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Influence of major nutrients and seasons in yellowing affected black pepper fields

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Abstract
The experiment was carried out during the period 2016-2019 at department of plantation crops and spices, College of Horticulture and from farmer's fields in Thrissur district. Survey was conducted based on disease spread and intensity of yellowing in black pepper gardens. Soil and leaf samples were collected from the different locations selected during the three different seasons. (July-August, October-November and February-March). During three seasons of the year, in the rhizosphere soils of healthy plants showed significantly high nitrogen and potassium compared to apparently healthy and yellowing affected plants. Phosphorus content was significantly lower in the rhizosphere soil of apparently healthy plants, while healthy and yellowing affected plants were statistically on par. Whereas, yellowing affected plants of leaves showed poor uptake of nutrients like nitrogen, phosphorus and potassium content. As the result of nutrient deficiency the total green berry yield per plant was shown significantly reduction in yellowing affected plants compared to healthy plants.

Keywords: Black pepper, yellowing, nitrogen, phosphorus and potassium and seasons

Introduction
Black pepper popularly known as "King of Spices" or "Black Gold" is one of the important and earliest known spices produced and exported from India. The original home of black pepper is the dense evergreen forests of Western Ghats of South India. Kerala and Karnataka account for a major portion of production of black pepper in the country. India, the "land of spices" is the world's largest producer, consumer and exporter of spices.
Kerala, the major pepper growing tract in India, has an area of 1, 35, 915 ha with production of 64,000 tonnes and productivity of 350 kg/ha. Black pepper production is showing shrinking trend all over Kerala. Production and productivity of black pepper have suffered a severe setback during the past several decades due to improper management and rampant incidence of pests and diseases. After foot rot disease, the major constraint in black pepper cultivation is the incidence of yellowing where the production is found to decline year after year.
Yellowing is caused by many factors like poor soil health, improper land management practices and changes in climatic factors leading to biotic and abiotic stresses. Among the abiotic factors, stress imparted due to inadequate soil moisture, water stagnation, deficiency of nutrients, scorching due to over exposure to sunlight are reported to be associated with this pernicious problem, while diseases incited by a myriad of pathogenic microbes such as fungi, virus, nematodes and sap feeding insects are placed under the category of biotic factors for yellowing.
Yellowing of pepper vines at the fag end of monsoon season is a serious problem in Waynad district, which is a pepper belt of Kerala. Extensive acidification, excess levels of phosphorus and wide spread deficiencies of potassium, calcium, magnesium and boron were the major limitations to crop production (Sreekumar *et al.* 2014) [14].

Material & Method
The present study entitled, "Investigations on yellowing of black pepper (*Piper nigrum* L.)" comprising laboratory and field experiments was carried out during the period 2016-2019 at department of plantation crops and spices, College of horticulture. The experimental fields were selected at college of horticulture, Vellanikkara and from farmer's fields in Thrissur district. Survey was conducted based on disease spread and intensity of yellowing in black pepper gardens. Fields were selected from those areas having maximum concentration of general yellowing.
The experimental area was influenced by a typical warm humid tropical climatic condition and benefitted by southwest and north east monsoons. The experimental area received maximum

amount of rainfall during the months of May, June, July and August. The mean maximum and minimum temperatures of location recorded were 33 ºC and 23.3 ºC respectively. The mean relative humidity was 74%. The total rainfall was 2360.6 mm. It is situated at 10 ^{0} 32' N latitude and 76 ^{0} 13' E Longitude with an altitude of 22.5 m above mean sea level. The area enjoys a warm humid tropical climate and the soil is deep laterite with sandy clay loam texture.

A comprehensive purposive sampling survey was conducted in the pepper growing tracts of Thrissur so as to initially identify the intensity and spread of yellowing. Based on the survey, six different fields were selected for conducting the experiment.

