

Integration of Traditional Knowledge for Pest Management in Organic Farming in West Sikkim Agro Ecosystem

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Abstract Indigenous knowledge (IK) generated through sequential trial and error at the community level has been the basis for development of cutting edge agricultural technologies. Sikkim Himalaya with rich biodiversity and diverse ethnic communities, harbors treasure of indigenous knowledge. With the advent of organic farming policies in the state, indigenous knowledge of agriculture, particularly for the pest and disease management were brought into practice intensively across the state. During the studies, thirty five plants were found to be used by the farmers for preparation of botanical or for the control of pests, out of which 13 plants were found cultivated but only 9 plants were found abundantly whereas four were found moderately. Eight plants were studied to be abundance in wild, 4 were moderately found whereas the rest are rear. Twelve methods of preparation of extracts, botanicals or pesticides have also been described. Some of the plants in use are found rarely which warrants mass propagation or conservation measures. Validation of the IK will boost the organic farming practice in the hills.

Keywords Organic farming, Indigenous, Sikkim.

Introduction

Sikkim, a Himalayan state in north eastern part of India is unique in terms of cultural and biological heritage. The state is inhabited by 14 hill tribes and have a dynamic history of agriculture ranging from shifting cultivation before 1890 till the creation of separate agriculture department in the state in 1984 [1]. The state harbors 4458 species of flowering plants, 506 species of lichens, 480 pteridophytes and 17 gymnosperm [2] owing to varied agro-climatic conditions and farming system. Such diverse ethnic communities and the species richness make Sikkim, a treasure house of traditional knowledge and farmers knowledge or local knowledge or indigenous (IK) has played major role in agriculture system management.

The policy decision of state government in 2003 for adopting organic farming has attended a complete organic certification status on 2016. The organic farming practices adopted in entire state has strengthened the role of IK. The organic farming practices demand eco-friendly pest control technologies well adapted to the requirement of farming communities based on their knowledge. Farmers of Sikkim have now intensified the IK practice in pest management, though their documentation and validation is still obscure. Compelling situations to innovate or adapt some things for pest management, in fact, motivate farmers of Sikkim to generate knowledge out of necessities, curiosity and extinct. This work envisaged to document indigenous practices followed by farmers for the management of pests in organically grown crops of West Sikkim.

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Materials and Methods

This study was undertaken in selected nine villages of West district of Sikkim coordinated at 27°00'46'' to 28°07'48'' N Latitude and 88°00'58'' to 88°55'25'' Longitude. Methods employed in this study were designed with the purpose of providing base line information on use of plants for the preparation of biopesticides in local system through surveys, Participatory Rural Appraisals (PRA) and field visits to various areas of West Sikkim. The data were collected through structured and semi-structured interviews with native practicing farmers. Respondents were chosen from three villages representing agroecological situation viz. Very high altitude (1500-2500 m from Mean Sea Level), mid altitude (800-1500 m from MSL) and low altitude (upto 800 MSL) region of west Sikkim consulting key informants like local panchayats, extension employees of agriculture and horticulture department. Interview approach i.e. asking questions about use of plants for different purposes and making forest/community visits to identify the species. After initial enumeration, a total of 15 respondents were chosen to finalize status, utilization aspects, methods of preparation of local biopesticides/botanicals and to identify the most valuable plant species from farmer's perspectives. Direct observations of specific plants were undertaken in accompanying excursions to different niches so as to observe the cited plants, to collect samples for botanical identification. Data were also collected during field trips and PRA opportunistically when information was offered by companions based on their direct observations.

