempunctata</i> (Linnaeus, 1758)	Major
3		<i>Coccinella transversalis</i> (Fabricius, 1781)	Major
4		<i>Propylea</i> sp.	Major
5	Coccinellidae: Chilocorinae (1)*	<i>Brumoides suturalis</i> (Fabricius, 1798)	Major
6	Coccinellidae: Scymninae (2)*	<i>Scymnus latemaculatus</i> (Motschulsky, 1858)	Minor
7		<i>Pseudaspidimerus trinotatus</i> (Thunberg, 1781)	Minor

Note: Major= > 1.00 coccinellids per plant per observation

Minor= < 1.00 coccinellids per plant per observation

*Values in parentheses are total number of species in that group

Table 4: Predatory coccinellid fauna recorded during the investigation and their status in the sprayed - Doddaballapur area

Sl. No.	Family and subfamily	Species	Status of coccinellids
1	Coccinellidae: Coccinellinae (4)*	<i>Cheilomenes sexmaculata</i> (Fabricius, 1781)	Major
2		<i>Coccinella septempunctata</i> (Linnaeus, 1758)	Major
3		<i>Coccinella transversalis</i> (Fabricius, 1781)	Major
4		<i>Propylea</i> sp.	Major
5	Coccinellidae: Chilocorinae (1)*	<i>Brumoides suturalis</i> (Fabricius, 1798)	Major
6	Coccinellidae:	<i>Scymnus latemaculatus</i> (Motschulsky, 1858)	Minor
7	Scymninae (2)*	<i>Pseudaspidimerus trinotatus</i> (Thunberg, 1781)	Minor

Note: Major= > 1.00 coccinellids per plant per observation

Minor= < 1.00 coccinellids per plant per observation

*Values in parentheses are total number of species in that group

Table 5: Relative abundance of different predatory coccinellids in unsprayed area of brinjal crop at Attur Farm

Coccinellid species	Kharif			Rabi			Summer		
	Total	Mean± SD	% species composition	Total	Mean± SD	% species composition	Total	Mean± SD	% species composition
<i>Brumoides suturalis</i>	64.00	5.33±2.15	11.13	26.00	2.17±1.47	10.48	33.00	2.75±1.14	11.15
<i>Coccinella septempunctata</i>	80.00	6.67±2.53	13.91	36.00	3.00±0.74	14.52	42.00	3.50±1.31	14.19
<i>Coccinella transversalis</i>	76.00	6.33±2.27	13.22	35.00	2.92±1.44	14.11	44.00	3.67±0.98	14.86
<i>Cheilomenes sexmaculata</i>	89.00	7.42±2.15	15.48	39.00	3.25±1.76	15.73	44.00	3.67±1.07	14.86
<i>Propylea</i> sp.	75.00	6.25±3.28	13.04	34.00	2.83±1.40	13.71	37.00	3.08±1.16	12.50
<i>Pseudaspidimerus trinotatus</i>	65.00	5.42±2.64	11.30	25.00	2.08±1.16	10.08	32.00	2.67±1.23	10.81
<i>Scymnus latemaculatus</i>	57.00	4.75±1.66	9.91	28.00	2.33±1.50	11.29	35.00	2.92±1.16	11.82
Others	69.00	5.75±2.34	12.00	25.00	2.08±1.08	10.08	29.00	2.42±1.08	9.80
Total	575.00	47.92±9.58	100.00	248.00	20.67±5.66	100.00	296.00	24.67±4.89	100.00

Table 6: Relative abundance of different predatory coccinellids in sprayed area of brinjal crop at Chikkaballapur

Coccinellid species	Kharif			Rabi			Summer		
	Total	Mean± SD	% species composition	Total	Mean± SD	% species composition	Total	Mean± SD	% species composition
<i>Brumoides suturalis</i>	23.00	1.92±0.79	14.94	18.00	1.50±1.17	14.40	16.00	1.33±0.98	12.03
<i>Coccinella septempunctata</i>	29.00	2.42±1.44	18.83	24.00	2.00±0.43	19.20	26.00	2.17±1.40	19.55
<i>Coccinella transversalis</i>	26.00	2.17±1.03	16.88	22.00	1.83±1.11	17.60	24.00	2.00±0.60	18.05
<i>Cheilomenes sexmaculata</i>	33.00	2.75±1.29	21.43	26.00	2.17±1.19	20.80	28.00	2.33±0.98	21.05
<i>Propylea</i> sp.	24.00	2.00±1.21	15.58	21.00	1.75±0.45	16.80	23.00	1.92±0.79	17.29
Others	19.00	1.58±1.38	12.34	14.00	1.17±0.58	11.20	16.00	1.33±0.78	12.03
Total	154.00	12.83±3.64	100.00	125.00	10.42±2.15	100.00	133.00	11.08±3.20	100.00

Table 7: Relative abundance of different predatory coccinellids in sprayed area of brinjal crop at Doddaballapur

