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Potential of Some Methods Described in Vrikshayurvedas in Crop Yield Increase and Disease Management

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Abstract

Knowledge of plant protection generated by our ancient and medieval scholars has become available during the last two decades. A good deal of that knowledge, the author believes, is applicable to the crop production in modern India, especially at the small farmers level. It is necessary, however, to validate effectivity of several ancient practices. This paper attempts to suggest the potential of some of those old practices in managing plant diseases. It is hoped that plant pathology researchers will take interest and conduct experiments to check validity of the suggested practices.

In the recent past, whereas the Sanskrit term "Vrikshayurveda" (the science of plant life) was known to a few scholars, most agricultural graduates, including me, had never heard the name during our college education. This situation continued until the Asian Agri-History Foundation (AAHF), Secunderabad, India began its activities in 1994.

There is only one ancient copy on palm leaves of Surapala's Vrikshayurveda (c.1000 AD) in the world preserved at the Bodleian Library, Oxford University, UK. The author obtained a microfiche in 1994 from the Bodleian Library. A printout was then obtained using the microfiche. A Bulletin with Sanskrit text, its English translation, and commentaries by scientists was published in 1996 by AAHF. In the last 15 years, the term "Vrikshayurveda" has become widely known amongst agriculturists not only in India but also in other countries.

In fact the term "Vrikshayurveda" has been in use since ancient times. By the time Kautilya (296–321 BC) compiled his "Arthasastra", the term "Vrikshayurveda" was well-established and well-known. The next document on Vrikshayurveda, a very brief one, was compiled as "Brhat Samhita" by Varahamihira (505–581 AD).

We then find two texts compiled in the 11th century AD; Surapala's Vrikshayurveda (c. 1000) and Vrikshayurveda chapter in Lokopakara composed by Chavundaraya (1025). In the 12th century AD, Chalukya King, Someshvardeva compiled an encyclopedia "Abhilashitarthachitamani" or "Manasollasa" in which a full chapter on Vrikshayurveda was included. We then find a 13th-century AD text titled

"Upavanavinoda", which deals with landscape gardening. Upavanavinoda was compiled by Sarangadhara, a courtier and scholar in the court of King Hammira. In the court of great Maharana Pratap, a scholar, Chakrapani Mishra, compiled (c. 1577 AD), adding his own experience, the text "Vishvavallabha", which has contents similar to Surapala's Vrikshayurveda, with a good deal of additional information.

Chronologically the last text available is "Shivatatvaratnakara" (in Kannada) compiled by King Basavaraja of Keladi, now in Karnataka; it has a chapter on "Vrikshayurveda". Figure 1 shows where these authors lived and worked.

In general, Vrikshayurvedas deal with the following aspects:

Detection of underground water; spacing between trees; methods of propagation; preparation of pits for planting; seed treatments; nourishment; protection; and some other relevant information.

Use of *kunapajala*

Depth of pits and spacing between trees was almost the same as we follow today. Pits were dug and soil was allowed to dry. These were then filled with crushed bones and cattle dung and burnt in the pits themselves. Only after the ash became cool, *kunapajala* (described later) was liberally sprinkled on all sides of the pits. Pits were then filled with good soil. Saplings were placed in the pits. Cattle dung manure was applied and mixed in the top 20 cm soil for up to only 5 years. Trees that developed flowered and fruited abundantly. We should critically evaluate whether annual application of fertilizers, which is so commonly done today, is really needed.

