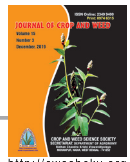
Journal of Crop and Weed, 17(3): 70-75 (2021)

ISSN- O : 2349 9400 ; P : 0974 6315



http://cwssbckv.org
www.cropandweed.com

Identifying soil fertility constraints and evolving management strategies for Pencil Point Disorder in coconut

***C. SUDHALAKSHMI**

Coconut Research Station, Tamil Nadu Agricultural University, Aliyarnagar - 642 101.

Received : 14.08.2021; Revised : 31.08.2021 ; Accepted : 10.09.2021

DOI: https://doi.org/10.22271/09746315.2021.v17.i3.1493

ABSTRACT

Pencil point disorder is a serious menace constraining coconut production throughout the state of Tamil Nadu, India. Although the disorder is witnessed in palms ageing more than 40 years, a cluster of soil fertility conditions favour the condition. Survey conducted in 56 pencil point disorder manifested palms of Tamil Nadu revealed that shallow depth of soil, rocky substratum, heavy soil texture and erosion hazards were the common physical constraints favouring the disorder. Although coconut gardens affected by pencil point disorder expressed plethora of soil fertility constraints, deficiencies of available potassium, organic carbon, DTPA Zn, DTPA Cu and hot water soluble (HWS) B were highly correlated with its expression. Zinc, copper and boron were the most critical micronutrients contributing for the disorder and application of these nutrients either as solid formulation or through root feeding was imperative to improve the growth attributes and nut yield of pencil point disorder affected palms of Tamil Nadu.

Keywords: Coconut, micronutrients, pencil point, physical constraints and soil fertility

Coconut is an important horticultural crop which has a significant bearing on the livelihood security of small and marginal farmers of the country and on the economy of the nation. In India, coconut is cultivated over an area of 2.15 million hectares with an average productivity of 9897 nuts per hectare per year (CDB, 2019). Coconut production is endowed with several yield depressing factors which include ever fluctuating price chart of copra, pests and diseases, water scarcity, declining fertilizer responses due to deteriorated soil health and multi faceted nutritional problems. Systems approach is emphasized in the context of enhancing the productivity and profitability of coconut cultivation (Ghosh and Bandopadhyay, 2011). Button shedding, pre-mature nut fall, husk splitting, shriveled nuts, fragile fronds and poor yield are the common tribulations encountered in coconut due to nutritional deficiencies. Complete failure of the palms due to pencil point disorder has attracted the attention of the researchers in the recent past as nearly 15 – 35 % of the palms of a garden are affected by this disorder annually. Although pencil point disorder was identified as early as 1903 in Jamaica and in 1923 in Burma, detailed investigation commenced during 1950 with Cooke (Thirumalaisamy *et al.,* 1994).

Pencil point disorder was assumed to be caused due to a pathogen in 1970s (Jaganathan and Ramaswami, 1977) and later to nutritional disorders. The characteristic symptoms include tapering of the trunk towards the crown with smaller and fragile fronds and the affected palms exhibit reduced vigour and unthrifty appearance. Trees in advanced stage fail to produce buttons or nuts and the palms eventually die. Although the occurrence of pencil point disorder is mainly attributed to micronutrient deficiencies, even in well managed coconut gardens, the syndrome is on the rise (Sudhalakshmi *et al.,* 2020). In pursuit of the perplexity, the present investigation was framed to identify the soil fertility constraints in pencil point disorder manifested coconut gardens and evolve best management strategy for combating the disorder.

MATERIALS AND METHODS

(i) Preliminary survey

A survey was conducted during 2017-18 at Coconut Research Station, Aliyarnagar in 56 pencil point disorder affected coconut gardens of Tamil Nadu. Information pertinent to varieties, age of the palms, intercrops cultivated, details of macronutrients and micronutrients applied, intercultural operations adopted and pest and disease incidence were collected. Soil physical constraints were assessed and parameters *viz.,* pH, Electrical Conductivity, Organic carbon, $KMnO_4$-N, Olsen P, $1NNH_4OAc$-K, DTPA Fe, Mn, Zn, Cu and hot water-soluble B were analysed in the soil samples collected in the gardens employing standard procedures (Jackson, 1973). Grading was done based on the following indices

1. Mild: 20 - 25 fronds per palm; Ratio of girth at base and collar is 1.36
2. Moderate: 15 - 20 fronds per palm; Ratio of girth at base and collar is 1.64