Coccinellid species	Kharif			Rabi			Summer		
	Total	Mean± SD	% species composition	Total	Mean± SD	% species composition	Total	Mean± SD	% species composition
<i>Brumoides suturalis</i>	25.00	2.08±1.16	14.79	16.00	1.33±0.89	11.85	20.00	1.67±1.50	13.51
<i>Coccinella septempunctata</i>	33.00	2.75±2.01	19.53	24.00	2.00±0.43	17.78	30.00	2.50±1.09	20.27
<i>Coccinella transversalis</i>	30.00	2.50±1.45	17.75	25.00	2.08±1.00	18.52	25.00	2.08±0.51	16.89
<i>Cheilomenes sexmaculata</i>	36.00	3.00±1.13	21.30	36.00	3.00±0.85	26.67	35.00	2.92±1.08	23.65
<i>Propylea</i> sp.	29.00	2.42±0.90	17.16	22.00	1.83±0.39	16.30	21.00	1.75±0.75	14.19
Others	16.00	1.33±0.78	9.47	12.00	1.00±0.43	8.89	17.00	1.42±0.79	11.49
Total	169.00	14.08±4.44	100.00	135.00	11.25±1.82	100.00	148.00	12.33±1.97	100.00

4. Discussion

In the present study, ten species of coccinellids were recorded among them the sub-family wise species composition was as follows: Coccinellidae: Coccinellinae (6 species), Chilocorinae (1 species) and Scymninae (3 species). The more abundant species were *Cheilomenes sexmaculata*, *Coccinella septempunctata* and *Coccinella transversalis* constituting a mean of 15.0 per cent, 21.0 per cent and 20.0 per cent of species composition under unsprayed and sprayed conditions. The present findings are in confirmatory with the earlier work in brinjal ecosystem [9]. The staphylinid predator *Oligota* sp. was recorded feeding on all stages of tetranychids [10, 11]. A predatory thrips, *Scolothrips rhagebianus* and *S. sexmaculatus* was recorded [12, 11]. Different species of

predator in different places in their study, species like *Oligota* sp., *Scolothrips rhagebianus* Preiesner and two unidentified predatory bugs belong to family Anthocoridae and Miridae of Heteroptera were observed in Narendera, while in Garaga, only *Oligota* sp. was recorded, whereas *Oligota* sp. and *S. rhagebianus* were recorded in Lokuru [13]. 17 families among them 7 families were identified as predators and Formicidae was occupied 67 per cent of the total surface dwelling predaceous arthropod was reported [14]. Survey was carried out in three different ecosystems viz., agricultural, horticultural and organically grown crops. A total of 18 different species of coccinellids were collected and identified. The species were *Coccinella transversalis* Fabricius, *Micraspis discolor* (Fabricius) complex, *Brumoides*

suturalis (Fabricius), *Cheilomenes sexmaculata* Fabricius, *Chilocorus melas* Weise, *Propylea dissecta* (Mulsant), *Rodolia fumida* (Mulsant), *Coelophora bissellata* Mulsant, *Epilachna vigintioctopunctata* (Fabricius), *Telsimia bangalorensis* Kapur, *Harmonia octomaculata* (Fabricius), *Scymnus* (Pullus) *castaneus* Sicard, *Illeis cincta* (Fabricius), *Scymnus* (Pullus) *coccivora* Ayyar, *Illeis* sp. (Bistigmosa group), *Pseudaspidimerus flaviceps* (Walker), *Hippodamia variegata* (Goeze) and *Scymnus nubilus* Mulsant. *Cheilomenes sexmaculata* was the most dominant predatory coccinellid species found in all the three crop ecosystems (144), the next predominant species was *Hippodamia variegata* (133). Species diversity of Horticulture ecosystem (12 species) was more as compared to Agriculture (9 species) and Organic farming block (9 species) has been reported [15]. Highest population of ladybird beetles in organic farming than conventional methods was also reported [16].

5. Conclusions

Total ten species of coccinellids were recorded in brinjal ecosystem, among the 10 species, the seven species more abundant species in Attur Farm (Unsprayed area) and in sprayed area, i.e., Chikkaballapur and Doddaballapur area, five dominant species were recorded. By observing the faunal composition of coccinellids, highest number of species was observed at unsprayed area compared with sprayed area. At Bengaluru (Attur Farm) unsprayed area, the relative abundance of *Cheilomenes sexmaculata* was highest 15.48 per cent in all the seasons and lowest abundance was recorded for *Scymnus latemaculatus* (9.91%), *Pseudaspidimerus trinotatus* (10.08%) and *Propylea* sp. (12.50%) during Kharif, Rabi and summer seasons, respectively. A similar trend was observed for sprayed areas, viz., Chikkaballapur and Doddaballapur, where *Cheilomenes sexmaculata* was recorded dominant species comprising of 21.43, 20.80 and 21.05 per cent of all species composition in different seasons.

6. Acknowledgements

The authors wish to thank the authorities of National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru - 560024, Karnataka, India for their facilities to undertake this work. We also extremely thankful to Dr. J. Poorani, Principal Scientist (Entomology), NBAIR, Bengaluru and Dr. C. A. Viraktamath, Professor (Emeritus), ICAR Network Project on Insect Biosystematics, Department of Entomology, UAS, GKVK, Bengaluru, for identifying the insect specimens. We acknowledge all technical staff who assisted their help in successful completion of work and also farmers who have cooperated for collection of field samples at different places.

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