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Research Article

SUSTAINABLE MANAGEMENT OF TOMATO COLLAR ROT CAUSED BY *Sclerotium rolfsii* (Sacc.)

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Abstract: The collar rot caused by fungal pathogen *Sclerotium rolfsii* (Sacc) is one of the serious diseases causing huge loss to tomato throughout the world. The pathogen being soil-borne, polyphagous in nature and longer persistence in soil, due to which its control with chemicals alone seems to be ineffective and uneconomical. Soil organic amendments are known to improve soil aeration, structure, drainage, moisture holding capacity, nutrient availability and microbial ecology. Hence, field experiments were conducted at agricultural farm of Palli-Siksha Bhavana, Visva-Bharati, Sriniketan, during the winter season of 2014-16 on Tomato with a view to manage the disease in a sustainable manner by using eco-friendly approaches with less hazards and safer chemicals. The soil was enriched through various organic materials *i.e.*, Poultry manure, Goat Manure, Farm Yard Manure (FYM), Vermicompost, Spent Mushroom Substrate, Neem cake, Sesamum cake, Mustard cake and Groundnut cake and their effects were evaluated against collar rot disease of tomato. Application of neem cake in soil reduced 72.70 % and 69.05 % disease incidence followed by Sesamum cake 66.83 % and 65.09 % and lowest decrease in disease incidence was observed with Goat Manure treated plot with 27.61 % and 29.37 % in two year of experiments. In case of yield, neem cake also showed its supremacy and gave maximum increase in yield over control 14.13 % and 14.99% followed by sesamum cake (13.27 % and 14.46 %) and lowest increase in goat manure 7.94 % and 8.80 %. The maximum plant height (89.47 cm and 88.47cm) at 80 days after transplanting and number of primary branches per plant (6.77 and 6.80) was found Vermi-compost treated plot whereas minimum plant height (80.57 cm and 81.90 cm) and number of primary branches (5.20 and 5.37) was recorded in ground nut treated plots during 2014-15 and 2015-16.

Keywords: Tomato, collar rot, *Sclerotium rolfsii*, Sustainable Management

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Introduction

The collar rot caused by *Sclerotium rolfsii* Sacc. is one of the major threat for tomato cultivation in majority of the tropical and subtropical countries. In India, the pathogen occurs in all most all states, but extensively in Assam, [1] Uttar Pradesh [2], Andhra Pradesh [3,4] and West Bengal [5]. The pathogen causes pre-and post-emergence damping off, root/collar rot and wilt of the seedlings as well as older plants by killing plant tissues in advance of colonization by production of oxalic acid, pectinolytic, cellulolytic and some other cell-wall degrading enzymes [6]. The pathogen is a facultative saprophyte, polyphagous, ubiquitous, omnivorous and most destructive soil inhabitant fungus, having a wide host range of 500 plant species [6, 7]. The fungus overwinters as sclerotia and mycelia in or on infected plants and debris, near soil surface or buried in soil which serve as a major source of primary infection by germinating in response to alcohols and other volatile compounds released from decomposing plant material [6]. Sclerotia can be disseminated through seedlings, water, wind and possibly as concomitant contaminants along with seeds or any cultural practice that moves infested soil or plant debris [8]. Due to omnipathogenic nature, abundant growth habits, prolonged saprophytic survivability and wide adaptability of the pathogen, its control with chemicals alone seems to be not satisfactory in view of the environmental concerns and cost benefit ratio. Hence alternative management methods are strongly desired for sustainable agriculture. Organic amendments play an important role as eco- friendly and sustainable alternative approach to protect plants against soil borne pathogens. Soil organic amendments are known to improve soil aeration, structure, drainage, moisture holding capacity, nutrient availability and microbial ecology [9]. Lumsden, *et al*., [10] stated that organic amendment produced volatile and non-volatile substances during their decomposition and also stimulate resident and introduced antagonists. Bulluck and Ristaino, [11] found that organic amendments reduced the incidence of the disease caused by *S. rolfsii* and favored the proliferation of the antagonistic micro-flora of the soil, especially Trichoderma species. Enhancing numbers of antagonists in soil generally leads to a decrease in viable pathogen inoculums and a reduced need for fungicides [12,13]. Under this concept the present investigation was carried out to study the effect of organic amendments against collar rot disease of tomato.

Materials and Methods

To evaluate the effects of soil organic amendments viz., Sesamum cake, Groundnut cake, Mustard cake, Neem cake and Vermicompost, Spent Mushroom Substrate (SMS), Goat manure, poultry manure and Farm Yard Manure (FYM) on collar rot incidence as well as plant vigour and yield, field experiments was carried out at the Agricultural Farm of Palli-Siksha Bhavana, Visva-Bharati, Sriniketan during the winter season of 2014-15 and 2015-16. The field trial was laid out in a Randomized Block Design with three replications along with control plot. The plot size was 4 x 3 sq. m. Tomato genotypes Punjab Chuhara was used during the experiment. All oil cakes apply at the rate of 500 kg per ha and Vermicompost, Farm Yard Manure, Goat manure, Poultry manure and Spent Mushroom Substrate apply at the rate of 1000 kg per ha. All soil amendments were mixed in plot and moistened giving light irrigation at 10 days before of transplanting as it could decompose properly. After mixing the soil amendments in field, the field was kept undisturbed for building up of the soil micro flora. Soil without amendments served as control. All agronomic practice was carried out as per recommendations. Observations were recorded on percent disease incidence, plant height, number of primary branches per plants and yield. The percent disease incidence was recorded up to the incidence in untreated checked was maximum. The interval between the date of transplanting and the appearance of first symptoms in

