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Development of Rural Women Entrepreneurs at Village Level for Production of Biological Control Agents for Management of Mulberry Insect Pest Mealy Bug and Silkworm Pest Uzi Fly in Karnataka

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Abstract: ***Mulberry plant an only food crop of silkworm Bombyx mori is prone for attack by so many insect pests which cause considerable loss to the mulberry leaf yield and in turn affecting silkworm cocoon yield. The important insect pest attacking mulberry is mealy bug causing Tukra disease leading to huge crop loss that making the plants unproductive and poor in its quality to use them for feeding silkworms and silkworms are also prone for attack by an insect pest Uzi fly, Exorista bombycisis causing a huge loss to the silkworm cocoon yield. An IPM package developed through biological control components form important constituents are Coccinellid beetles against mealy bugs and Hymenopteran hyperparasitoids for Uzi fly management. These bio control agents though effective are not available due to lack of multiplication centers. A successful project work has been made to develop entrepreneurship for production of these bio control agents through imparting training in mass production technology to women self-help groups at different villages. To create market for their produce, the sericulturists of the entire district were enlightened about the use of bio control agents for management of important sericultural pests. The self-help group is successfully producing the biocontrol agents and selling it to fellow sericulturists and earning profit for the self-help group.***

Keywords: silkworm, tukra disease, mealy bug, uzi fly, Exoristabombycis, biocontrol, self-helpgroup's, IPM.

1. Introduction

The present study was aimed to develop the biocontrol agent against the mealy bug and Uzi fly to develop entrepreneurship for production of these bio control agents in mass through women self-help groups at village level. The Bio control component of Integrated Pest Management (IPM)*i.e.,* predators and parasitoids recommended for IPM of mealy bug and Uzi fly were made available to farmers in required quantity by identifying women entrepreneurs in village level and developing the production units to produce the biocontrol components. Considering the economic importance of the mulberry and silkworm, the establishment of the unit and the economics of the unit will be discussed in the present paper.

Mulberry (*Morus* spp.) foliage forms a sole food to silkworms, *Bombyx mori* L. Its quality plays a pivotal role in superior silk fiber production and also as a supplement for livestock's (Venkatesh et al., 2015). Like any other plants, mulberry is susceptible to detrimental diseases and infested by insect pests (Mahadeva, 2018, Sakthivel et al., 2019)). Totally 30 species were observed to inflict damage on the mulberry leaves by sap sucking. Amongst sapsuckers, 18 Heteropterarans, 10 Homopteran and 2 Thysanopteran species were recorded. Further, they were categorized into major pests (2 species), minorpests (15 species) and occasional pests (13 species) (Annonomous, 2017). The sap suckers which cause significant damages were mealy bug, thrips, jassids, scale insect and white fly and play an important role in decreasing the crop yield significantly (Atkins, 1980; Sengupta et al., 1990; Ananthakrishnan, 1994; Rajadurai and Thiagarajan, 2003). The mealy bug, *Maconellicoccus hirsutus* popularly known as "Hard to Kill" pest was a serious major pest of mulberry and affects the plant production throughout the year and the incidence is higher in summer (Govindaiah et al., 2005). The average mulberry leaf yield loss due to mealy bug is around 4500 kgs/year/hectare (Kumar et al., 1989). As like mulberry silkworms are also prone to various diseases due to micro pathogens, pest infestation and attacked by predators (ZhaoNa *et al.,* 2008). The Uzi fly is the major insect pest of sericulture infesting silkworm. The average yield loss due to Uzi fly is 5 to 10 kgs of cocoon yield for100 Disease free layings (Dfls) of rearing. An IPM package comprising mechanical, chemical and biological (release of predators and parasitoids) was developed and found effective in suppressing the pest by 80 to 90% (Pratap and Sharma, 2004). In view of the hazardous nature of the chemicals in Pest management the biological consideration is one of the best solutions for pest management in sericulture. The bio control of the pest in sericulture is much more effective, selective and safe for humanity (Singh et al., 2002). Since then, the effective usage of bio control agents in pest management has been reported by many workers (Bhat et al., 2018), but the extent and the amount of usage in sericulture practicing areas was very negligible. A Self Help Group (SHG) is a community-based group with 10-25 members. They are usually women from similar social and economic backgrounds (Kabeer, 2005). The concept of self-help was envisaged to empower the poor in a holistic manner. Through the self-help groups (SHGs), a variety of people's institutions emerged for addressing various issues of empowerment (Gugerty et al., 2018). Self-help demanded

mobilization of people and their resources for dealing with the social problems that plagued their community. The assumption was that collective action was mandatory both for poverty alleviation and for women's empowerment, which would in turn lead to social, economic and political empowerment, ultimately resulting in holistic human development. SHG has emerged as an "Indian Model of Micro-Finance" (Shivganga, 2016).