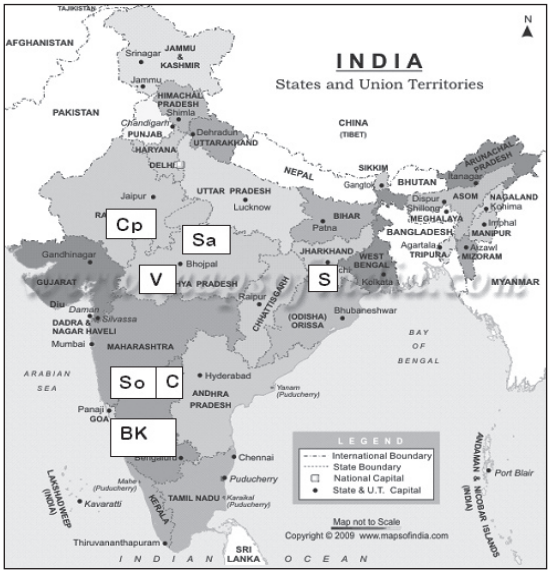

Figure 1. Location of Vrikshayurveda authors.

Author	Vrikshayurveda
Cp – Chakrapani Mishra (courtier) (1577 AD)	Vishvavallabha
Sa – Sarangadhara (courtier) (1283–1301 AD)	Upavanavinoda
V – Varahamihira (scholar) (505–581 AD)	Brhat Samhita
S – Surapala (physician) (c. 1000 AD)	Vrikshayurveda
So – Someshvardeva (king) (1131 AD)	Manasollasa
C – Chavundaraya (scholar, poet) (1025 AD)	Lokopakara
BK – Basavaraja of Keladi (king) (1698–1725 AD)	Shivatatvaratnakara

Besides the cattle dung manure, animal wastes and products manure, *kunapajala*, liquid manure prepared essentially from animal wastes, was used for manuring. Constitution of *kunapajala* was flexible and no standard formulation was prescribed in any of the Vrikshayurvedas.

Since *kunapajala* was a liquid ferment from animal wastes that contained animal flesh, dung, urine, bones, marrow, and skin, the fermented product contained basic constituents such as amino acids, sugars, fatty acids, keratins, macro- and (almost all) micronutrients in available form, it was natural that plants responded very well to the nourishment provided by *kunapajala* and flourished with excellent growth, flowering, and fruiting.

To assist present-day researchers, I suggest the formulation given in Table 1 for making a start. The *kunapajala* thus prepared will surely give excellent response. Afterwards, researchers themselves can make modifications in the constitution.

Cook items 1–4, and 7 (Table 1) together in 5 L or more water. After the liquid has cooled, transfer to a 200 L container and add items 5, 6, and 8–10 (Table 1), and water to make up the volume to 100 L. Stir the mixture twice everyday for 1–3 months; longer the better. Twelve hours before straining, stir the mixture so that the supernatant can be easily removed. The strained liquid should be filtered further depending upon needs. For spraying, fine filtering will be necessary. Make the final volume 200 L. The author has always seen positive effects of *kunapajala* on growth, flowering, and fruiting of plants. An alternative method is anaerobic fermentation. After all the ingredients are placed in the container, it is sealed and placed in a large pit and buried for 3 months (Sadhale, 1996). Substitution of a non-available ingredient with a similar one is acceptable.

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To keep supply of *kunapajala* always available, prepare new batch of *kunapajala* every two weeks. Total batches will depend upon the size of the farm/garden/plantations, etc. For the purpose of spraying field crops, the *kunapajala* batch of 200 L will have to be subjected to mixing/grinding/and fine filtering, to avoid clogging of spray nozzles.

Three applications of *kunapajala* to seasonal vegetables will be needed: one in nursery, one at growth stage, and one prior to flowering. For fruit trees, four soil drenches in one year or 6 spray applications in a year would be adequate. However, changes in schedules must be made on the basis of experience.