Email: soilsudha@yahoo.co.in

3. Severe: 10 -15 fronds per palm; Ratio of girth at base and collar is 1.67

(ii) Field experiment

Two field experiments were conducted during 2018 – 20 at Coconut Research Station, Aliyarnagar in West Coast Tall variety of coconut ageing 40 years and in ALR(CN)1 variety of coconut planted 50 years ago in a farmer's field at Aliyarnagar, in a Randomized Block Design with each of the following treatments replicated six times @ 5 palms per replication. Macronutrients *viz.,* nitrogen, phosphorus and potassium @ 560 – 320 – 1200 g per palm per year were applied through Urea -1300 g, Single Super Phosphate – 2000 g and Muriate of Potash – 2500 g respectively in two equal splits during the months of June and December by digging a trench of 15 cm at a radius of 1.8 m from the trunk. Neem cake @ 3 kg and farmyard manure @ 50 kg per palm per year were applied along with the fertilizers and the trench was covered with garden soil. One month after the application of macronutrients, micronutrients required as per the treatment schedule were applied on the surface of the palm basin in two equal splits along with farmyard manure. Coconut tonic @ 200 ml per palm were root fed once every six months selecting an active root of pencil thickness, at the radius of 1.8 m from the trunk of the palm. Both the locations were moderately alkaline in soil reaction, harmless in reaction, low in $KMnO_4$-N, medium in Olsen-P, medium in 1NNH_4OAc-K and deficient in DTPA extractable micronutrients *viz.,* Zn, Cu and B.

Treatments

T_1 : Control (Without micronutrient application)
T_2 : $ZnSO_4$ @ 200 g palm^{-1} year^{-1}
T_3 : Borax @ 50 g palm^{-1} year^{-1}
T_4 : $FeSO_4$ @ 200 g palm^{-1} year^{-1}
T_5 : $ZnSO_4$ @ 200 g + $CuSO_4$@ 200 g + Borax @ 50 g palm^{-1} year^{-1}
T_6 : $CuSO_4$ @ 200 g palm^{-1} year^{-1}
T_7 : TNAU Micronutrient mixture @ 1 kg palm^{-1} year^{-1}
T_8 : TNAU coconut tonic @ 200 ml palm^{-1} (Twice a year)

Initial growth parameters *viz.,* height of the palm, girth of the trunk at 1 m height, number of fronds, bunches per palm, number of immature and mature nuts per bunch, number of unopened spathe and spadices were recorded before imposing the treatments and at the end of the experimental period. Nutrient Index Values (NIV) were calculated employing the procedure of Ramamoorthy and Bajaj (1969). The index values were rated into various categories viz., low (<1.67), medium (1.67-2.33) and high (>2.33) for OC and available NPK.

Nutrient Index Value = [(No. of samples in low category x 1) + (No. of samples in medium category x 2) + (No. of samples in high category)]/ Total number of samples

RESULTS AND DISCUSSION

About 30 % of the coconut palms which expressed pencil point disorder in the surveyed gardens had rocky substratum without sufficient soil depth of 80 to 100 cm (Fremond, 1964) and massive gneissic outcrops (Sudhalakshmi *et al.,* 2017). In the surveyed gardens, proliferation of roots to greater depth was restricted because of rocky substratum resulting in impaired nutrient uptake eventually leading to pencil point syndrome.

Nearly 42 % of the pencil point manifested coconut palms suffered from water logging in the basins or in their vicinity because of heavy clayey texture of soils. These soils had clay content of > 50 % which impeded free water flow across the horizons resulting in pencil point syndrome. Although very low clay content of soil leading to high infiltration and percolation coupled with low cation exchange capacity (Malhotra *et al*., 2017) is reported to pull down the productivity of coconut, earlier researchers attributed waterlogging (Menon and Pandalai, 1960), permanent water table within one metre depth (Malhotra *et al*., 2017), improper drainage (Furtado, 1923), presence of hard pan and senility (Park and Fernando, 1941) to be the causes for pencil point disorder. During survey, it was found that about 23 % of the coconut gardens affected by pencil point disorder suffered from sheet erosion. Whenever soil is subjected to erosion, primary nutrients *viz.,* nitrogen, phosphorus, potassium and calcium are eroded. A tonne of fertile topsoil averages 1 to 6 kg of nitrogen, 1 to 3 kg of phosphorus and 2 to 30 kg of potassium whilst the topsoil on the eroded land has an average nitrogen content of only 0.1 to 0.5 kg per tonne (Troeh *et al*., 2004). Thus, in the present survey, the coconut gardens located on the foothills of the slopes were prone to sheet erosion and suffered from pencil point disorder.