In the selected tracts, samples were specifically identified and collected in a scale that included healthy, apparently healthy and yellowing affected plants. Fifteen yellowing affected plants and fifteen apparently healthy plants were selected from the same field. Healthy plants were selected from fields without disease symptoms. Black pepper varieties like Panniyur 1, Panniyur 2, Panniyur 3, Karimunda, and Vijay were included in the study.

Soil samples were collected from the different locations selected during the three different seasons. (July-August, October-November and February-March). Altogether 45 samples were collected in separate polythene bags tied with rubber band and labeled. The soil samples were air dried under shade, ground and sieved through 2 mm sieve and used for characterization with respect to available nutrient status of (N, P, K).

The procedure followed for characterization of soil samples are detailed here under. Modified Kjeldhal's method (Jackson, 1958) [6] was followed to estimate nitrogen, Monoacid digestion using sulfuric acid and digestion mixture followed by distillation using Micro Kjedahl's distillation apparatus was carried out. Available phosphorus was determined by extracting with Bray No. 1 reagent and estimating calorimetrically by reduced molybdate ascorbic acid blue colour method using spectronic 20 spectrometer (Bray and Kurtz, 1945) [2]. Available potassium were extracted with neutral normal ammonium acetate solution and their contents determined by flame photometry (Jackson, 1958) [6].

Nutrient analysis of leaves of black pepper leaf samples

First mature leaves of laterals were considered as index leaves. Leaf samples of black pepper were collected following the procedure suggested by De Ward (1969) [3]. The leaf samples were cleaned, first dried under shade and then dried in a hot air oven at 70 ^{0} C, powdered and stored in plastic bottles for analysis.

Nitrogen was done by Micro-Kjeldahl distillation after digestion in H_2 SO_4 (Jackson, 1958) [6]. Phosphorus was extracted by Nitric-perchloric (9:4) acid digestion and colorimetry using vanado-molybdo phosphoric yellow colour method (Piper, 1966). Potassium was extracted with Nitric-perchloric (9:4) Di acid digestion of plant sample followed by filteration and flame photometry determination (Piper, 1966) [11].

Green berry yield per vine

Immediately after harvest, total yield of green berries per vine was recorded. Yield of tagged plants in the healthy, apparently healthy yellowing affected groups were recorded for two consecutive years.

Results & Discussion

During February-March, healthy plant showed significantly high (321.44 kg ha^{-1}) nitrogen content. Yellowing affected plants showed significantly lower nitrogen content in the rhizosphere soil compared to healthy and apparently healthy plants (table.1). During July-August, the rhizosphere soils of healthy plants showed significantly higher (316.13 kg ha^{-1}) nitrogen content when compare to apparently healthy and yellowing affected plants. In all the three seasons analyzed the rhizosphere soils of apparently healthy plants showed significantly lowest phosphorus compared to healthy and yellowing affected plants (table 2). Krishnamoorthy and Vajranabhaiah, (2000) [7] indicated that in the yellowing of areca nut, deficiency of phosphorus in the soil was one of the main cause for yellowing. During February-March, healthy plants showed significantly highest (411.61 kg ha^{-1}) potassium content when compared to rhizosphere soils of apparently healthy and yellowing affected plants. Yellowing affected plants showed significantly lower potassium content (300.78 kg ha^{-1}).

During October-November, the rhizosphere soils of healthy plants showed significantly higher (291.73 kg ha^{-1}) potassium content when compared to apparently healthy and yellowing affected plants. The other two categories were statistically on par (table 3). During, July-August the rhizosphere soils of yellowing affected plants showed significantly lower (187.03 Kg ha^{-1}) potassium content compared to other two categories, which were statistically on par. Wahid and Kamalam (1982) [16] reported that foliar yellowing and necrosis of distal ends of lamina in slow wilt affected gardens were due to N and K deficiencies. The disappearance of these symptoms with the onset of monsoon was attributed to increased nutrient uptake, and their reappearance after the monsoon season to soil moisture stress and a consequent reduction in nutrient uptake. Similar results reported by Aloka (2016) [1] and Wahid *et al*. (1982) [16] low pH reduced plant growth and was associated with low root nutrient concentrations of K. Nematode was widely prevalent in all major pepper growing areas in Kerala and Karnataka (Ramana and Mohandas, 1987) [12]. It might be root level cause for hindrance of nutrient uptake. Similar results reported that general foliar yellowing and defoliation were low during July and high during April- May. (Pervez, 2018) [10].