2. Methodology

The project villages were identified and selected in association with Karnataka State Sericulture Departments of Maddur and Mandya based on the survey on pest incidence (Mealy bug and Uzi fly infestation). The studywas undertaken in individual farmers mulberry field and silkworm rearing houses of the villages. Before implementing project components base data on pest incidence and its severity were collected in the entire farmers field and 30 farmers from each village were selected before implementing the project components. Group meetings and discussions were arranged for the farmers/Self Help Group members selected to know their knowledge level on pest (Mealy bug and Uzi fly) control and information were given and discussed on IPM components and the impact of biocontrol agents to suppress the pest incidence.

Figure 1: Meetings with Experts/Scientists of CSR & TI and Officials of Sericulture department along with SHG's

Meetings with Experts/Scientists of Central Sericultural Research and Training Institute and Officials of Sericulture department were arranged to the farmers to have direct interaction and to gain information on pest and disease control. Later video shows were arranged on Tukra and Uzi fly management to the farmers and self-help members encouraging more women sericulturists to participate in the programme.

Figure 2: Demonstrations on IPM package to control mealy bug and Uzi fly for SHG's

3. Results and Discussion

The details of the pest incidence of tukra and Uzi fly is recorded in different villages are depicted in table 1. and the details of Villages / Farmers covered under IPM of Uzi fly implementation in table 2-5. Mass production of biocontrol agent-*Cryptolaemus montrouizeri & Scymnus coccivora* is shown in fig3-5 and *Nesolynx thymus is shown* in fig.6-11 respectively. Impact of IPM on tukra incidence and mealy bug population is depicted in fig 12-13. and on Uzi fly incidence in fig 14-15 respectively.

i. People's Participation from Planning to Implementation Stage: The people of the project villages were responsive to the programme as the main emphasis of the project is to popularize the IPM components to suppress the mealy bug and Uzi fly incidence and this was implemented through women self-help groups. The community responded very well to the programme and their participation in village level meetings, group discussions, video shows, training programme, exposure was appreciable.

As they acquired basic awareness and knowledge about the causative, control/preventive aspects of "Mealy bug" and "Uzi fly" they were motivated to demand for biocontrol agents as a result production in the unit was enhanced and created self-employment opportunity to the women sericulturists. The farmers showed keen interest in adopting biocontrol agents after observing the beneficial impact in their mulberry and horticulture gardens and silkworm rearing, the technology was replicated through farmer to farmer and to surrounding villages.

Support was also received from State Department of Sericulture officials, panchayat and other local political members of the target villages in establishing mass production unit's *i.e.,* in Bommanadoddi and H. Kodihalli and in popularizing the biocontrol agents. Once the general awareness level on Integrated Pest Management components to manage mealy bug was enhanced people started to demand for more demonstration of IPM components in and around target villages and their participation was high irrespective of gender.

Women participation as highly appreciable as they were involved right from the beginning of the project as they took keen interest to participate in demonstration, group discussion, video shows, community meetings, discussing with the local political leaders etc. they were one step ahead in disseminating the information on IPM components for mealy bug and uzi fly management and mass production of biocontrol agents on AIR. Their percentage of participation was high while training on mass production of biocontrol agents. As an impact they gained self-confidence in producing biocontrol agents in established units as well as individually in their home. Hence training has contributed in the improvement and adoption process of the technology and in building self-capacity of the women sericulturists.

ii. Impact analysis with indicators:

S. No.	Objectives	Achievements
1	To demonstrate and popularize IPM technology against mealy bug and Uzi fly.	IPM technology was demonstrated and implemented in all the selected villages.
2	Large scale production and release of predators and parasitoid of mealy bugs and Uzi fly *Cryptolaemus montrouizeri, Scymnus coccivora and Nesloynx thymus* respectively as a component of IPM for the management.	Mass production units of biocontrol agents (*Cryptolaemus montrouizeri, Scymnus coccivora and Nesolynx thymus*) has been established in H. Kodihalli and Bommandoddi. Each unit is producing and selling an average of 5000 beetles and 500 pouches of *Nesloynx thymus*/month.
3	Release of mealy bug predators and Uzi fly parasitoids in selected farmers field and rearings of selected villages.	Released **23, 750** *Cryptolaemus montrouizeri* beetles and **47, 500** *Scymnus coccivora* beetles in the field of selected villages under demonstration and implementation of IPM under Uzi fly management release 2310 pouches of *Nesolynxthymus* covering 1.15 lakhs Dfls in 11 villages with 155 farmers covering 832 crops.
4	Training of women sericulturist in selected villages in the mass production technology of biocontrol agents to make them self-reliant.	Women Self help groups in two villages were selected and trained in the mass production technology of biocontrol agents and they are running the mass production units. No. of Women sericulturist trained in H. Kodihalli=35 No. of Women sericulturist trainedin H. Bommandoddi =30
5	No. of villages to be covered 11 (4 in two years & 7 in extended period)	Covered **11** villages, **5** in Mandya and **6** in Maddur Taluk for demonstration and implementation of the project
6	775 mulberry crops.	Mealy bug suppression 66-72% and Uzi fly suppression 70 to 80 %.
7	Motivation and capacity building	Awareness among rural women for new technologies and supplementary sources of income generation. More than 200 women were trained on mass production of biocontrol agents. Substantial monetary gain has improved living standard of women beneficiary (s) and their families.

Special features:

- Hands on training given to 25 other women involved in sericulture apart from 75 women sericulturist.
- Motivated the women groups in establishment of biocontrol agent mass production unit in H. Kodihalli of Mandya taluk and Bommanadoddi of Maddur taluk.
- Cultivation of sweet pumpkin in their kitchen garden for mealy bug (host) culture. Usage of discarded materials (rotten & fungal infected pumpkin) of the unit for composting (Fig.3 to Fig. 5).
- Around 158.2 lakhs of (79.1 liters) (*Nesolynx thymus*) parasitoids of uzi fly were produced in the mass production unit established by the women's group and utilized in their rearing house to suppress uzi infestation (Fig. 6to Fig 11).

- Mass production of (house fly pupae) host culture in their unit. Usage of discarded materials *i.e.*, left over diet like a mixture of cow dung cake, wheat bran, yeast etc. of the unit for composting.
- Meeting with DOS officials for making liaisons for sale of biocontrol agents for unit sustainability.
- Women group of H. Kodihalli and Bommandoddi created awareness on biocontrol agents, functioning of the unit, availability of biocontrol agents etc. through a programme in All India Radio.
- Women group of Bommandoddi received Best Women entrepreneurs award from Central Silk Board, for mass production of biocontrol agents to suppress pest incidence in mulberry and silkworm rearing.

Figure 3: mealy bug (host) culture on sweet pumpkin

Figure 4: *Cryptolaemus montrouizeri* - A predator of mealy bug causing tukra in mulberry

Figure 5: Mass production of biocontrol agent- *Cryptolaemus montrouizeri & Scymnus coccivora.*

Figure 6: Uzi fly

Figure 7: Uzi fly infesting silkworm larva

Figure 8: Uzi fly pupa.

Figure 9: *Nesolynx thymus* - A parasitoid of Uzi fly pupa

Figure 10: *Nesolynx thymus* ovipositing on Uzi fly pupae

Figure 11: Mass production of *Nesolynx thymus* by SHG's

iv. Follow up action: Self Help groups are successfully handled the project and in order to enhance their knowledge and skill on mass production techniques scientists from CSR & TI are frequently visited the unit and informed them with latest information on mass production techniques apart from technical guidelines and motivating the group to enhance production in their unit.

Project coordinator and scientists of CSR & TI, DOS officials and other local institutions are taking keen interest to develop markets for sale of biocontrol agents in and around Karnataka, Andhra pradesh and Tamilnadu. Self Help Groups are taking up the task successfully and they are getting orders from other parts of Karnataka for supply.