Soil fertility parameters analysed in the pencil point disorder affected coconut gardens is presented in Table 1. pH of the soil samples ranged from 6.84 to 9.9 with a mean value of 8.36. Of the gardens surveyed, only three gardens had neutral pH whilst 53 gardens had pH in the alkaline range. Predominance of alkalinity in the coconut growing soils of Coimbatore and Tiruppur districts was earlier reported by Selvamani and Duraisami (2014). The content of $KMnO_4$-N was low (<280 kg ha^{-1}) in 76.7 % and medium in 23.2% of the gardens surveyed. Deficiency of available nitrogen in coconut growing soils has a significant bearing on the development of fronds which in turn impairs the photosynthetic

Table 1 : Soil fertility parameters in the pencil point disorder manifested coconut gardens (2017)

S. No.	Parameter	Minimum value	Maximum value	Mean value	Standard Deviation	Nutrient Index
1.	pH	6.84	9.90	8.37	0.68	-
2.	Organic carbon (%)	0.35	1.05	0.56	0.14	-
3.	$KMnO_4$ N (kg ha^{-1})	98.0	384.3	224.9	58.4	1.23
4.	Olsen P (kg ha^{-1})	10.8	24.9	14.63	3.35	2.01
5.	1NNH_4OAc K (kg ha^{-1})	109	864	331	217	2.34
6.	Free $CaCO_3$ (%)	14.06	0.94	6.77	4.16	-
7.	DTPA Fe (mg kg^{-1})	35.8	1.15	8.30	7.02	-
8.	DTPA Mn (mg kg^{-1})	22.67	4.22	10.30	4.77	-
9.	DTPA Zn (mg kg^{-1})	12.31	0.17	2.71	3.18	-
10.	DTPA Cu (mg kg^{-1})	9.47	0.26	1.44	1.65	-
11.	Hot water-soluble B (mg kg^{-1})	9.32	0.16	3.64	2.65	-

Table 2: Correlation matrix between soil fertility and pencil point disorder

	Index	pH	$KMnO_4$ N	Olsen P	NH_4 OAc-K	Organic C	DTPA Fe	DTPA Mn	DTPA Cu	DTPA Zn	HWS B
Index	1										
pH	-0.0945	1									
$KMnO_4$ - N	-0.0290	0.3142	1								
Olsen P	-0.0323	0.1822	-0.0390	1							
NNH_4OAc-K	0.1034	0.0628	0.2565	0.0019	1						
Organic C	0.0501	-0.0270	0.0722	0.1783	0.2034	1					
DTPA Fe	-0.0399	-0.1409	0.0575	-0.0711	0.0631	0.3755	1				
DTPA Mn	-0.0861	-0.1114	-0.2587	-0.1732	-0.0019	0.0478	0.1432	1			
DTPA Cu	0.0493	0.0857	0.0718	0.3386	0.1616	0.2493	-0.1210	0.1959	1		
DTPA Zn	0.6269	-0.1001	-0.0815	-0.0131	0.1775	-0.0104	-0.1289	-0.0141	-0.1041	1	
HWS B	0.0879	0.1459	-0.4398	0.1960	-0.1540	0.0631	-0.0956	0.1086	0.0788	-0.0687	1
Free $CaCO_3$	-0.0453	0.4804	0.2259	0.0050	-0.0400	-0.0868	-0.1112	0.0539	0.1548	0.0076	0.2269

Table 3: Differential effect of treatments on growth attributes and yield of pencil point disorder affected palms (Location: CRS, Aliyarnagar)

Treatment	Height (m)		Girth of the trunk (cm)		Total number of fronds per palm		Total number of spathe per palm		Number of nuts per palm per year	
	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020
T_1	13.9	14.2	93.3	93.6	7	7	5	3	7	5
T_2	15.1	16.5	115.0	115.6	9	11	4	6	6	12
T_3	14.3	14.4	106.5	107.0	8	8	6	7	5	8
T_4	15.5	16.2	135.0	136.1	11	10	7	6	8	13
T_5	15.6	16.9	128.0	128.5	10	12	5	9	8	15
T_6	12.9	13.1	97.8	98.3	9	8	7	8	6	10
T_7	12.1	13.4	94.8	95.9	8	10	6	9	8	12
T_8	15.1	16.2	96.0	96.8	8	9	6	8	6	10

