

# Soil Fertility and Potato Pest Spectrum in Nilgiris

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**Abstract** – A survey was undertaken in Nilgiri district of Tamil Nadu State in India during the year 2008 to witness the status of potato cultivation as well as the disease and pest spectrum and a comparison was made with the status during 2011 by conducting another sample survey. The principal conclusions of the survey are: The area under potato cultivation in Nilgiris is decreasing year after year. Late blight is the number one problem and cyst nematodes are spread in almost all the areas of potato cultivation. The available nitrogen content of the soils is medium to low and that of phosphorus is low to medium. Potassium is available in plenty. Soils with lower pH and high nitrogen content recorded more PCN (potato cyst nematodes) populations. Inclusion of cabbage in rotation recorded no change in soil pH, lower accumulation of phosphorus and lower PCN population. During the last five years, the average increase in PCN population in entire Nilgiris is 36 per cent. The increase is more spectacular in Kundah (50%) followed by Coonoor (41%) and Kotagiri (34%) taluks and the rate of increase in Ooty area is low (20%) because of the high initial population. There is advancement in the date of first appearance of late blight disease by 10 days (i.e., from 5<sup>th</sup> October to 25<sup>th</sup> September) especially during autumn season due to change in rainfall pattern and also temperature.

**Keywords** – Late Blight, PCN, Pest and Disease Spectrum, Potato Cultivation.

## I. INTRODUCTION

Generation of statistically valid data on current status of management practices, severity of disease and pest spectrum and on use of quality seed material can be a good contribution towards a sustainable crop production. This data can assist in identification of lacuna in crop production, plant protection and input use and thereby helpful in developing strategies to improve seed health, pesticide minimization and to make use of improved cultural practices. Initially, the founder of present day Udhagamandalam, Mr. John Sullivan introduced potato to Nilgiris (Tamil Nadu state) in 1822 A.D. The potato cultivation in this region picked up well during 1830's to produce up to an average of about 15 tonnes per ha. The records show that up to 125 hectares of potato was annually cultivated by 1845, which increased to about 300 hectares in 1875. Further, the British settlements in and around Ootacamund town and the mild climatic conditions

prevalent throughout the year in these hills for raising more crops per year, enhanced the potato cultivation in this hilly district. The then Imperial Government established a Potato Experimental Station at the village Nanjanad in the year 1917, as the Government gardens had limited area for seed potato production purposes to supply to the increasing demands. Moreover, due to the demands from Colombo, Bombay, Calcutta and other places the area under potato in the Nilgiris has been increasing considerably since 1910 onwards. Further, due to the world wars I and II, the area under potato cultivation increased substantially and it reached a peak of 10,000 ha during 1944. With the establishment of Central Potato Research Station in 1957, the potato production in the Nilgiris has gained a new momentum.

Though there was a setback in potato area during 1961 due to the attack of late blight, it again started rising with the introduction of new varieties and suitable management practices. However, with the introduction of premium price for tea due to its export opportunities, most of the area under annual crops has been converted into tea gardens and a very meager area of 3000 ha is under potato crop. In view of the above situation, it was felt necessary to study the present position of potato cultivation, its problems and prospects and to design strategies for extending the potato growing area of Nilgiris. As a sequel to the initial survey conducted during 2008, another quick survey was also found necessary to compare the potato growing situation in a period of five years.

The main objectives of the survey were

1. To assess the status of potato cultivation in Nilgiri area of Tamil Nadu
2. To evaluate the impact of management practices on soil fertility status, disease and pest spectrum
3. To design strategies for extending potato area in Nilgiris region

## II. MATERIALS AND METHODS

The Nilgiris district comprises of six taluks viz Udhagamandalam, Kundah, Coonoor, Kotagiri, Gudalur and Pandalur. These taluks are divided in to four Panchayat Unions viz., Udhagamandalam, Coonoor, Kotagiri and Gudalur besides two Municipalities,

Wellington Cantonment and Aruvankadu Township. The District consists of 56 Revenue Villages and 15 Revenue Firkas.

In order to witness the present status of potato cultivation, a Survey was conducted during 2007 to cover all the taluks of the district. Two Survey groups were made involving all the scientists and technical staff for this purpose. For survey purpose the following four taluks viz, Ooty, Coonor, Kundah and Kotagiri were selected which grow potato in the district.

