HERBAL PESTICIDE TECHNOLOGY FOR CONTROLLING INSECTS AND PEST IN VEGETABLE CROPS

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ABSTRACT: Production of different vegetable crops is adversely affected by harmful insects and pests, which causes severe economic losses to the growers. To contain these losses, farmers are widely using agro-chemicals, which are very harmful and toxic to the environment. As an alternative, several broad-spectrum herbal pesticides have been developed at Sadbhav SRISTI Sanshodhan Laboratory by pooling the best grassroots community based plant protection practices. These value added herbal pesticides provide low cost, extremely affordable and sustainable solutions for enhancing the productivity of small farmers. The developed herbal pesticides have been validated in field as well as in lab conditions. The production process includes identification and collection of correct plant materials, preparation of extracts, formulation, quality control of the final product and packaging. The products are stable for more than two years at normal storage conditions.

The developed formulations are appropriate for farmers who engage in organic as well as conventional farming. So far the policy dialogue on sustainable technologies has not given sufficient focus on a land-to-lab-to-land approach. In most developing countries, the approaches for sustainable agriculture have included so called IPM (Integrated Pest Management) but these often seem to legitimize the use of chemicals even if in smaller quantities. A grassroots innovation led approach, following the Honey Bee Network values, implies a radical shift in favour of people's knowledge blended with formal scientific or institutional knowledge.

Keywords: Herbal pesticide, organic farming, whitefly, aphids, jassids, vegetable pest

1. INTRODUCTION: In the last few years, Indian economy has been growing at the slower than the expected rate. Lower growth of the agriculture sector may also be one of the important factors for this (Bedi, 2008, World Bank[a,b]). Various crops such as cereals, oilseeds, pulses, vegetables and fruits are severely damaged by various diseases, insects and pests. Farmers are forced to use large quantities of chemical pesticides to protect their crops. The Indian agriculture is currently suffering a loss of about INR 8,63,884 million annually due to insects and pests alone (Dhaliwal *et. al.,* 2010). Accounting for 15% of the total global vegetable production (over 90 MT), India stands at the second position in the world after China. The area under vegetable cultivation is about 6.2 million hectares, which is 3% of the total area under cultivation in the country. Major vegetable crops grown in the country are tomato, onion, brinjal, cabbage, cauliflower, okra and peas. Vegetable plants are known to suffer heavily due to infestation of sucking pests, shoot and fruit borers and chewing pest. Aphids (*Aphis gossypii* Glover), Jassids (*Amrasca biguttulabi guttula* Ishida) and white flies (*Bemisia tabaci* Gennadius) suck the cell sap and prohibit normal crop growth. Besides direct damage, these sucking pests also act as vectors for various viral diseases. *Amrasca biguttula biguttula* (Ishida) (Homoptera: Cicadellidae) is an important sucking pest that attacks most vegetable crops (Singh *et al*. 1993; Kakar and Dobra, 1988; Dhandapani *et al*., 2003, Munde *et al.* 2011) and lays maximum number of eggs on vegetables, which are suitable places for their survival and feeding (Hussain *et al*., 1979; Bernardo and Taylo, 1990; Sharma and Singh, 2002). Apart from vegetables, sucking pests and borers also damage other important crops. Anwar *et al.* (2007) reported that the aphid infestation in cotton crop in USA had caused yield reduction in 9,307,757 acres, which contributed to a loss of 31,450 bales.

To protect their crops from insects and pests farmers of both developed and underdeveloped countries are mainly relying on the chemical pesticides spending about US $ 9,000,000,000 per annum (Cork *et al.*, 2003). The yearly increase in the cost of pesticides has gone out of the reach of a common farmer. Further, the irrational use of chemical pesticides has caused serious health hazards and environmental problems in various countries, including India. Vegetables picked at short intervals are more prone to have toxic residues. Excessive use of chemical pesticide creates many serious threats such as elimination of beneficial predators and insects, depletion in soil microbial diversity, resistance among the pests and diseases, deposition of toxic residues, etc. (Gupta *et al.*, 1997). Similar were the reports of Korsak and Sato (1977); they found that the chemical pesticide results in the destruction of various beneficial microbes, flora & fauna and also causes serious diseases in human. Therefore there is a great need to develop green and cheaper alternatives for handling economically important pests.