Results and Discussion

Locally available plants for pest and diseases management and their cultivation status

During the study, thirty five plants were found be used by the farmers for preparation of botanical or for the control of pests. Table 1 describes the details of plants used by the farmers with local name and the plant part used. It was found that all of these plants were either used as the fermented extracts or as the mulching material. For using as the extracts, the partially crushed plant parts are mixed with the cowdung slurry, cow urine or water and keep under storage for

7-10 days. In many cases, people have also mixed the burnt ashes. The resultant extracts were then used with different dilutions depending upon the crops. All the plants were used as broad spectrum pesticides and also as a nutrients. No specific crops, pests or diseases were reported by the farmers. Table 1 also describes the availability of the plants and their cultivation status. Out of all, 13 plants were found to be cultivated, amongst them 9 plants are abundantly found and widely cultivated whereas four were found moderately. Eight plants were studied to be abundance in wild, 4 are found moderately whereas the rest are rear.

Preparation of indigenous pest specific extracts or formulation and other indigenous knowledge

The farmers in West Sikkim have refined knowledge on making different plant formulation for pest management. Most widely followed methods are documented as follows :

1. The sucking pest such as aphids, thrips and jassids and some larvae were found to be controlled by spraying cow urine (desi cow). The cow urine is mixed with water with different dilution. To spray the perennial crop like orange during the period other than flowering, 1:3 (Urine : Water) dilution is made. Spraying of 1:5 (Urine: Water) dilution is followed against the above pests in vegetable crops.
2. Growing or tender portion of stinging nettle and a gave leaves is crushed and kept for 7 days for fermentation in air tight container. The extracts after fermentation is diluted 4-6 times for drenching the soil for controlling or repelling red ants in potato field.
3. The mixture of garlic, onion, marigold and chilli have been well adopted by farmers for controlling sucking pests like thrips, aphids and Jassids in vegetables. 5-10 bulblets of garlic + 2-3 nos. of small onion + 4 hand full of marigold leaves + 5 nos. of red chilli is boiled and the resultant 5 liters of extract is sprayed.
4. Mechanical method in controlling pest like trunk borer in orange is well practiced in some part of the district. The hole bored by the insect in tree trunk is

Table 1. Locally available plants used for management of pests and diseases. Words in parentheses are in nepali vernacular.