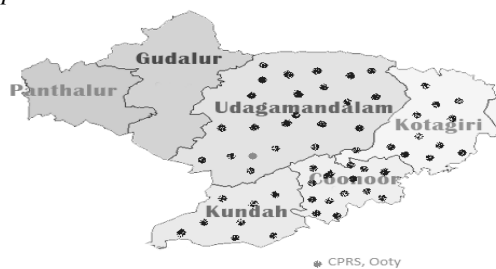


Fig. 1. Survey points in the Nilgiris District

We started our survey in Ooty block on 18<sup>th</sup> July 2008 accompanied by the local Horticulture Directorate officials. In total 15 trips were under taken to cover all the taluks of the district. During such survey trips, we covered 58 villages and about 104 different farmers were contacted to collect the information. The soil samples collected from different locations were analysed for available nutrients, physical properties and potato cyst nematodes. From the soil test reports, the fertility status of the soils was estimated using Parker's method (1951) and nutrient use efficiency was calculated with the help of Berntrup et al [1].

As a sequel to the original survey, another quick survey was also conducted during June, 2011 in 40 villages of all the four taluks of potato cultivation and surveyed 60 farmers to compare the potato cultivation practices and the pest spectrum.

### III. RESULTS AND DISCUSSION

#### a. Status of potato cultivation

According to the figures expressed by farmers, the total area under potato crop in three seasons adds up to 3800 ha. In almost all the places of Nilgiris, potato is being grown mostly during summer season spreading the planting time from March to May. More than 60 per cent of the farmers are growing potato during main season. Around 30 per cent of the farmers are taking up potato crop during autumn with planting time spreading from June to August. Very few farmers are growing potato during irrigated season as most of them are not having irrigation facilities. During the past five year period, there seems to be a shift in planting season i.e., the potato area under autumn (40%) is progressively increasing with the simultaneous decrease in summer (50%) season area. There is no much change in area and fertilizer application practice for potato during the last five year period.

#### b. Soils

From the laboratory analysis of various samples collected during survey, the soils of Nilgiris can be

broadly categorized into Ootacamund, Coonoor, Kotagiri and Kundah series. The Ootacamund and Coonoor soils are more acidic in reaction in comparison with that of Kotagiri and Kundah soils. The clay content is more in Kundah soils than that of Ooty and Coonoor soils. Organic carbon content is generally high in all the soil types. The available nitrogen content of the soils range between medium to high and it is very high in some places like Ketti, Santhur, K.Palada and Kateri of Coonoor area and Kokkal and Chinna Coonoor of Ooty area. Similarly, the available phosphorus content of the soils ranges between low to medium mainly due to fixation of phosphate ion in sesquioxides. In all soil types the available potassium content is on higher side.

Soil pH influences the availability of nutrients and the activity of the flora and fauna of the soil. A change of pH may influence the growth of the plant and the population dynamics of PCN. From the survey sample analysis it was observed that PCN populations are more in soils with more acidic pH than the soils with less acidic pH. This could be because of better plant and root growth in acidic soils which might have attracted more cysts to break open and produce juveniles. However, more damage due to PCN was observed in light soils than heavy soils.

#### (i) Fertility status of Nilgiris soils

The nutrient index (NI) [5] of the soils is used as the basis to classify different locations of the Nilgiris with respect to their fertility status. In general, the average nutrient status of the Nilgiris is medium with a nutrient index of 2.11 (all the three nutrients i.e., NPK put together) medium for nitrogen and phosphorus and high with respect to potassium.

$$\text{Nutrient index} = \frac{(N1 \times 1) + (Nm \times 2) + (Nh \times 3)}{Nt}$$

Where,

Nt : Total number of samples analysed for a nutrient in any given area.

Nl : Number of samples falling in low category of nutrient status

Nm : Number of samples falling in medium category of nutrient status

Nh : Number of samples falling in high category of nutrient status

The samples are rated as low, medium or high with respect to nutrient status using the rating chart given by Parker et al., (1951).

Nutrient Index	Fertility status
<1.5	Low
1.5 – 2.5	Medium
>2.5	High

Table I: Number of locations falling in different classes of nutrient status and their respective nutrient index in Nilgiris

Location	Low	Medium	High	Nutrient Index
<b>Nilgiris</b>				
N	42	41	19	1.77
P	41	47	14	1.74

K	1	16	85	2.82
<b>Ooty</b>				
N	25	19	5	1.59
P	19	18	12	1.89
K	0	2	47	2.96
<b>Kotagiri</b>				
N	4	6	2	1.83
P	5	7	0	1.58
K	0	0	12	3.0
<b>Kundah</b>				
N	5	5	0	1.50
P	9	1	0	1.10
K	1	4	5	2.40
<b>Coonoor</b>				
N	1	6	6	2.38
P	4	9	0	1.69
K	0	7	6	2.46

If individual taluks are considered for fertility status of soils, the nitrogen content is medium in all the taluks, phosphorus content is low in Kundah soils and medium in Ooty, Coonoor and Kotagiri soils and potassium content is high in Ooty and Kotagiri soils and medium in Coonoor and Kundah soils.