SRISTI, which means creation, is a voluntary organization established in 1993 (in Ahmedabad, Gujarat, India) essentially to support the activities of the Honey Bee Network (HBN). The objectives of SRISTI include identifying and promoting institutional, cultural, technological and educational innovations at grassroots community level. It documents, disseminates and develops green grassroots innovations; provides IPR protection to grassroots innovations; promotes conservation of local biodiversity and also provides venture support to grassroots innovators. SRISTI, with the help of National Innovation Foundation - India (NIF) and other network partners has documented large number herbal agricultural practices for controlling insects and pests in various crops. Sadbhav SRISTI Sanshodhan Laboratory (SSSL) has been engaged in validating the traditional knowledge based claims of the innovators and in developing value added products by linking formal and informal science. SSSL has developed many herbal pesticides by pooling the best grassroots practices, which have been found to be quite effective and useful for application on wide range of crops to protect them from pests. Value added product development starts with the process of scouting, documentation, and obtaining Prior Informed Consent (PIC) from knowledge holders. Further, it also includes various steps such as selection of practices for validation, collection of plant samples, validation of practices, value addition, and testing to develop value added product. The present paper describes land-to-lab-to-land approach followed for developing herbal pesticides, by giving example of SRISTI Sarvatra, a herbal product developed by SSSL.

SRISTI Sarvatra effectively controls different vegetable pests such as aphids, white fly, jassids, bollworm, spotted borer etc. The grassroots practices which were used as a basis for developing this herbal pesticide were scouted and documented from Kheda district in Gujarat and Erode, Virudhunagar and Dindigul districts of Tamil Nadu and Pondicherry, a Union Territory during 1998 to 2000. The herbal pesticide has been well tested in the laboratory and in the field conditions in different seasons, crop stages and loci. This value added herbal pesticide provides low cost, affordable and sustainable solution for enhancing productivity of small farmers. The production process includes collection of plant materials, preparation of extracts, formulation, quality control of the final product and packaging. The product is stable for more than two years at normal storage conditions.

In Gujarat, this pesticide is being used by the farmers of more than eighteen districts and the users' feedback has been positive (Fig 1). The product is also being used by some farmers in other states of

India as an alternative to the chemical pesticides to protect their vegetable crops.

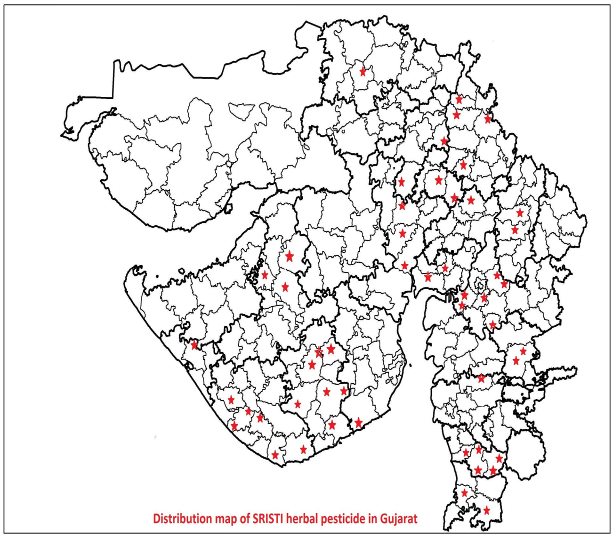

Fig. 1. Farmers using SRISTI herbal pesticide (Sarvatra) in different areas of Gujarat