Ingredients suggested for plant disease management in addition to *kunapajala* are: mustard, honey, milk, neem bark, *vidanga*,

Table 1. Formulation of *kunapajala.*[1]

Item	Quantity
(1) Animal flesh (fresh or stale, not rotting)	2 kg
or Eggs (fresh or old)[2]	25
or Soybean meal or nuggets plus *Paneer*[2]	1 kg + 1 kg
or Fish meal	2 kg
or Paneer[2]	2 kg
(2) Marrow (crushed bones) *or* Tofu[2] from soybean	0.5 kg / 1 kg
(3) Rice husk *or* any grain husk	1 kg
(4) Available oilcake	1 kg
(5) Cattle dung	10 kg
(6) Cattle urine	15 L
(7) Black gram (optional)	0.5 kg
(8) Honey	0.25 kg
(9) Ghee	0.25 kg
(10) Milk	1 L

1. Developed by YL Nene and SL Choudhary (AAHF).
2. Not mentioned in any of the Vrikshayurvedas.

and hair/nails/horns. Their key properties are given below.

Mustards. When black mustard (*Brassica nigra*) seeds are broken, the enzyme myrosinase is released and acts on a glucosinolate known as sinigrin to give allyl isothiocyanate. Likewise the white mustard [*Brassica* (*Synapsis*) *alba*] seeds yield sinalbin. Both species possess the property of insect antixenosis [a resistance mechanism employed (usually by a plant) to deter or prevent pest colonization; intended to parallel antibiosis] and are antifungal, acaricidal, insecticidal, and nematicidal. White mustard is preferred over black because of low volatility and pungency, compared to black mustard, and has extended residual effect.

In general, Vrikshayurvedas deal with the following aspects: detection of underground water; spacing between trees; methods of propagation; preparation of pits for planting; seed treatments; nourishment; protection; and some other relevant information.

Honey. Honey is antimicrobial, used for treating wounds in plants and animals; contains proline, which induces systemic resistance in plants, increases contents of cytokinins and auxins, and protects against stresses – salt, drought, etc. Proline-rich peptides are antimicrobial; honeybee apidaecin is a unique antibacterial peptide derivative found in immune honeybee lymph.

Milk. Milk is a sticker (on leaves) and growth promoter. Bovine milk contains a number of proteins such as lactoferrin, lactoperoxidase, glycolactin, angiogenin-1, lactogenin, alpha-lactalbumin, lactoglobulin, and casein. Milk proteins contain amino acids such as proline, which, as stated before, is known to induce general disease resistance in plants. Lactoferrin present in bovine milk has antifungal, antibacterial, antiviral, and anti-nematode properties.

Neem. Neem contains a number of antimicrobial chemicals. Seeds are the main source of active ingredients of neem. The bitter taste of neem is due to the presence of an array of complex compounds called limnoids or limonoids (triterpenoids). So far, nine limnoids have been isolated and identified in neem seeds, viz., salanin, salannol, salannol acetate, diacetyl salanin, 14-epoxy azaradion, gedunin, nimbine, D-acetyl nimbenin, and azadirachtin. Of these, azadirachtin is the most active compound. The neem derivatives do not kill but modify the biological processes of harmful insects in a detrimental way. The actions include antifeedant effect, larval repellent, oviposition deterrent, growth and metamorphosis inhibiting effects, effect on fecundity and egg sterility, attractants, etc. Neem bark has also antibacterial and anti-insect properties.

Besides the cattle dung manure, animal wastes and products manure,* kunapajala, *liquid manure prepared essentially from animal wastes was used for manuring. Constitution of* kunapajala *was flexible and no standard formulation was prescribed in any of the Vrikshayurvedas.

Vidanga (bidanga). Vrikshayurvedas by different authors have recommended fruits of *vidanga/bidanga* (*Embelia ribes*) as an anthelmintic material. Embelin (2, 5-dihydroxy-3-undecyl-p-benzoquinone) is found to be the active principle of *Embelia ribes* and reported to possess a wide spectrum of biological activities including antibacterial and insecticidal properties.

Hair, nails, and horns. These contain keratin, which have large amounts of the sulfur-containing amino acid cysteine, required for the disulfide bridges that confer additional strength and rigidity by permanent, thermally-stable cross linking. When burnt, keratin emits sulfurous smell as it consists of sulfur in high amount. Smoke from nails, etc. releases sulfur that controls diseases and pests.