T_1 : Control (Without micronutrient application)
T_2 : $ZnSO_4$ @ 200 g $palm^{-1}$ $year^{-1}$
T_3 : Borax @ 50 g $palm^{-1}$ $year^{-1}$
T_4 : $FeSO_4$ @ 200 g $palm^{-1}$ $year^{-1}$
T_5 : $ZnSO_4$ @ 200 g + $CuSO_4$@ 200 g + Borax @ 50 g $palm^{-1}$ $year^{-1}$
T_6 : $CuSO_4$ @ 200 g $palm^{-1}$ $year^{-1}$
T_7 : TNAU Micronutrient mixture @ 1 kg $palm^{-1}$ $year^{-1}$
T_8 : TNAU coconut tonic @ 200 ml $palm^{-1}$ (Twice a year)

Table 4: Differential effect of treatments on growth attributes and yield of pencil point disorder affected palms (Location: Farmer's field, Aliyarnagar)

Treatment	Height (m)		Girth of the trunk (cm)		Total number of fronds palm^{-1}		Total number of spathe palm^{-1}		Number of nuts palm^{-1}	
	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020
T_1	12.2	12.3	86.6	87.4	7	5	4	6	6	4
T_2	13.1	13.4	91.4	102.6	8	12	3	7	5	9
T_3	12.3	12.8	98.7	109.8	7	9	5	7	5	8
T_4	13.1	13.3	102.5	110.8	8	10	6	8	7	10
T_5	13.6	13.9	117.4	124.6	7	11	7	11	7	12
T_6	12.9	13.1	90.7	95.7	6	9	8	10	6	10
T_7	12.1	12.8	112.8	120.7	7	11	6	10	7	11
T_8	15.1	15.7	107.8	128.7	8	11	5	9	8	'11

T_1 : Control (Without micronutrient application)
T_2 : $ZnSO_4$ @ 200 g palm^{-1} year^{-1}
T_3 : Borax @ 50 g palm^{-1} year^{-1}
T_4 : $FeSO_4$ @ 200 g palm^{-1} year^{-1}
T_5 : $ZnSO_4$ @ 200 g + $CuSO_4$@ 200 g + Borax @ 50 g palm^{-1} year^{-1}
T_6 : $CuSO_4$ @ 200 g palm^{-1} year^{-1}
T_7 : TNAU Micronutrient mixture @ 1 kg palm^{-1} year^{-1}
T_8 : TNAU coconut tonic @ 200 ml palm^{-1} (Twice a year)

efficiency. Nitrogen deficiency although expressed first on older fronds, gradually extends along the entire canopy except for the spear leaf (Broeshart *et al*., 1957; Broschat, 1984; Bull, 1961; Manciot *et al*., 1979) and when all the mature leaves are depleted of nitrogen, growth of the palms eventually gets ceased. About 7.14 % of the surveyed gardens had low status (<11 kg ha^{-1}), 53 samples had medium status (11-22 kg ha^{-1}) and 5.3 % of the samples had high status (> 22 kg ha^{-1}) of Olsen P. Phosphorus deficiency manifests itself as sharp reduction in growth of the palms with "pencil pointing" or tapering trunk in chronic situations (Von Uexkull and Fairhurst, 1991).

About 10.7 % of the soil samples had low (<118 kg ha^{-1}) status, 44.6 % of the samples had medium and an equal proportion of the samples had high (> 280 kg ha^{-1}) status of 1NNH_4OAc-K. Premature senescence of the older leaves and pencil pointing is reported to be the symptoms of potassium deficiency (Elliott *et al.,* 2004) in addition to necrosis. Potassium is required in high quantities by the palm (Pillai and Davis, 1963; Ramadasan and Lal, 1966) followed by nitrogen, calcium, magnesium and phosphorus (Malhotra *et al*., 2017). The content of organic carbon varied from 0.359 % to 1.051 % with a mean value of 0.564 %. About 30.4 % of the samples had low (< 0.5 %), 60.7% of the samples had medium (0.5 – 0. 75 %) and only 8.93 % of the samples had high (>0.75 %) status of organic carbon. A threshold organic carbon content of 1 % is suggested for cultivation of coconut as it is a reliable measure of several plant nutrients especially nitrogen. Free $CaCO_3$ content of the soil samples varied from 0.94 % to 14.06 % with a mean value of 6.77 % and standard deviation of 4.15 %. About 41.1 % of the samples were non-calcareous and 58.9 % of the samples exhibited calcareousness. Nutrient index values were low for $KMnO_4$-N, medium for Olsen P and high for 1NNH_4OAc-K.