*(ii) Fertiliser use efficiency of potato crop in different locations*

In order to assess the efficiency of agricultural crop production to convert applied fertilizer nitrogen into harvested products, the indicator “nitrogen use efficiency” (NUE) should be used. Nitrogen use efficiency provides information about the utilization of additional nitrogen applied to an agricultural production of a particular location. It considers agricultural productivity more than nitrogen balance. NUE is calculated as the ratio between the amount of fertilizer nitrogen removed by the crop and the amount of nitrogen fertilizer applied. The method suggested by Frank Brentrup (2010) is used to calculate the fertiliser use efficiency in potato crop.

Table II: Fertiliser use efficiency of different potato growing locations of Nilgiris

Taluk	Av yield (kg/ha)	N removal (kg/ha)	P removal (kg/ha)	K removal (kg/ha)	N applied (kg/ha)	P applied (kg/ha)	K applied (kg/ha)	NUE	PUE	KUE
Ooty	24500	96.8	51.6	87.3	120	240	120	80.7	21.5	72.7
Coonoor	22300	88.1	47.0	79.4	120	240	120	73.4	19.6	66.2
Kotagiri	19400	76.7	40.9	69.1	120	240	120	63.9	17.0	57.6
Kundah	22620	89.4	47.6	80.6	120	240	120	74.5	19.8	67.1

(Average Conc. of N = 1.52% P = 0.81% K = 1.37%)

(NUE: Nitrogen use efficiency, PUE: Phosphorus use efficiency, KUE: Potassium use efficiency)

The differences in nitrogen use efficiency among different taluks of Nilgiri district can be attributed to differences in soil particle fraction, pH and rainfall pattern. In all the places, the applied nutrients are more than nutrients removed by the crop. This shows increased risk of leaching and it is not a sustainable practice as it causes acidification as well as eutrophication of water bodies as per the classification of Brentrup et al (2004). Based on the field trials and nutrient removal by potato crop, the CPRS recommends 90 : 135 : 90 kg NPK per hectare. Farmers are applying No.4 mixture which supplies all the three nutrients of NPK. Application of higher doses of nutrients can lead to more vegetative growth in potato crop including root growth which ultimately increases the PCN population.

*(c) Varieties*

Most of the farmers are obtaining the potato seeds from Mettupalayam market and they call it as variety ‘Kufri Jyoti’. Different nomenclatures such as Bangalore, Kolar, and Punjab etc words were prefixed probably denoting the place of origin. Some of them are growing ‘Kufri Giriraj’ and ‘Kufri Swarna’. In Ooty taluk, about 40 percent of the farmers are growing ‘Kufri Giriraj’. Many of the farmers are unaware of the availability of quality seed of varieties at our station. Very few farmers are purchasing seeds from a reliable source such as CPRS or other State Department offices. Growing of resistant varieties can reduce the multiplication rate of PCN and thereby reduce the length of time required for rotating the potato crop. Farmers are

unaware of these facts and they are not giving any importance to selection of PCN resistant varieties.

*(d) Seed tubers*

The seeds are mainly purchased from Mettupalayam market and the farmers are not much bothered about the quality of the seed material. The seed is being called by different names by prefixing Bangalore, Kolar, and Punjab etc to “Jyothi” denoting the place of origin. The size of the tubers also is not uniform and recommended grade as the seed is being purchased from auctioned market. The farmers are not storing any seed material for their own planting purpose as they are not following any fixed pattern to grow potato crop in a particular season. If the price for potato tubers is more during summer harvest, the area under potato during autumn increases and vice versa. Recommended rate of seed tubers are not being planted as the seeds are being purchased from local traders which are of not uniform sized.

*(e) Plant protection*

*Late blight:* Late blight was first reported in the Nilgiris in between 1870 and 1880. This disease appeared in an epidemic form in Nilgiris in the year 1961 and since then it is appearing regularly in both the summer and autumn crops. The disease is now a major problem in all the potato growing areas sometimes destroying the entire crop before it matures. Every farmer is adopting plant protection measures for control of late blight. The selection of chemicals mostly depends upon the advice of the local traders and the farmers are not hesitating even to mix three

or four chemicals (both systemic and contact) each time. They are spraying mancozeb and cyamoxinil (Curzate) in combined form with other chemicals with average 17 to 20 sprays. The dosage of chemical is also on higher side (3 to 5 kg per hectare per spray) as they assume that appearance of a thick coating of the chemical on the foliage can only prevent the spread of the disease. During the last five years, there seems to be an advancement in the date of first appearance of disease by 10 days (i.e., from 5<sup>th</sup> October to 25<sup>th</sup> September) especially during autumn season due to change in rainfall and temperature pattern.