Panchamula. *Panchamula* consists of a powdered mixture from dried roots of five plants. Names of these plants and their properties are given in Table 2.

Rabbing (parching) for paddy disease management

The word *rab* in Marathi (possible origin: in Sanskrit *raksha* means ash, which is *raakh* in Marathi; *rab* may be the corrupt form of *raakh*) signifies burning. *Rabbing* (parching) paddy nursery soil controls most seedling and adult paddy plant diseases in the field. This is a practice of burning refuse to parch the soil reserved for raising nurseries before the advent of monsoon.

Table 2. Plant species used in preparing *Panchamula* and their relevant properties.[1]

Plant species (Latin and Hindi names)	Properties
Aegle marmelos (bael)	Antifungal, nematicidal, insect antifeedant
Clerodendrum phlomides (agnimantha, arani)	Antifungal, antiviral, antibacterial, insect antifeedant
Gmelina arborea (gambhari)	Antiviral
Oroxylum indicum (sonapatha)	Antimicrobial
Stereospermum suaveolens (padhal)	Antifungal, antibacterial

1. *Dashamula* powder, which has dried root powder of five more plant species, is commercially available. This can be used. Separate ingredients of *Panchamula* can be bought and *Panchamula* prepared. Decoctions are prepared in water.

The steps taken were: (i) elevated land for nursery, bunded to prevent surface washing; (ii) 2.5 to 5 cm thick layer of broken cattle dung cakes (when plentifully available); (iii) a layer of leaves or chopped loppings (preferably of *Terminalia tomentosa*) to provide intense heat; (iv) a layer of dry grass; and (v) a layer of finely divided straw or husk to close openings between the stems of the coarse grass and prevent the earth (final layer) falling through. To prolong burning the fire was started on the lee side.

The system of *rabbing* is commonly practiced in Thane district of Maharashtra and was first documented in 1787 (Nene, 2005). The ash provides nutrients and the weeds are reduced. Rice seedlings grow vigorously. Farmers also find the nuisance of weeds, pests, and diseases greatly reduced in the transplanted crop from *rabbed* nurseries. It is claimed that yields double if the practice of *rabbing* is followed. It is intriguing why most rice researchers in the last 60 years have outrightly dismissed the practice of *rabbing* on the grounds of 'wasting' compostable organic matter. This argument does not hold ground because the organic matter thus burnt for *rabbing* is so little and the benefits are likely to exceed the loss of burnt organic matter.

It is noteworthy that *rabbing* nursery soil was recently reported from Karimnagar (Andhra Pradesh), Dang (Gujarat), Shimla (Himachal Pradesh), and Sindhudurg (Maharashtra) (ICAR, 2003). I sincerely hope better sense would prevail and rice researchers would try to study *rabbing* in depth.

Crop protection practices in Vrikshayurvedas

Protection and treatment practices recommended in Vrikshayurvedas involve methods of applications that are followed even today, but with more efficacious appliances. These are balanced nutrition using *kunapajala*, seed dressing (dry/wet), root-dipping, wound dressing, soil drenching, fumigation (smoking), crude spraying (sprinkling), and dusting. Application of fishmeal to standing paddy crop might give better results than top

dressing with urea. The suggested crop yield increase and disease management prescriptions are given in Table 3 for experimentation.

General discussion

With over 40 years of experience as a professionally active plant pathologist, I firmly believe that Indian agriculture, and plant pathology in particular, has been at a great loss because of our ignorance of knowledge documented in Vrikshayurvedas written by different scholars over a period of two millennia. We were thoroughly and systematically brainwashed, through formal teaching since the beginning of twentieth century, to think and apply to Indian agriculture the knowledge generated by European and American agricultural scientists. Therefore generations of Indian agriculturists and plant pathologists for over 100 years have mostly been reading and learning from Western journals for new ideas and then spending their time in "applying" those to Indian situation. My prediction is that the present situation will continue unless and until the top leadership in the Ministry of Agriculture, Government of India and the Indian Council of Agricultural Research (ICAR) demonstrates aggressive faith in our own agricultural heritage and equally aggressively discourage "repeat research" from the West.