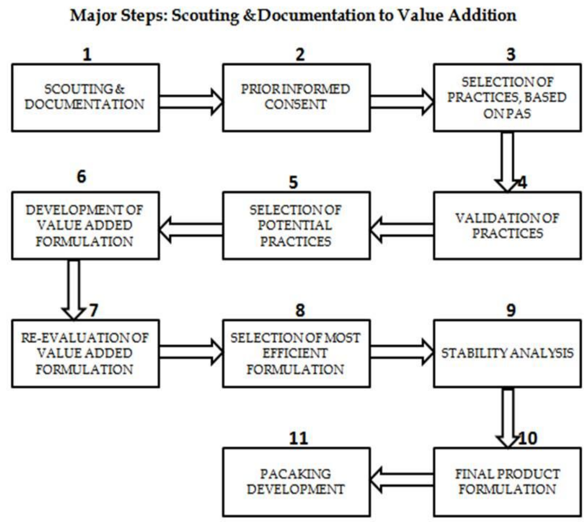

Fig. 2. Steps involved from Scouting and Documentation to Value Addition

2. MATERIALS AND METHODS:

2.1 Process of Scouting & Documentation, Validation and Value addition: Looking for an innovation or a traditional knowledge practice, called scouting is the first activity, involving going out from village to village in search of creative people and outstanding traditional knowledge holders. Once an innovation or traditional knowledge is spotted, it is documented for possible inclusion in the database of grassroots innovations. The practice is re-verified in the field and selected for validation based on prior art search report after written Prior Informed Consent (PIC) has been obtained from the knowledge holder(s) (in case of an illiterate person, PIC is recorded on video). The PIC is followed at three stages. First at a preliminary stage assuring that whatever is discovered about the properties of the claim will be shared with the knowledge provider and his/her consent will be taken for taking any further step. Second stage of PIC is when something unique is found and third stage is when a technology has to be commercialized and the benefits have to be shared. Sometimes second and third stage are combined. The practices, which show potential efficacy in the validation trials, are selected for value addition. The value added formulations are evaluated at different concentration and doses and based on the results the products are developed. The entire process from scouting to value addition is shown in Fig. 2.

2.2 Preparation of Herbal Pesticide Formulation: SRISTI Sarvatra is based on the practices of grassroots innovators (Muljibhai Patel, K. Chellamuthu, Sankara Lingam, R. Venkatasubbu and Muthusamy). The grassroots innovators were using different plants and their parts (*Azadirachta indica, Pongamia pinnata, Ricinus communis, Vitex negundo, Ferula asafoetida*) in different forms (seed cake, aqueous extracts, border crops etc.) to protect their crops from insect and pest attack. Originally, the innovators were using the above mentioned plants and/or their parts as herbal extract for spraying on crops, as border crops and seed cake for soil application. During the process of value addition oil fractions of the plants were used in order to increase efficacy and stability of the herbal pesticide formulation. The herbal pesticide formulation contains oil of four different plants blended in a balanced ratio, which makes it broad spectrum and highly effective. The details of the extraction procedure and formulation are given below:

Preparation of *Azadirachta indica* oil: The ripened fruits of *Azadirachta indica* were collected and coat was removed to obtain the seeds. The seeds were dried at the temperature of 50^0C to 60^0C for 48 to 72 hours to remove the moisture content. Oil was extracted from dried seeds and was filtered to remove the unwanted particles.

Preparation of *Vitex negundo* oil: Hydro-distillation of fresh mature leaves of *Vitex negundo* (chaste tree) was carried out for 16 to 18 hours at 65^0C to 70^0C. The oil obtained after distillation was used in the formulation of the pesticide.

Preparation of *Ricinus communis* oil: Seeds of the matured pods of *Ricinus communis* (*castor*) were collected and dried under net house. The healthy and mature seeds were dried at temperature between 50^0C - 70^0C for 60 to 72 hours. The oil obtained was filtered to remove the impurities and used for the formulation of herbal pesticide.

Preparation of *Pongamia pinnata* oil: The seeds of matured fruits of *Pongamia pinnata* (*karanj*) were dried at temperature between 50^0C - 65^0C for 62 to 72 hours. The extracted oil was filtered to remove unwanted particles.

Preparation of *Ferula asafetida* extract: An aqueous extract of *Ferula asafoetida* (*hing)* was prepared by adding water in the ratio of 1:10 (*hing*:water). The solution was allowed to stand for 60 minutes and then stirred vigorously with the help of a mixer. The filtrate was obtained for use in the formulation.