**Nematodes:** The potato cyst nematodes (PCN), also known as the 'Golden Nematode of Potato' is one of the most important plant protection problems of potato cultivation in Nilgiris. The tuber yield loss estimates vary from 5 to 80 per cent depending on the infestation levels. It is believed to be introduced through potatoes from Europe, the secondary distribution centre for this pest. There are two species of PCN that are characterized by the colour of the developing females, viz., *Globodera pallida* (white or cream coloured females) and *G. rostochiensis* (yellow coloured females). The *G. rostochiensis* populations were observed mainly at higher elevations of Ooty taluk whereas, *G. pallida* populations were common in little lower elevations of Coonoor and Kotagiri areas. Severe nematode infestation was observed in Thummanatti, Odakadu, Dodanni and Kallakorai villages of Ooty Taluk and in Vanakambi village of Kotagiri Taluk. The earlier surveys indicated that *G. rostochiensis* could develop into females only below 24<sup>o</sup> C, means at an elevation of 1400 M and above MSL. Compared to the initial survey (2008), which reports negligible nematode population especially in lower elevations of Coonoor and Kotagiri taluks, there is an increase in nematode populations in most of the localities. This could be because most of the farmers are not well aware of the ill effects of these nematodes and they are not taking any control measures. This is an alarming sign and unless the farmers are made well aware of the impact of this PCN in long run, it will become impossible to continue potato cultivation in this part of the country. Nearly, 40% of farmers are applying 'Furadan' but only 50% or even less than that of the recommended dose. Some farmers are applying Phorate for the control of nematodes.

From the analysis of the soil samples, a relationship between soil attributes and PCN population could be established. Higher level of positive correlation existed between soil pH and nitrogen content with that of PCN population. Soils with lower pH and high nitrogen content recorded more PCN population and of course, interactions existed between these two factors also. Haverkort et al., (1993) reported that tuber yields were about 11% lower at pH 6.5 than at pH 4.5 in the absence of nematodes, but about 44% lower when an initial population of 27 juveniles per g soil was present. Mulder et al., (1997) reported that potato cyst nematode infections aggravate the adverse effect of soil pH in depressing yield. It was shown that both potato cyst nematode infection and increasing soil pH values reduce the buffering capacity of the root system.

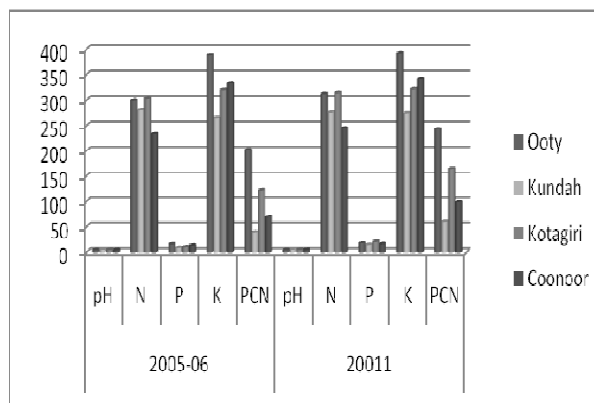


Fig.2. PCN population as influenced by altitude, pH and nutrition status

#### (f) Crop rotation

Farmers are adopting crop rotation but without any scientific rationale behind it. Depending upon the demands from market, they are selecting the crops. Potato is mainly rotated with carrot and cabbage sometimes with French beans. However, monocropping of potato is very rare. Rotation with carrot is more prevalent in Ooty area and with French beans is more popular in Kotagiri and Kundah regions. Farmers believe that rotating potato either with carrot or French beans is more advantageous. In general it is observed that the PCN population and late blight disease incidence are comparatively less in the fields where the potato crop is regularly rotated with non solanaceous crops like cabbage, carrot, French beans and peas in a longer rotation. In Ooty and Coonoor area though the potato is rotated regularly with non-solanaceous crops, the frequency of growing potato is very high i.e., almost in one season in a year. This makes the host plant available in some part of the year facilitating improvement in PCN population. Beetroot-potato-carrot, Potato-potato-carrot, Potato-carrot and Potato- cabbage are more common rotations in Ooty area and Carrot-potato, Carrot-potato-Carrot and Carrot-potato are more common rotations in Coonoor area.