Nitrogen content of plant samples showed that the healthy plants contained significantly high nitrogen content when compared to apparently healthy and yellowing affected plants (fig. 1, 2 and 3). However, yellowing affected plants showed significantly lower phosphorus content in plants (0.12 per cent) when compare with apparently healthy plants. At first, the lower leaves turn yellowish but the upper canopy of affected plants tends to remain relatively green. In severe cases, leaves of the entire plant show a characteristic yellow to orange yellow discoloration and the extreme end of the leaf tip becomes necrotic in some instances. (George *et al.*, 2005) [5]. Chlorosis of older leaves and later followed by younger leaves, growth retardation, stunted growth and reduction in leaf size. Similar results reported by De Ward 1969 [3]. The disappearance of these symptoms with the onset of the monsoon was attributed to increased nutrient uptake, and their re-appearance, after the monsoon season, to soil moisture stress and a consequent reduction in nutrient uptake. Healthy plants showed significantly high potassium content compared to other two categories and yellowing plants showed significantly lower potassium content. Necrosis is usually confined to the distal end, while the portion beyond the

boundary separating necrotic and live tissues displays a 'V' shape band, which is yellow to reddish brown. Table 4 shows green berry yield per plant in the five varieties in the three categories of yellowing affected, apparently healthy and healthy plants in varieties Panniyur 1, Panniyur 2, Panniyur 3 and Karimunda, there was significantly reduction in yield in yellowing affected plants compared to healthy. Whereas the significant difference between apparently healthy and yellowing affected plants only in case Panniyur 1. In variety Vijay there was no significant difference in yield among the three categories. During three seasons nutrient values showed optimum range. Similar results reported infested with *M. incognita* it affects physiological changes like reduction in absorption and translocation of P, K (Ferraz *et al*., 1988) [4].
The black pepper vines remained healthy until large portions of the roots were damaged. In the advanced stages of the root rot, plant showed foliar yellowing, and shedding of leaves, spikes and lateral branches were noticed. The amount of defoliation due to root rot infection was equal to root damage. The root loss to regeneration determines the spread of the decline and death of the vine. Several plant parasitic nematodes belonging to different groups were reported in association with pepper. This nematode was widely prevalent in all major pepper growing areas in Kerala and Karnataka (Ramana and Mohandas, 1987 [12]; Ramana and Eapen, 1999) [13]. This disease was also widely prevalent in Johore and Sarawak in Malaysia, and yield losses ranged from 25-90 per cent and the life span of the vine was reduced to 8-10 years (Varuguese and Anuar, 1992) [15]. Yellowing of areca nut palms root tips turn to dark and gradually rot (Nair and Rawthar, 2000) [8].