Sl. No.	Common 7 (Local name) (Nepali vernacular)	Botanical name	Family	Part used	Cultivation status	Availability
1	Acid Lime (Nimbu)	<i>Citrus aurantifolia</i> (Cristm.) Swingle	Rutaceae	Leaf	Cultivated	Medium
2	African marigold (Sayapatri)	<i>Tagetes erecta</i> L.	Asteraceae	Whole plant	Cultivated	Abundant
3	(Angeri)	<i>Pieris formosa</i> (Wall.) D Don	Ericaceae	Leaf and bark	Wild	Moderate
4	(Bepari)	<i>Ostodespeniculata</i> Blume	Euphorbiaceae	Leaf	Wild	Moderate
5	(Bhaley Timur)	<i>Zanthoxylum alatum</i> Roxb.	Rutaceae	Fruit and leaf	Wild	Rare
6	Chilli((Khorsani)	<i>Capsicum annum</i> L.	Solanaceae	Dried fruit	Cultivated	Abundant
7	(Bokay Timur)	<i>Zanthoxylum macanthopodium</i> DC.	Rutaceae	Fruit and leaf	Wild	Rare
8	(Dokray Phool)	<i>Brugmansia</i> spp.	Solanaceae	Root, bark, leaf	Wild	Abundant
9	French marigold (Sayapatri)	<i>Tagetes patula</i> L.	Asteraceae	Whole plant	Cultivated	Abundant
10	(Gantey)	<i>Gynocardia odorata</i> R. Br.	Achariaceae	Fruit	Wild	Rare
11	Garlic (Lasun)	<i>Allium sativum</i> L.	Liliaceae	Leaf and bulb	Cultivated	Abundant
12	(Hing)	<i>Ferula narther</i> Boiss	Apiaceae	Latex	Cultivated/wild	Rare
13	(Kali Jyambir)	<i>Citrus jambhiri</i> Lush.	Rutaceae	Leaf, fruit juice, fruit rind	Cultivated	Moderate
14	Mandarin orange (Suntola)	<i>Citrus reticulata</i> Blanco	Rutaceae	Leaf, fruit rind	Cultivated	Abundant
15	Onion(Piyaj)	<i>Allium cepa</i> L.	Liliaceae	Whole plants	Cultivated	Abundant
16	Stinging Nettle (Patley Sisnu)	<i>Laportea terminalis</i> Wight	Urticaceae	Whole plants	Wild	Abundant
17	Pirey Uney	<i>Glaphylopteriopsis erubescens</i> (Well ex.Hook.) Ching}	Thelypteridaceae	Leaf	Wild	Abundant
18	Rough Lemon (Naiteyjamir)	<i>Citrus junos</i> Sieb. ex Tanaka	Rutaceae	Leaf, fruit juice, fruit rind	Cultivated	Rare
19	Sil Timur	<i>Litsaeacitrata</i> Bl.	Lauraceae	Fruit and leaf	Cultivated/wild	Rare
20.	Mug-wort (Titepati)	<i>Artemisia vulgaris</i> L.	Asteraceae	Leaf	Wild/cultivated	Abundant
21	Turmeric (Hardi/Besar)	<i>Curcuma longa</i> L.	<i>Gingeraceae</i>	Dried rhizome	Cultivated	Abundant
23	Big Nettle (Thullosisnu)	<i>Girardinia palmatai</i> (Forssk.) Gaudich.	Urticaceae	Whole plant	Wild	Moderate
24	Lantana (Aulay Banmara)	<i>Lantana camara</i> L.	Verbanaceae	Flowers and leaves	Wild	Abundant
25	Poinsettia (Lal pati)	<i>Euphorbia pulcherrima</i> Willd. ex Klotzsch	Euphorbiaceae	Leaves	Wild	Abundant
26	Needlewood Tree (Chilaunay)	<i>Schima wallichii</i> (DC.) Korth	Theaceae	Tender leaves	Wild/cultivated	Abundant
27	(Lekh Angeri)	<i>Andromeda villosa</i> Wall.	Ericaceae	Leaves	Wild	Moderate
28	Drum stick (Sajana)	<i>Moringa oleifera</i> Lam.	Moringaceae	Leaves and root	Cultivated	Abundant
29	(Kalijhar)	<i>Eupatorium odoratum</i> L.	Asteraceae	Whole plant	Wild	Abundant
30	Papaya (Mewa)	<i>Carica papaya</i> L.	Caricaceae	Leaves	Cultivated	Moderate
31	(Ratnaullo)	<i>Polygonum runcinatum</i> Buch. Ham. ex D). Don	Polygonaceae	Whole plant	Wild	Abundant

Table 1. Continued.

Sl. No. (Nepali vernacular)	Common & (Local name)	Botanical name	Family	Part used	Cultivation status	Availability
32	Agave (Hathibar)	<i>Agave americana</i> L.	Agavaceae	Leaves	Wild/cultivated	Abundant
33	(Ban Haldi)	<i>Curcuma aromatic</i> Salisb.	Zingiberaceae	Rhizome/ leaves	Wild/cultivated	Moderate
34	Black Turmeric (KalolHaldi)	<i>Curcuma zeodaria</i> (Christm.) Roscoe	Zingiberaceae	Rhizome/ leaves	Wild/cultivated	Rare
35	(Chari amilo)	<i>Oxalis corniculata</i> Linn.	Oxalidaceae	Whole plant	Wild	Abundant

first fumigated with the *bidis* smoke and close the hole with piece of wood so that smoke do not come out.

5. White grubs are trapped in fresh cow dung. The fresh cow dung is kept in some earthen container, which is dugged to the level of soil in between the beds or at certain interval. The dung attracts the grubs which are then killed manually.

6. The local people have been using plant parts for control of stored grain pests in Pulses and Rice. The grains are kept in the earthen pot or specialized structure of bamboo called *Kotha* and the leaves of neem, basil or *Ostodespericulata* [Bepari (N)] are kept in the container. If powdered, about 10-20 grams of powdered are tied in a piece of cloth and place them at about 10 different location of the stored structure along with grain.