Formulation of Herbal Pesticide: The pesticide formulation was prepared by adding oil of different plants in a sequential manner in a big stainless steel vessel. Required quantity of neem oil was poured in the vessel at room temperature and then *karanj* and *castor* oils were added to it under continuous stirring condition. After 30 minutes of mixing at 1500 RPM, distilled *Vitex* oil was added to it and stirred for 45 minutes. Finally, the *hing* extract along with the natural emulsifier was added to the above mixture and stirred for 60 minutes. The final composition of the herbal pesticides of SRISTI includes *Neem* oil (5.0 to 10%), *Karanj* oil (5.0 to 10%), Castor oil (5.0 to 10%), *Vitex* oil (0.01 to 0.1%), *Hing* extract (0.5 to 1.5%) and natural emulsifier (5.0 to 10%). The prepared formulation was left undisturbed to observe any sedimentation. The quality of the product was analysed and the final product was packed in the bottles. A complete cycle of production of the herbal pesticide is given below (Fig. 3). The patent of the above mentioned formulation (SRISTI herbal pesticide - Sarvatra) has already been filed in the name of the innovators to protect their IPRs.

2.3 Standardization and Quality Control: Freshly prepared formulation was analyzed using HPTLC for quality control purposes. The samples were centrifuged for 10 minutes to remove particles. Band of 5µl was spread on HPTLC plate-Silica gel 60F254 (E. Merck) using Linomat V sample applicator (Camag, Muttenz, Switzerland). TLC was then developed using suitable mobile phase solvent system and dried in air. Densitometry scanning was carried out using Camag TLC Scanner III in the absorbance mode between wavelengths 250nm to 300 nm. Band pattern was matched with the original formulation to ensure the quality.

2.4 Evaluation of SRISTI Sarvatra against different pests: The herbal pesticide formulation developed by SSSL was evaluated in the laboratory as well as through field trials monitored and conducted by Agriculture Universities, SSSL and Farmers.

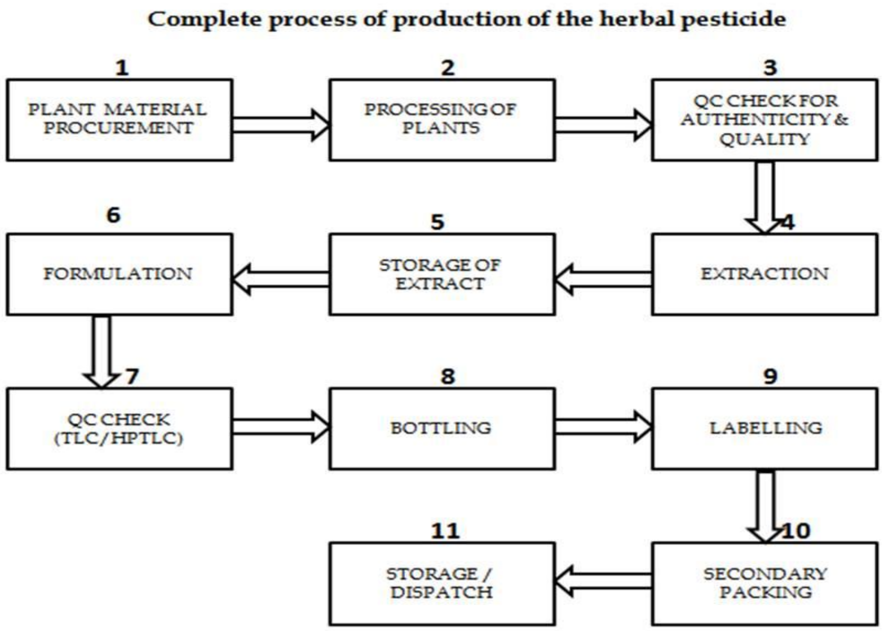

Fig. 3 Complete process of production of the herbal pesticide

2.4.1 Agriculture University Monitored trials: The herbal pesticide developed by SSSL was sent to different agricultural universities to evaluate its efficiency. Field trials were conducted at Sardarkrushinagar Dantiwada Agriculture University (SDAU), Dantiwada, Gujarat on the Okra crops. Randomized Block Design (RBD) was used to sown the seeds of popular variety of Okra, having plot size of 2.25 x 3.0 m and spacing of 45 x 10 cm. The standard agronomic practices were followed. Data were recorded for the variation in the population of leaf hoppers, *Helicoverpa armigera* and *Earias vitella* per plant before and after the spray of the herbal pesticide formulation. The untreated plots and the plots treated with Chlorpyriphos @ 0.05% served as control and positive control respectively.