4. Conclusion

This study has shown that there is a potential to use Self-help groups especially women self-help group platform to promote and to develop production and popularization of bio-control agent technologies and practices. The use of women (sericulturists) farmers to learn by themselves discovering the various attributes related to technologies and to draw their own inferences based on informed decisions. The approach also stimulated closer working relationship established between extension, research and farmers in the process of technology development especially through frequent and regular meetings and through exchange of experiences. At farm level, the process has started to bear a fruit by strengthening farmer's relationships and group cohesion, a situation that may auger well for the sustainability of Self help group as a platform for research, extension and farmer interactions. Popularization of biocontrol agents with increased awareness on natural enemies among the farmers. With the establishment of Mass production unit self employment for the rural women folk has been created with assured income. This case study helpful in understanding the requirement of the sericulturists and can be popularized in other potential sericulture zones as well.

Table 1: Details of mealy bug incidence, pest suppression and leaf yield in Target villages.

	Season	% incidence of Tukra		% suppression	Mealy bug population		% suppression	Leaf yield (kg)	
		C	**T**		**C**	**T**		**C**	**T**
Village 1	Summer	47.7	12.7	73.64	92.44	22	86.59	4522.17	6690.14
	Rainy	44.33	15.2	68.85	53.94	20.72	90.24	5152.58	6863.21
	Winter	41.03	14.05	69.57	37.51	16.03	87.16	5015.67	6864.28
	Total	**44.36**	**13.99**	**70.58**	**60.56**	**19.7**	**87.91**	**4896.8**	**6811.61**
Village 2	Summer	48.8	9.8	79.3	93.46	38	79.77	4962.61	6638.17
	Rainy	49.76	13.2	72.3	70.8	38.9	80.92	5287.88	6931.02
	Winter	47.2	22	54.09	43.75	36.77	75.03	5906.79	7081.78
	Total	**53.77**	**15.7**	**67.128**	**186.44**	**37.78**	**78.22**	**3615.76**	**6888.39**
Village 3	Summer	46.74	9.33	80.08	103	34.8	80.46	4462.92	6821.16
	Rainy	38.77	28.7	55.46	53.19	34.52	75.75	5203.13	6185.63
	Winter	34.29	16.23	68.96	49.44	42.23	78.49	5288.91	6809.27
	Total	**39.82**	**19.15**	**66.9**	**67.01**	**36.92**	**77.99**	**4984.98**	**6563.38**
Village 4	Summer	45.06	8.73	77.1	93.6	36.56	78.98	4256.33	7002.06
	Rainy	35.05	20.57	47.09	40.1	35.85	74.25	5263.5	6613.36
	Winter	35.26	10.8	64.05	68.74	43.3	76.15	5301.73	7094.28
	Total	**38.16**	**14.99**	**61.18**	**70.47**	**38.3**	**76.24**	**4940.52**	**6901.25**

V1= Pannedoddi [P], V2= H. Kodihalli [K], V3=Bommandoddi [B], V4=Kyathkatta [Ky]C= Control, T=Treate

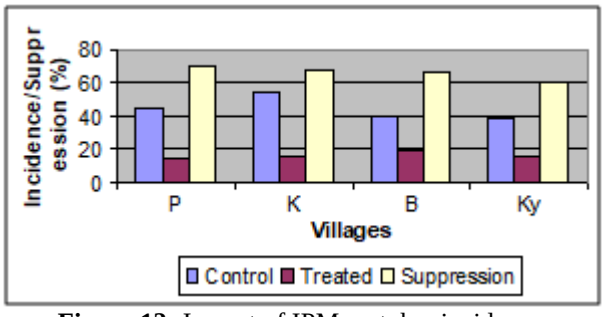

Figure 12: Impact of IPM on tukra incidence

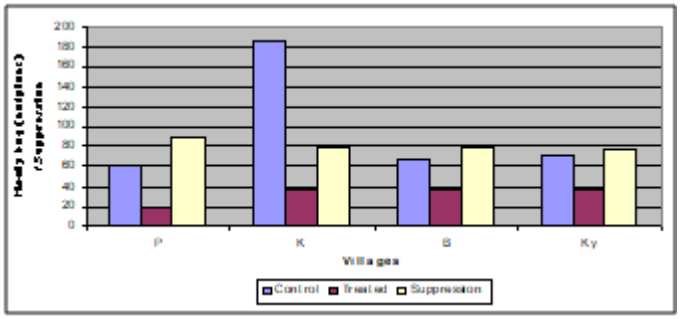

Figure 13: Impact of IPM on mealy bug population

Table 2: Details of Villages / Farmers covered under IPM of Uzi fly implementation in 1st year

Sl. No.	Name of the TSC	Name of the Village	Total crops covered
Mandya taluk			
1.	Mandya	H. Kodihalli	152crops / 30 farmers
Maddur taluk			
2.	Koppa	Pannedoddi	177 crops / 30 farmers
TOTAL			329 crops / 60 farmers

Table 3: Details of Villages / Farmers covered under IPM of Uzi fly implementation in 2nd year.