Reluctance to prepare and use *kunapajala*

In my lectures, I have noted a sense of general reluctance of the audience towards using *kunapajala.* This is because nearly 40% people do not eat meat. Even amongst those who eat meat, my guess is 10% people will not like to handle raw meat; such people go to restaurants to eat meat dishes. This is the reason I have suggested non-meat alternatives in making *kunapajala.* I would also like to point out that most authors of Vrikshayurvedas were vegetarian Brahmins, but they had no hesitation in recommending use of animal flesh and bones as plant nutrient. Invariably these authors have observed excellent effects of *kunapajala* on growth, development, and health of all kinds of plants. The positive effects of *kunapajala* should not surprise anyone. Normal solid manures are slow in releasing nutrients because the process of decomposition is slow. Liquid manure such as *kunapajala* contains fully decomposed nutrients in readily available form and roots absorb them quickly. It is the ingenuity of our scholars, without formal knowledge of nutrient uptake by plants, to think in terms of fermenting complex organic wastes to simple nutrient ingredients. In no other ancient civilization, scholars thought of manure similar to *kunapajala.* Our vegetarian farmers must understand the science involved and overcome reluctance to use animal flesh and bones in the interest of prosperous farming. In recent years, *Panchagavya* (five items from cow: milk, curd, ghee, dung, and urine) is being used to "purify" polluted premises and to "purify" self. In fact only fresh *Panchagavya* has to be used for "purification", and not the fermented one. *Panchagavya* thus recommended and used is a kind of *kunapajala.*

Foul smell emanating from *kunapajala* in the process of fermentation is yet another reason given for not using it. This is surprising because several agrochemicals

Table 3. Suggested procedures for crop yield increase and disease management based on recommendations made in Vrikshayurvedas.

Disease/Pest	Prescription	Notes
Seed and seedling rots	Prepare 10% cattle dung (dry or wet) slurry with water. Dip the seed for 10 min and sun-dry.	More than one batch of seed can be treated with same slurry.
Leaf and stem blights (fungal)	*Kunapajala* 30% with appropriate herbal (e.g., *Clerodendrum* root extract) ferment (3 days) in cattle urine	Foliar sprays at 10-day intervals, starting before the expected disease incidence.
Downy mildews	*Kunapajala* 30% with mustard + honey + milk ferment (3 days) in cattle urine	Foliar sprays as above. Instead of mustard, honey, milk, use *Panchamula* ferment in cattle urine as alternative.
Powdery mildews	*Kunapajala* 30% with 68% milk (10%) + 2% honey	Foliar sprays at 10-day intervals starting just before flowering time.
Foliar rusts (not for white rust)	*Kunapajala* 30% + 60% milk + crushed white mustard ferment (3 days) in urine (10%)	Foliar sprays at 10-day intervals just before flowering time.
Leaf and stem blights (bacterial)	*Kunapajala* (30%) + white mustard (1 kg) + curd (5 kg) in cattle urine (10 L) in a 3-day ferment; final volume 200 L (70%)	Spray at 10-day intervals and after every rain (with winds).
Nematodes (on roots)	Soak seed overnight in a 3-day old ferment of neem bark and crushed *vidanga (Embelia ribes)* seed in cattle urine (70%)	Drenching soil around plant base. Quantity according to size of plant (range 5 to 20 L).
Viral diseases of perennials	*Kunapajala* 30% + 3-day old ferment of *Clerodendrum* roots and leaves in cattle urine 60% + milk 10%; final volume 200 L	Start spraying weekly as soon as symptoms are visible in some plants or trees; later the sprays can be reduced to 2-week intervals. Alternative: drench soil around trees with 5 L suspension every 2 weeks.
Seed transmitted smuts (both internally and externally seed borne)	Soak seed overnight in 3-day old ferment of milk (50%) and cattle urine (50%)	Dust-cover the seed with dry cattle dung powder so that the seed can be handled easily for sowing.
Leaf diseases (and pests) of trees	Fumigation with a mixture of powdered hair, nails, white mustard oilcake, and/or horns	Place materials on dried cow dung or hemp fiber. Use one to two smoking apparatuses per tree.