The herbal pesticide was also evaluated at Govind Ballabh Pant University of Agriculture and Technology (GBPUAT), Pant Nagar, Uttarakhand. Tomato (Variety Pant Tomato) was used as the test crop. The design used for the experimental plots was Randomized Block Design (RBD). The spacing between the plant and row were kept at 45 x 60 cm, having plot size of 4 x 3 m. The formulation was sprayed on the tomato crops twice at interval of 15 days. The data was recorded for pest control (whitefly, borers etc), fruit damage and finally the tomato fruit yield. The untreated plots served as control and the plots treated with Imidaclopid @ 0.25 ml/l and Nimibicidine @ 5ml/l served as positive controls.

2.4.2 SSSL Monitored Trials: SSSL has conducted field trials to evaluate the value added product “Sarvatra”. The trials were conducted at farmer’s field and also at the experimental plots located in Amrapur, Gandhinagar. The trials at farmer’s field were conducted on vegetable crops (as strip trials) and were monitored by SSSL and the farmer both. The field experiments were conducted on cotton crop (Variety H-8 at the experimental farm. The treatments were: a. T1 -@ 2ml/L water; b. T2 -@ 4ml/L water; c. T3 -@ 6ml/L water, d. T4 -*Neem* oil @ 25 ml/L water & e. T5 –Water

There were total 20 plots with plot size of 6.0 x 6.0 m each. Row to row and plant to plant spacing was maintained at 120 x 60 cm respectively. All the five treatments had four replicates. Standard agronomic practices were followed throughout the experiments as per recommended practices for cotton crop**.**

The herbal pesticide was sprayed on the plants when the population of the pests reached the Economic Threshold Level (ETL). Spray applications were made with the help of hand operated Knapsack sprayer. Observations on the population and mortality of aphids, jassids and whiteflies were recorded from ten plants at different time intervals (before and 1, 3, 5 and 7 days after spraying), selected randomly from replicate plots of each treatment. The number of nymphs and adults of aphids, jassids and whiteflies were recorded from 3 leaves (top, middle and bottom) of ten plants. The mean population of aphids, jassids and whiteflies were calculated and the data was subjected to statistical analysis in order to find out the effects of the herbal formulation on population control and mortality of the pests.

3. RESULTS AND DISCUSSION:

3.1: Agriculture University Monitored trials:

3.1.1: Results of SDAU, Dantiwada field trials conducted on Okra crop indicated a significant control in the pest attack. The herbal pesticide (at 5ml/l) exhibited reduction in the leaf hopper (42%) and other (*Helicoverpa armigera* and *Earias vitella*) larval population (77%) on Okra plant as compared to the untreated control. This caused significant reduction (42%) in the fruit damage in Okra as compared to untreated control. Per cent damage in the okra fruit with Sarvatra (at 10ml/l) treatment was at par with the chemical control Chlorpyriphos (at 0.05%). SRISTI Sarvatra was found to be effective in controlling the pest (sucking and fruit borer) of Okra crop.

3.1.2: Results of field trials conducted at GBPUAT, Pant Nagar on tomato plants showed that there was a significant reduction in the population of insects after spray. The herbal pesticide was found to have deterrent action against white flies (*Bemisia tabaci*) and other pests, which reduced damage to the tomato plants and the fruits. This resulted in the higher yield of tomato (6.55 t/ha) as compared to untreated control plots (4.55 t/ha). There was an increase of more than 30% in the yield of tomato as compared to untreated control plots. Tomato yield in the plots treated with SRISTI Sarvatra was at par with Nimbicidine treated plots, however it was slightly less than the chemical pesticide (Imidacloprid) treated plots.

3.2 SSSL Monitored Field Trials:

3.2.1: Field Trails at Farmer's Field: The herbal pesticide demonstrated good control in the pest population and the damage caused by the pest. The farmers also gave positive feedback.