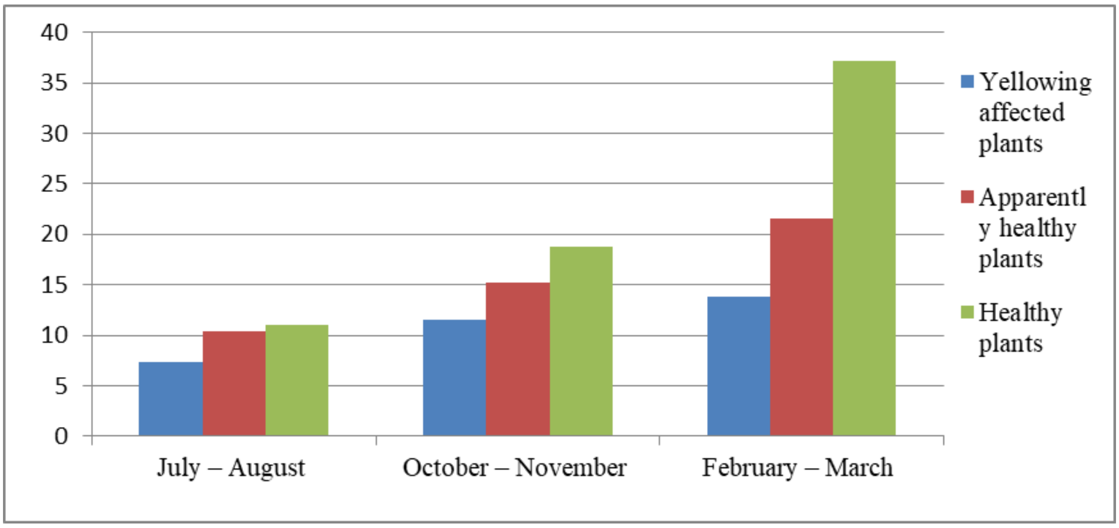

Fig 1: Nitrogen content in the pepper leaves of healthy, apparently healthy and yellowing affected plants

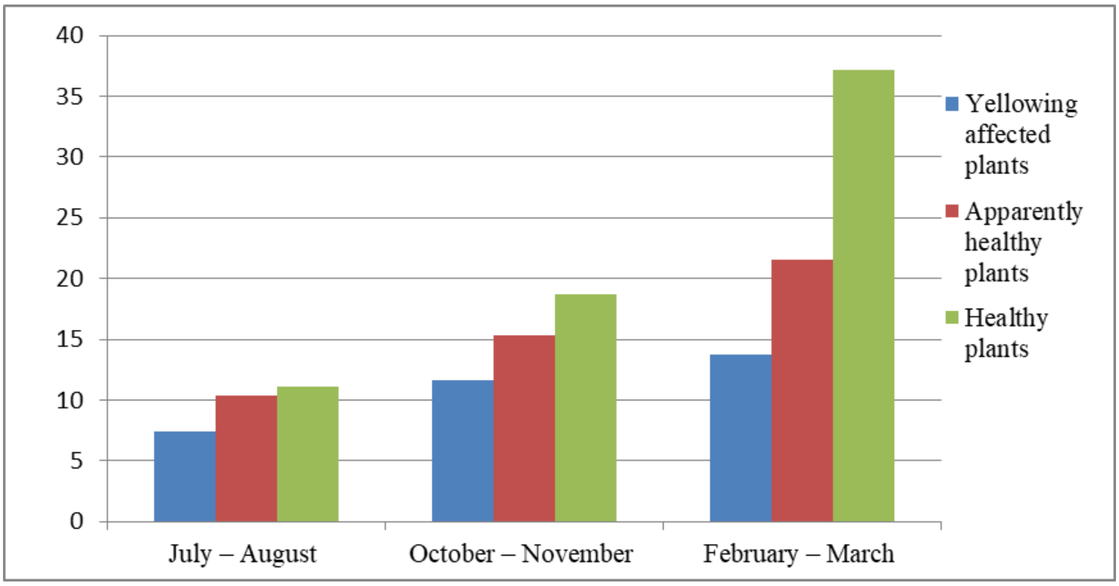

Fig 2: Phosphorus content in the pepper leaves of healthy, apparently healthy and yellowing affected plants