The percentage increase in pH during the last five years had been 0.9 in Coonoor and it is followed by Kotagiri area (0.4%). However, pH got reduced further in Ooty and Kundah areas (0.5%). The available nitrogen status of Ooty and Kundah soils got increased by 4.2 and 1.7 per cent, which could be due to reduced pH content leading to delayed mineralization. In Coonoor and Kotagiri area, the available N got reduced by 2.4 and 1.8 per cent, respectively. Available P and K status had shown positive values of increase in all the areas with certain degree of variation with change in the altitude. More accumulation of P and K were noticed at lower elevations in comparison with that of higher elevations. Positive correlation between PCN count and lower pH and higher nitrogen status of the soil was observed.

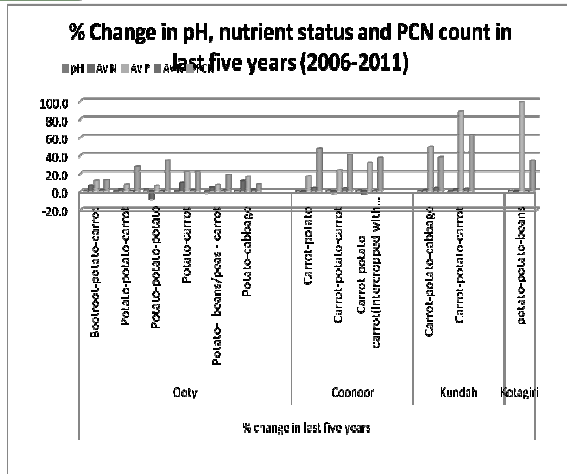


Fig.3. Change in pH and nutrient status along with PCN population as influenced by crop rotations in different Taluks of Nilgiris district

In Ooty Taluk, monocropping of potato in three seasons recorded increase in pH, lower available N, P and K status but more PCN population. This could be due to increase in pH which might have improved the mineralization thereby utilizing more of applied nutrients. The nutrient status of the soil was affected by the choice of crops in rotation. Whenever potato is rotated with carrot the nutrient status did not go down considerably. Growing of cabbage in rotation was effective in controlling PCN multiplication. In Coonoor area potato is mainly rotated with carrot and whenever two crops of carrot is grown with one potato crop the per cent increase in PCN was lower when compared with that of growing potato-carrot rotation in a year. In Kundah Taluk, inclusion of cabbage was found beneficial as it recorded no change in soil pH, lower accumulation of phosphorus and lower PCN population.

#### IV. CONCLUSIONS AND RECOMMENDATIONS

1. Crop rotation is in vogue but without any scientific rationale. The frequency of potato cultivation is more in Ooty and Coonoor area and it is less in Kundah and Kotagiri area. The potato crop should be rotated with other vegetables in a longer rotation of at least four years by including a resistant potato variety. The land should be divided in such a way that potato crop should be planted once in every four years in one part of it so that the potato is available regularly for consumption.
2. Fertilisers are being applied at higher rate than the requirement which leads to leaching and accumulation of nutrients in water bodies (acidification and eutrophication). Location specific nutrient recommendations are to be followed for avoiding ecosystem degradation.
3. Late blight occurs regularly in all the places of Nilgiris but severity is more in Ooty area. This could be due to low temperatures prevailing in higher altitude combined with more cloud cover. Ooty is located at a higher altitude compared to other taluks. The initial date of appearance of late blight disease is advanced by 10 days in Autumn season in Ooty area. Growing of

4. resistant varieties like 'Kufri Girdhari' and 'Kufri Himalini' can bring down the loss due to late blight.
4. PCN population is more in Ooty area (243) and it is followed by Kotagiri (165), Coonoor (99) and Kundah (60). During the last five years, the average increase in PCN population in entire Nilgiris is 36 per cent. The increase is more spectacular in Kundah (50%) followed by Coonoor (41%) and Kotagiri (34%) taluks. The rate of increase in Ooty area is low (20%) because of the high initial population. Following the integrated package for PCN control, the multiplication of PCN would definitely be kept under check.
5. Higher level of positive correlation existed between soil pH and nitrogen content with that of PCN population. Soils with lower pH and high nitrogen content recorded more PCN population. Application of higher doses of fertilisers results in more root and shoot growth of potato crop which encourages higher PCN population. Inclusion of cabbage in potato based crop rotations is more advantageous both for maintaining soil quality and reducing PCN populations.

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