3.2.2: Field Trials Conducted by SSSL at Grambharti:

Efficacy of the SRISTI Sarvatra against aphid (*Aphis gossypii* Glover): Significant reduction in the aphid population was observed in all the treatments in cotton (Table 1). There was a gradual decrease in the population of aphids after spraying the formulation. The aphid population was found to be reduced by about 50% and the application of higher doses (4 and 6 ml/liter) was more effective. Mortality of 17 to 23% was recorded with different treatments, one day after spray (DAS) of the herbal pesticide. A dose dependent relationship was recorded with respect to the mortality of aphids by herbal pesticide. Mortality percentage increased with the duration of application of formulation. Highest mortality was recorded after seven DAS, which ranged from 30 to 50% at different concentration. Per cent mortality of aphids at the concentration of 6 ml/liter herbal pesticide was at par with the positive control neem oil (@ 25 ml/liter) (Table 2).Various other workers have used several chemical pesticides to control sucking pests (Vadodaria *et al.* 2004, Choudary *et al.* 2004, Gupta and Shankar 2007).

Shivanna *et al.* (2011) studied efficacy of seven different pesticides against aphids and found reduction in the population with mortality ranging from 29 to 66%, highest with Dimethoate 30. Per cent mortality caused by SRISTI Sarvatra (50%) was higher than the Eco-neem (46%), which contains (Aza.) as an active ingredient.

Table 1. Effect of SRISTI herbal pesticide on Aphid population in the field conditions

Sr. No.	Treatment	Before	Avg. number of Aphids per plant			
			1DAS	3DAS	5DAS	7DAS
1	2 ml/l	15.78	13.23	12.20	11.20	11.13
2	4 ml/l	13.80	10.78	9.63	8.78	7.73
3	6 ml/l	14.58	11.33	9.83	8.48	7.35
4	25 ml/l Neem oil	17.20	12.10	10.73	9.53	7.90
5	water	16.85	15.85	16.25	15.45	16.75
S. Em. (±)		0.39	0.62	0.85	0.94	1.40
CD (0.05)		1.09	1.70	2.34	2.60	3.86
CV (%)		18.47	16.29	16.10	15.23	14.23

Table 2. Mortality (%) of Aphids after treating the plants with SRISTI Sarvatra

Sr. No.	Treatment	Percent (%) mortality			
		1 DAS	3 DAS	5 DAS	7 DAS
1	2 ml/l	16.16	22.66	29.00	29.48
2	4 ml/l	21.92	30.25	36.41	44.02
3	6 ml/l	22.30	32.59	41.85	49.57
4	25 ml/l Neem oil	29.65	37.65	44.62	54.07
5	water	5.93	3.56	8.31	0.59

Efficacy of SRISTI Sarvatra against Jassids (*Amrasca biguttula biguttula* Ishida): The results obtained from the above trials revealed a significant reduction in the population of Jassids, one to seven days after spray (DAS) (Table 3). Reduction in the population of aphids increased with increasing duration, which indicates that the formulation was effective for at least six to seven days. There was about 50% decrease in the Jassid population at higher dose of herbal pesticide (6 ml/liter). Data shows that there was significant effect of the herbal pesticide on the reduction of Jassids with the mortality ranging from 15 to 24% at three DAS, which was higher than the positive control neem oil (17% @ 25 ml/liter) (Table 4). At seven DAS, mortality of Jassids ranged from 32 to 56%, with the highest dose of the herbal pesticide (6ml/liter) achieving the highest result. The mortality caused by SRISTI Sarvatra (56%) was at par with the positive control (57%). Various researchers have reported the use of chemical and non-chemical pesticides for controlling sucking pests (Khattak *et al.* 2004, Saleem and Khan 2001).

Table 3. Effect of SRISTI Sarvatra on Jassid population in field conditions

Sr. No.	Treatment	Before	Avg. no. of Jassids per plant			
			1DAS	3DAS	5DAS	7DAS
1	2 ml/l	4.70	4.50	4.00	3.55	3.20
2	4 ml/l	5.05	4.65	4.26	3.98	3.16
3	6 ml/l	6.43	5.95	4.90	3.55	2.88
4	25 ml/l Neem oil	4.08	3.71	3.41	2.21	1.76
5	water	6.20	6.11	5.96	5.66	5.56
S. Em. (±)		0.61	0.56	0.53	0.70	0.83
CD (0.05)		1.69	1.55	1.46	1.93	2.29
CV (%)		8.17	9.12	9.19	8.88	8.36