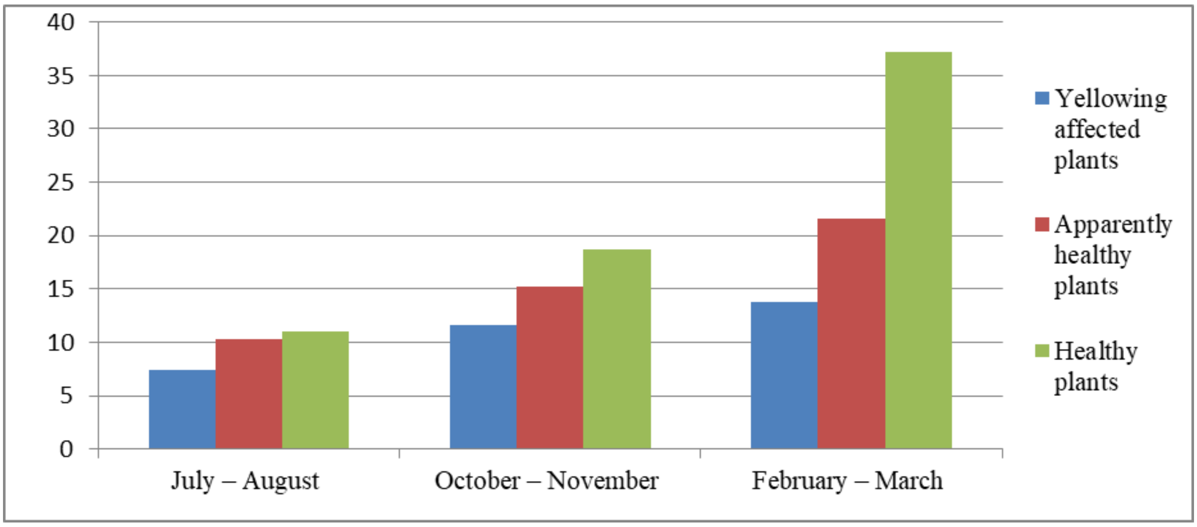

Fig 3: Potassium content in the pepper leaves of healthy, apparently healthy and yellowing affected plants

Table 1: Content of Nitrogen (kg ha^{-1}) rhizosphere soils of yellowing affected plants, apparently healthy and healthy black pepper plants

Category / Year	July – August A1			October – November A2			February – March A3		
	2017 B1	2018 B2	Category mean	2017 B1	2018 B2	Category mean	2018 B1	2019 B2	Category mean
Y	247.15	291.95	269.55	303.89	305.03	304.46	280.00	251.63	265.81
A. H	193.39	313.30	253.34	317.33	309.07	313.20	300.91	279.33	290.12
Healthy	318.08	314.20	316.14	311.36	319.20	315.28	321.07	321.81	321.44
Year mean	252.87	306.48		310.86	311.09		300.66	284.26	
Seasonal mean	279.68			310.98			292.46		

Category (C) / Year	2017 (B1)	2018 (B2)	Treatment Mean
Yellowing affected plants	277.01	282.86	279.94
Apparently healthy plants	270.54	300.56	285.55
Healthy plants	316.83	318.40	317.62
Category /Year mean	288.13	300.61	

	CD (0.05)		CD (0.05)
Season- (A)	12.99	Season x Year (A x B)	18.38
Year – (B)	10.61	Season x Category (A x C)	22.51
Category – (C)	12.99	Year x Category (B x C)	18.38
		Season x Year x Category (A x B x C)	31.836

Yellowing affected plants (Y), Apparently healthy plants (A.H), Healthy plants (H)

Table 2: Content of Phosphorus (kg ha^{-1}) rhizosphere soils of yellowing affected plants, apparently healthy and healthy black pepper plants

Category / Year	July – August A1			October – November A2			February – March A3		
	2017 B1	2018 B2	Category mean	2017 B1	2018 B2	Category mean	2018 B1	2019 B2	Category mean
Y	124.94	146.83	135.88	164.45	150.68	157.56	135.16	136.13	135.65
A. H	106.50	81.40	93.95	103.93	108.64	106.29	79.06	97.13	88.09
Healthy	185.63	184.50	185.07	145.08	173.22	159.15	112.15	122.67	117.41
Year mean	139.02	137.58		137.82	144.18		108.79	118.64	
Seasonal mean	138.30			141.00			113.72		