7. Dead crab is hanged in the stakes of cucumber, when the growth of the cucumber is stunted. There is myth and belief that died crab helps in repelling insect pests and diseases.

8. The mixture of turmeric powder and burnt ash are used for controlling powdery mildew in pea. Different proportion of mixing the turmeric was reported. Usually 1:5 (turmeric : burnt compost) is practiced. About 10 kg of mixture is sufficient to dust for controlling powdery mildew in 1 hectare of pea filed.

9. Fungal diseases : 1 kg turmeric powder mixed with powder of 5 bulblets of garlic mixed with 5 cups of water (1 L), boiled and a pinch of sulfur is added to it and keep for 2 days. The resultant solution is diluted to 100 times and sprayed regularly and interval of 15 days.

10. Paste of *Glaphylopteriopsis* sp. [(Pirey Uniyu (N)] is also use as fungicide. Most of the practices they followed seem to have the scientific basis, whereas few of them are just the myth and belief. So far, no scientific documents on the authenticity of the above methods were found.

Use of plants (rotenone, neem, pyrethrin) and plant parts for pest control have been reported for thousands of years [3]. The use of plants for pest management is based on the facts that, they are basically rich in secondary metabolites as a defence mechanism against the herbivore predator or other environmental stresses. The traditional ecological knowledge is a result of continuous practice and perception by the local communities and hence rigorously tested and refined, though it requires even more scientific validation. Though there has been lots of research on ethnomedicine but very less plants are being reported to have insecticidal properties in India. Phani and Alka [4] described only two plants to be insecticidal, but in some other report various plants were described to have insecticidal and wormicidal effect Aravalli hill range of India [5]. In Sikkim, 15 different formulations of the plants against the specific pests and diseases was reported earlier [6]. The reported plants like *Zanthoxylum allatum*, *Lyonia ovalifolia*, *Curcuma longa*, *Artemesia vulgaris*, *Chromolaena odorata* corroborates with the present finding. Pest and management practices were reviewed and documented in North Eastern region of India [7], and advocate for preserving, documenting and validating the knowledge. Cow urine has been the focal constituent in most of the formulations in organic farming system in Sikkim. Usually the extracts are being made in the cow urine, preferably of local breed. Cow urine extracts of *Calotropis procera* was reported to

have 91% inhibition of conidial germination of *Bipolaris sorokiniana*, which cause leaf blight of wheat [8]. Cow urine with pongamia seed extracts was also shown to have inhibitory effect against *Xanthomonas oryzae* pv *oryzae* [9]. Inhibition of *Rhizoctonia solani* was also reported by Tiwari and Das [10]. The conservation and sustainable use of the plant is of vital importance. As seen in the studies some of the plants are wild harvested and are rear which means they are already over exploited. The traditional knowledge is a continuous and dynamic process, which tends to be refined time to time. The indigenous pest and disease management practices need to be thoroughly validate through some mission mode research. Mountains harbor numerous plant biodiversity with high efficacy to manage pest and diseases, and traditional are in use. There has been huge advocacy for adopting the organic farming practices in the mountain from the perspective of fragile ecosystems and many other reasons. Pest and disease management are the major challenges in organic farming. The strategic research to validate the indigenous knowledge and intensive research in finding the lead molecules in the Himalayan plants and herbs for pests and disease control would be a boon to the organic agriculture.

There are abundance of knowledge and practices of local people in crop protection which need to be documented for sustainable food production. There is a need to validate the data on indigenous pest management knowledge derived through long experiences and perceptions of community. Some of these validated data may be incorporated as an integral component into the Integrated Pest Management (IPM) concept for evolving better pest and disease management strategies in any farming system. Attempt is being made here to document some of the indigenous practices followed by farmers for the management of pests of certain common crop organically. The biopesticides being used by the locals of Sikkim are

excellent alternatives to the chemical synthetic pesticides. The locals are aware about the need to organize and promote the knowledge on indigenous biopesticide along with other organic based pest management component like resistant crop varieties, trap crop, use of predators, use of entomophagus microbes and crop rotation.

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