Table 4. Mortality (%) of Jassids after treating the plants with SRISTI Sarvatra

Sr. No.	Treatment	Percent mortality of Jassids			
		1 DAS	3 DAS	5 DAS	7 DAS
1	2 ml/l	4.26	14.89	24.47	31.91
2	4 ml/l	7.92	15.59	21.29	37.38
3	6 ml/l	7.39	23.74	44.75	55.25
4	25 ml/l Neem oil	9.13	16.48	45.89	56.92
5	water	1.45	3.87	8.71	10.32

Efficacy of SRISTI Sarvatra against whitefly (*Bemisia tabaci*): Data shows that SRISTI herbal pesticide significantly reduced the population of whitefly on the cotton plants. The higher concentration (6ml/liter) of the herbal pesticide was most effective and there was reduction of about 50% in the population of whiteflies (Table 5). The herbal pesticide also caused mortality in the whiteflies ranging from 33 to 51%, highest at the dose of 6ml/liter. The mortality % of whiteflies due to SRISTI Sarvatra was found to be at par with the positive control. Several researchers have also reported the control of whiteflies and sucking pests using various pesticides (Dhawan and Brar 1995, Anuradha and Rao 2005, Singh and Kumar 2006).

Table 5. Effect of SRISTI herbal pesticide on white flies population in field conditions

Sr.No.	Treatment	Before	Avg. no. of White flies per plant			
			1DAS	3DAS	5DAS	7DAS
1	2 ml/l	4.95	4.65	4.10	3.80	3.35
2	4 ml/l	5.30	4.90	4.26	3.94	2.96
3	6 ml/l	6.53	5.73	4.73	3.58	3.23
4	25 ml/l Neem oil	4.41	3.59	2.93	2.20	1.98
5	water	6.03	5.91	5.74	6.17	6.07
S. Em. (±)		0.45	0.57	0.70	0.65	0.64
CD (0.05)		1.24	1.59	1.94	1.79	1.76
CV (%)		9.39	8.10	7.29	11.01	11.96

Table 6. Mortality (%) of whitefly after treating the plants with herbal pesticide

Sr. No.	Treatment	Percent mortality of White flies			
		1 DAS	3 DAS	5 DAS	7 DAS
1	2 ml/l	6.06	17.17	23.20	32.30
2	4 ml/l	7.55	19.58	25.71	44.10
3	6 ml/l	12.26	27.59	45.21	50.57
4	25 ml/l Neem oil	18.75	33.65	50.08	55.13
5	water	1.99	4.69	-2.37	-0.71

CONCLUSIONS: The irrational use of chemical pesticides has caused serious health hazards and environmental problems in developing countries including India. The herbal pesticide developed by Sadbhav SRISTI Sanshodhan Laboratory has proved efficacy in controlling different vegetable pests such as aphids, white flies, jassids, bollworms, spotted borer etc. The value added herbal pesticide provides an affordable and sustainable environment friendly solution for enhancing productivity of the small farmers. This process of developing a value added product (based on grassroots innovations) is an unique example of land-to-lab-to-land approach. There is a great need to develop and promote such approach and green formulations at a larger scale. This example also shows that the farmers may not only be looked at as consumers. They can also be considered as a source of solutions, many of which may be validated, optimised, patented and converted into useful products. It is pertinent here to note the experience of SRISTI in organising Shodh Sankals (meetings of experimental farmers), which shows that the rate of horizontal diffusion of such ideas can be accelerated by creating a communication platform of farmers. This provides the farmers an opportunity to learn from each other.

Several policy implications thus follow: a) while scouting the knowledge of the people, due care should be taken in sharing the findings with the knowledge providers in their local language, b) prior informed consent in the case of unique knowledge is essential to fulfill the ethical requirement, but such an obligation may not be due when public domain knowledge is used for developing products, c) sustainable agriculture requires building upon the traditions of experimentation by farmers on non-chemical alternatives, d) farmer to farmer distribution of knowledge just like the cross pollination of bees is fundamental for creating sustainable communities.

Sustainable agriculture requires not just technologies but also institutions. The Honey Bee Network (HBN) started in late 1980's has practiced and propagated the philosophy of acknowledgement (knowledge holder should not remain anonymous), sharing (people to people, in local language) and giving back (a fair share of profit, accrued if any, from the knowledge of the holder). The HBN welcomes partnerships with groups which value what people know, excel in and are willing to share for the common good or even with their IPR protected.

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