Category (C) / Year	2017 (B1)	2018 (B2)	Treatment Mean
Yellowing affected plants	141.51	144.54	143.03
Apparently healthy plants	96.49	95.72	96.11
Healthy plants	147.62	160.12	153.87
Category /Year mean	128.54	133.46	

	CD (0.05)		CD (0.05)
Season- (A)	21.89	Season x Year (A x B)	30.96
Year – (B)	17.87	Season x Category (A x C)	37.92
Category – (C)	21.89	Year x Category (B x C)	30.96
		Season x Year x Category (A x B x C)	53.634

Yellowing affected plants (Y), Apparently healthy plants (A.H), Healthy plants (H)

Table 3: Content of Potassium (kg ha^{-1}) in rhizosphere soils of yellowing affected, apparently healthy and healthy black pepper plants

Category / Year	July – August A1			October – November A2			February – March A3		
	2017 B1	2018 B2	Category mean	2017 B1	2018 B2	Category mean	2018 B1	2019 B2	Category mean
Y	193.51	180.54	187.03	179.24	181.95	180.59	333.90	267.66	300.78
A. H	250.40	227.72	239.06	196.72	193.02	194.87	344.83	367.38	356.10
Healthy	293.95	281.26	287.61	287.09	296.37	291.73	469.68	353.54	411.61
Year mean	245.95	229.84		221.02	223.78		382.80	329.53	
Seasonal mean	237.90			222.40			356.16		

Category (C) / Year	2017 (B1)	2018 (B2)	Treatment Mean
Yellowing affected plants	235.54	210.05	222.79
Apparently healthy plants	263.98	262.70	263.34
Healthy plants	350.23	310.39	330.31
Category /Year mean	283.25	261.04	

	CD (0.05)		CD (0.05)
Season- (A)	29.71	Season x Year (A x B)	42.01
Year – (B)	24.25	Season x Category (A x C)	51.46
Category – (C)	29.71	Year x Category (B x C)	42.01
		Season x Year x Category (A x B x C)	72.77

Yellowing affected plants (Y), Apparently healthy plants (A.H), Healthy plants (H)

Table 4: Green berry yield/plant (g) of yellowing affected, apparently healthy and healthy black pepper plants

Treatments	P1 2017	P1 2018	Pooled mean	P2 2017	P2 2018	Pooled mean	P3 2017	P3 2018	Pooled mean	Karimunda 2017	Karimunda 2018	Pooled mean	Vijay 2017	Vijay 2018	Pooled mean
Y	1000.0	883.3	941.7	2533.3	1766.7	2150.0	2433.3	1900.0	2166.7	333.3	283.3	308.3	3100.0	3033.3	3066.7
A.H	2516.7	2033.3	2275.0	3000.0	2623.3	2811.7	3833.3	2933.3	3383.3	1530.0	1503.3	1516.7	3216.7	3133.3	3175.0
Healthy	6833.3	6270.0	6551.7	4166.7	4466.7	4316.7	4333.3	3533.3	3933.3	1700.0	1766.7	1733.3	3300.0	4000.0	3650.0
Variety Mean	3450.0	3062.2		3233.3	2952.2		3533.3	2788.9		1187.8	1184.4		3205.6	3388.9	
Varieties	3256.1			3092.8			3161.1			1186.1			3297.2		

CD (0.05)	CD (0.05)
Varieties	785.152
Variety x category	1359.924

Yellowing affected plants (Y), Apparently healthy plants (A.H), Healthy plants (H)

Conclusion

Yellowing was influence mainly based on season during the winter season plant condition was poor compared to other season. The disappearance of these symptoms with the onset of monsoon was attributed to increased nutrient uptake, and their reappearance after the monsoon season to soil moisture stress and a consequent reduction in nutrient uptake. Plant parasitic nematodes are serious threats to crop production. Yield loss due to nematode attack may range from 39 to 65% under field conditions; it might be a reason for foliar yellowing. Even though the soil nutrient status in the rhizosphere soil of experimental plants was satisfactory, absorption of nutrients was severely affected due to damage of roots caused by nematodes. The yellowing expressed must be due to multiple factors and combined effect of multiple nutrient deficiencies in plant tissue.