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emanate strong foul smell that it is difficult to breathe when exposed; even then these are used. Thus the argument of "foul smell" is untenable.

Isn't Vrikshayurveda outdated?

Another question often asked is: What guarantees these "old, possibly outdated" methods would work in fields and will farmers adopt these? This question really arises from ignorance of our millennia-old agricultural past. Our agriculture degenerated because of continuous fights, battles, and wars throughout the second millennium AD and colonialists reshaping Indian agriculture to suit their needs. All we need to do is to connect our present-day agriculture to the rich past prior to second millennium. Many old techniques can be reintroduced and modified with the help of modern knowledge. This is the right time to do so because of the whole world's concerns about using "environment-unfriendly" chemicals and also because of strong interest in organic agriculture. In ancient times lifestyle of people was simple. Because long distance communications were difficult, life was village-centered. All needs of farmers were met in the village itself or at short-distance locations. Resources used were local. Therefore scholars, who looked for answers to farmers' problems, depended on local resources and indigenous techniques. Knowledge of Ayurveda had developed very well and medicinal powders, decoctions (fresh or fermented), fumigations, pastes, etc. were made from locally available materials. The raw materials used were cattle products, herbals, and natural products such as honey. Since scholars treated plant life and human (animal) life as similar, application of Ayurvedic principles and prescriptions to plants slowly developed into a distinct discipline, Vrikshayurveda. It must have been realized at some stage that plant growth and development are better with fermented animal products in comparison to other materials; preparation of *kunapajala* was the result of such a realization.

I should strongly emphasize that I am not suggesting that knowledge of Vrikshayurveda should be used as such. In fact I would like to bring entire Vrikshayurveda into a research domain. Every item, formulation, procedure, technique, etc., which are found useful in initial testing should be

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scrutinized. Better substitutes to materials, herbal and non-herbal, should be looked for. We possess today a wide basic knowledge base that should be used to make advances in Vrikshayurveda. Let me take one example. As described before, Vrikshayurvedacharyas learnt an excellent medicinal concoction from Ayurveda called *Panchamula,* and found it effective in restoring plant health. Today we know the families to which each of the five species of *Panchamula* belongs. We can evaluate other species that belong to the respective families. For example, *Aegle marmelos* belongs to family Rutaceae. We know the Citrus species and *Murraya exotica (kadhipatta)* also belong to Rutaceae. We should try to find substitutes to *Aegle marmelos.* Likewise *Clerodendrum* spp. and *Gmelina arborea* belong to Verbenaceae and so do species of *Tectona* and *Premna. Oroxylum indicum* and *Stereospermum suaveolens* belong to Bignoniaceae and so do species of *Jacaranda*, *Spathodea*, and *Tecomella. Panchamula* was developed by Ayurvedacharyas for humans and animals, and then extended its use to plants. There is no compulsion on plant health workers to strictly confine to *Panchamula.* Alternatives to *Panchamula* can be and should be found. Also these need not be roots of 5 plants; these could be 1 to 4 plants provided these give results comparable to *Panchamula.* The same holds true for other herbals and new herbals can be tried. For example, garlic and onions can be tried in place of mustard, since the former two contain allicin, which is antimicrobial.

In the very recent past, I have noted plant pathologists undertaking validation research to confirm Vrikshayurveda methods. This is highly encouraging. I have said this before and I would like to state again that if I were to start my professional career in 2011, I would have had my entire research agenda mainly on Vrikshayurveda.

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