Sl. No.	Name of the TSC	Name of the Village	Total crops covered
Maddur taluk			
1.	K. M. Doddi	Bommanadoddi	174 crops / 30 farmers
		Kyathaghatta	154 crops / 30 farmers
Total			328 crops / 60 farmers

Table 4: Details of Villages / Farmers covered under IPM of uzi fly implementation in 3rd year.

S. No.	Name of the TSC	Name of the Village	Total crops covered
Mandya taluk			
1	Mandya	Kagehalladadoddi	25 crops / 05 farmers
2	Keragodu	Keragodu	25 crops / 05 farmers
3	Doddagarudana halli	Dyapasandra	25 crops / 05 farmers
4	Dudda	Kalenahalli	25 crops / 05 farmers
Maddur taluk			
5	Koppa	Rampura	25 crops / 05 farmers
6	K. M. Doddi	Madrahalli	25 crops / 05 farmers
7	Thoreshattahalli	Nidalghatta	25 crops / 05 farmers
Total			175 crops / 35 farmers

Table 5: Summarized data on Implementation of IPM of Uzi fly during the project period

Number of villages	11
Number of farmers selected	155 farmers
Number of crops	832 crops
Number of Dfls	1, 15, 325
No. of Biocontrol agent released	2310 pouches (1 pouch contains 50 ml parasitoid pupae *i.e.*, 15, 000-20, 000 adults in one pouch)
Percentage of uzi infestation before IPM	8-12%
Percentage of uzi infestation after IPM	3-4%

Graphical representation of the results obtained for the components implemented: A significant decrease in uzi infestation was recorded in all the treated crops of 4 villages compared to the control.

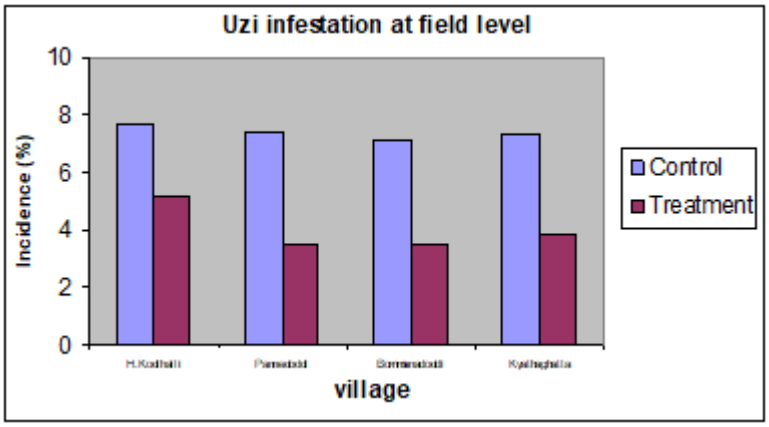

Figure 14: Impact of IPM on Uzi fly incidence

Significant parasitization was recorded during rainy season followed by winter and summer. This is mainly due to the availability of the host pupae.

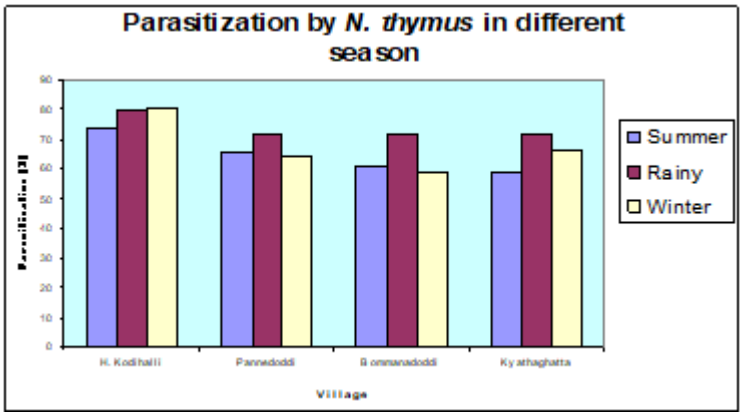

Figure 15: Impact of IPM on Uzi fly incidence in different seasons

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