DTPA Fe content of the gardens surveyed ranged from 1.147 to 35.8 ppm with a mean value of 8.302 ppm. About 46.45 % of the surveyed gardens were sufficient in DTPA Fe whilst 53.5 % of the soil samples exhibited deficiency. Leaf spot diseases are accentuated due to iron deficiency (Broschat and Elliott, 2005) and the disease can be corrected only on reclamation of iron chlorosis. Iron deficiency is commonly noticed in calcareous soils and in soils with poor aeration. DTPA Mn content varied from 4.218 to 22.6 ppm with a mean value of 10.29 ppm and standard deviation of 4.77 ppm. Although 'Frizzle Top' is a common symptom of manganese deficiency, all the surveyed gardens had sufficient level of DTPA Mn (> 2 ppm). About 60.7 % of the soil samples expressed deficiency and only 39.3 % of the soil samples had sufficient level of DTPA Zn.

Delayed growth, malformed leaves and shortened internodes are the common symptoms of Zn stress in plants due to the disturbance in auxin metabolism (Henrique *et al.,* 2012). About 69.4 % of the soil samples expressed Cu deficiency and only 31.6 % of the soil samples expressed sufficiency. Copper deficiency results in stunted growth with leaflets reduced in size and with necrosis (Broschat, 1984). Hot water-soluble boron content of the pencil point disorder affected gardens ranged from 0.1555 to 9.321 ppm with a mean value of 3.638 ppm. Only 21.4 % of the samples expressed deficiency whilst sufficiency was witnessed across 78.6 % of the samples. The most common symptom of boron deficiency includes failure of spear leaves to open normally and presence of more than one unopened spear leaf (Broschat, 2007). Heavy leaching accelerates boron deficiency resulting in epinastic growth and chronic boron deficiency kills the meristematic tissues.

Correlation matrix was framed between soil fertility parameters and disorder index. It was found that the index expressed negative correlation for parameters *viz.,* pH, $KMnO_4$-N, Olsen P, DTPA Fe, DTPA Mn and free $CaCO_3$ whilst deficiencies of available potassium, organic carbon, DTPA Cu, DTPA Zn and HWS B had a significant bearing on the expression of pencil point disorder (Table 2).

Differential effect of treatments on growth attributes and nut yield recorded at both the locations is furnished in Tables 3 and 4. Height of the palms showed a conspicuous increase in the treatments T_2, T_5, T_7 and T_8 which was higher by 1 m over that recorded in the pre-experimental period at the research station whereas in farmer's field, the treatments T_3, T_7 and T_8 registered superiority by enhancing the height of the palms by 50 cm and more. Combined application of all the micronutrients either as solid formulation (T_7) or through root feeding was beneficial for better growth of the palms. Although girth of the trunk at 1 m height from the base of the palm did not register any spectacular difference between treatments at research station, it scaled up by more than 10 cm in the treatments T_2, T_3 and T_8 in the farmer's field. Number of fronds per palm and total number of spathe per palm were higher in the treatments T_2, T_5 and T_7 in both the locations during 2020 compared to the pre-experimental period. Number of nuts per palm showed a conspicuous increase during the experimental period in the treatment which received zinc, copper and boron supplements (T_5) in both the locations.

Results revealed that shallow depth of soil, rocky substratum, heavy soil texture and erosion hazards were the common physical constraints favouring pencil point disorder in the state of Tamil Nadu. Zinc, copper and boron were the most critical micronutrients contributing for the disorder in coconut and when they were supplied to the palms through solid or liquid formulation, a promising improvement in growth attributes and nut yield was witnessed irrespective of the locations.

REFERENCES

Henrique, A.R., Junior A. C., and Aart, M, 2012. Strategies to increase zinc deficiency tolerance and homeostasis in plants. *Braz. J. Plant Physiol*., **24**: 3-8.

Broeshart, H., Ferwerda, J.D. and Kovachich, W.D. 1957. Mineral deficiency symptoms of the oil palm. *Pl. Soil*., **8**:289-300.

Broschat, T.K. 1984. Nutrient deficiency symptoms in five species of palms grown as foliage plants. *Principes,* **28**:6-14.