Reference

1. Aloka YG. Gypsum as a soil amelioration for black pepper (*Piper nigrum* L.) in acid soils of Wayanad. M.Sc. (Ag) thesis, Kerala Agricultural University, 2016, Thrissur, 104p.
2. Bray RH, Kurtz LT. Determination of total, organic and available forms of phosphorus in soils. Soil Sci. 1945; 59:39-45
3. De ward PWF. Foliar diagnosis nutrition and yield stability of black pepper (*Piper nigrum* L.) in Sarawak. Comm. No 58, Royal Tropical Institute. Amsterdam, The Netherlands, 1969, 150p.
4. Ferraz ECA, Lordllo LGE, de Santana CJL. Nutrient absorption of black pepper vine (*Piper nigrum* L.) infested with Meloidogyne incognita (Kofoid and White, 1999), (Chitwood, 1949). Boletin Tecnico Centro de Pesqisas do Cacau. 1988, Brazil No 160. 34p.
5. George CK, Abdullah A, Chapman K. Pepper production guide for Asia and the Pacific. IPC/FAO, 2005.
6. Jackson ML. Soil chemical analysis Prentice-Hall, Englewood Cliffs, N.J. 1958, 498p.
7. Krishnamurthy K, Vajranabhaiah SN. Arecanut Yellow leaf disease in Karnataka. Kisan world. 2000; 27:57-59.
8. Nair RR, Rawther TSS. Physiology. Arecanut yellow leaf disease (eds. Nampoothiri, K.U.K., Ponnamma, K.N. and Chowdappa, P.) Central Plantation Crop Research Institute, Kasaragod, 2000, 68 p.
9. Nybe EV, Nair PCS. Nutrient deficiency in black pepper (*Piper nigrum* L.)-Calcium, Magnesium and Sulphur. Agric. Res. J Kerala.1987; 25(1):52-65.
10. Pervez R. Current status of plant parasitic nematodes and their management of major spice crops. Trends in Horticulture, 2018, 1(2).
11. Piper CS. Soil and Plant Analysis. Hans Publishers Bombay. 1966, 135-136.
12. Ramana KV, Mohandas C. Plant parasitic nematodes associated with black pepper (*Piper nigrum* L.) in Kerala. Indian J Nematol. 1987; 17(1):62-66.
13. Ramana KV, Eapen SJ. Nematode induced diseases in black pepper. In: Ravindran, P.N. (Ed.), Black Pepper – a Monograph. Harwood Academy Publishers, Amsterdam, The Netherlands, 1999, 269-295.

14. Sreekumar KM, Jayaraj P, Sreenivasan V, Reshmi V, Mini V, Shankar M. Characterisation of the soils of pepper growing tracts of Wayanad. In: Proceedings of Twenty Sixth Kerala Science Congress, 28-31 January 2014, Pookode, Wayanad. Kerala Agricultural University, Indian Institute of Spices Research Kozhikode, 2014, 1-62.
15. Varughese J, Anuar M. Status of disease of pepper, *Piper nigrum* L. in Johor, Malaysia. In: Proceedings of the International Workshop on Black Pepper Disease, 1992, 118-129.
16. Wahid PA, Kamalam NV, Venugopal VK. Mineral nutrition of slow wilt affected black pepper (*Piper nigrum* L.). J of Plantation Crops. 1982; (10):21-25.