Broschat, T.K. 2007. Boron deficiency, phenoxy herbicides, stem bending, and branching in palms: Is there a connection? *Palms,* **51:**161-163.

Broschat, T.K. and Elliott, M.L. 2005. Effects of iron source on iron chlorosis and *Exserohilum* leaf spot severity in *Wodyetia bifurcata*. *Hort. Sci.,* **40:** 218-220.

Bull, R.A. 1961. Studies on the deficiency diseases of the oil palm. Macronutrient deficiency symptoms in oil palm seedlings grown in sand culture. *J. West African Inst. Oil Palm Res.,* **3:**254-264.

Coconut Development Board (CDB). 2019. https://coconutboard.gov.in/Statistics.aspx

Elliott, M.L., Broschat, T.K., Uchida, J.Y. and Simone, G.W. 2004. Compendium of ornamental palm diseases and disorders. APS Press, St. Paul, MN.

Fremond, Y. 1964. The contribution of IRHO to the study of mineral nutrition of the coconut palm. (In) Proc Second Sessn. FAQ Tech. Wkg. Pty. *Cocon. Prod. Prot. and Process*, Colombo, Sri Lanka.

Furtado, C.X. 1923. Coconut tapering disease. *Trop. Agric*., **61:**126.

Ghosh, D.K and Bandopadhyay, A. 2011. Productivity and profitability of coconut based cropping systems with fruits and black pepper in West Bengal. *J. Crop and Weed.* **7:**134-137.

Jackson, M.L. 1973. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, 498.

Jaganathan, T. and Ramaswami, R. 1977. Pencil point disease of coconut in Tamil Nadu. *Indian Coc. J.,* **8:**3-6.

Malhotra, S.K., Maheswarappa, H.P., Selvamani, V. and Chowdappa, P. 2017. Diagnosis and management of soil fertility constraints in coconut (*Cocos nucifera)*: A review. *Ind. J. Agrl. Sci.,* **87**: 711-726.

Manciot, E., Ollagnier, M. and Ochs, R. 1979. Mineral nutrition of the coconut around the world. *Ole´agineux,* **34:**511-515, 576-580.

Menon, K.P.V. and Pandalai, K.M. 1960. The Coconut Palm: A Monograph. Indian Central Coconut Committee. Pp: 384.

Park, M. and Fernando, M. 1941. Diseases of village crops in ceylon, colombo. *Peradeniya manual* IV.Roya. Pp. 1- 42.

Pillai, N.G. and Davis, T.A. 1963. Exhaust of macronutrients by coconut palm-preliminary study. *Indian Coc. J*., **16:** 81-87.

Ramamoorthy, B. and Bajaj, J.C. 1969. Available N, P and K status of Indian soils. *Fert. News*., **14:** 24-26.

Ramadasan, A. and Lal, S.B.1966. Exhaust of nutrients from coconut garden – Factors affecting production. *Coconut Bulletin,* **20**:173-175.

Selvamani, V. and Duraisami, V.P. 2014. Identifying and mapping soil fertility constraints for coconut in Coimbatore and Tiruppur districts of Tamil Nadu state, India. *J.Plant. Crops*, **42**: 348-357.

Sudhalakshmi, C., Kumaraperumal, R., Arulmozhiselvan, K. and Shoba, N. 2017. Exploring the spatial variability in soil macronutrients (NPK) of coconut research station, Aliyar Nagar employing geospatial techniques. *Mad. Agric. J*., **105:** 49 -53.

Sudhalakshmi, C., Sindhu,T., Rahamath Nisha, J., Venkatesan, K. and Ramaswami, V. 2020. Survey of pencil point disorder manifested coconut gardens of Pollachi taluk, Coimbatore Dt., Tamil Nadu. *Int. J. Chem. Studies,* **8**: 97-101.

Thirumalaisamy, K., Vijayaraghavan, H. and Savery, M.A.J.R. 1994. Management of tapering disorder in coconut. *CORD*, **01**:12-13.

Troeh, F.R., Hobbs, A.H. and Donahue, R.L.2004. Soil and Water Conservation; Productivity and Environmental Protection. Prentice Hall, Upper Saddle River, NJ. USA, 2004.

Von Uexkull, H.R. and Fairhurst, T.H. 1991. Fertilizing for high yield and quality the oil palm. Intl. Potash Inst., Berne, Switzerland.