Table-1 Effect of organic amendments on collar rot disease of tomato caused by *Sclerotium rolfsii*

Treatment	2014-15				2015-16				Pooled Analysis			
	Disease Incidence (%)	Disease Control over control plot (%)	Apparent Rate of Infection ("r")	AUDPC Value	Disease Incidence (%)	Disease Control over control plot (%)	Apparent Rate of Infection ("r")	AUDPC Value	Disease Incidence (%)	Disease Control over control plot (%)	Apparent Rate of Infection ("r")	AUDPC Value
Poultry manure	11.11 (3.39)*	55.72 (48.29)	0.02884	1041.8	12.11 (3.48)	56.90 (49.08)	0.02261	1280.1	11.61 (3.45)	56.63 (48.86)	0.02573	1160.95
Goat Manure	18.06 (4.27)	27.61 (26.70)	0.03398	1875.1	19.44 (4.42)	29.37 (31.81)	0.03532	2083.3	18.75 (4.35)	28.97 (31.36)	0.03465	1979.2
FYM	15.28 (3.91)	40.64 (39.45)	0.03152	1541.5	16.67 (4.05)	39.69 (38.39)	0.03313	1666.6	15.97 (3.98)	40.48 (39.19)	0.03232	1604.05
Vermi-compost	12.50 (3.75)	50.95 (45.55)	0.02925	1166.7	12.50 (3.57)	54.77 (47.86)	0.02310	1291.8	12.50 (3.57)	53.18 (46.88)	0.02618	1229.25
SMS	13.89 (3.73)	46.20 (42.70)	0.03065	1124.9	15.28 (3.94)	45.25 (42.14)	0.03192	1333.4	14.58 (3.84)	45.64 (42.37)	0.03129	1229.15
Neem Cake	6.94 (2.70)	72.70 (58.62)	0.02142	458.5	8.33 (2.91)	69.05 (56.82)	0.02105	583.6	7.64 (2.81)	71.03 (57.80)	0.02123	521.05
Sesamum cake	8.33 (2.91)	66.83 (55.26)	0.02385	583.6	9.72 (3.18)	65.09 (53.85)	0.02194	791.8	9.03 (3.06)	66.28 (54.62)	0.02289	687.7
Mustard cake	9.72 (3.18)	60.48 (51.16)	0.02501	791.8	11.11 (3.39)	59.53 (50.60)	0.02306	916.7	10.42 (3.29)	60.33 (51.02)	0.02404	854.25
Groundnut cake	11.11 (3.30)	57.61 (49.77)	0.02769	958.5	11.11 (3.30)	59.52 (51.22)	0.02386	1006.8	11.11 (3.30)	58.72 (50.59)	0.02578	982.65
Control	25.00 (5.04)	0 (0.00)	0.03658	2833.4	27.78 (5.31)	0 (0.00)	0.04009	3083.4	26.39 (5.18)	0 (0.00)	0.03833	2958.4
Sem±	0.27	5.52	0.14	185.67	0.25	4.08	0.26	162.06	0.23	3.91	0.17	165.17
CD at 5%	0.79	16.41	0.41	551.64	0.77	12.13	0.77	481.50	0.68	11.62	0.50	490.74
CV	12.85	22.91	8.35	25.99	11.90	16.77	16.30	20.00	10.70	16.03	10.38	21.66

**Note: Figures in parenthesis are square root transformed values*

Table-2 Effect of organic amendments on plant height and number of primary branches of tomato against collar rots disease caused by *Sclerotium rolfsii*

Treatment	Disease Incidence (%)			Plant Height (cm)			No. of Branches (Primary Branch) per plant		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Poultry manure	11.11(3.39)*	12.11(3.48)	11.61(3.45)	88.37	87.37	87.87	6.63	6.40	6.52
Goat Manure	18.06(4.27)	19.44(4.42)	18.75(4.35)	87.13	85.13	86.13	6.10	6.20	6.15
FYM	15.28(3.91)	16.67(4.05)	15.97(3.98)	86.60	85.93	86.27	5.90	6.37	6.13
Vermicompost	12.50(3.75)	12.50(3.57)	12.50(3.57)	89.47	88.47	88.97	6.77	6.80	6.78
SMS	13.89(3.73)	15.28(3.94)	14.58(3.84)	88.17	87.17	87.67	6.23	6.20	6.22
Neem Cake	6.94(2.70)	8.33(2.91)	7.64(2.81)	85.03	86.03	85.53	5.77	5.93	5.85
Sesamum cake	8.33(2.91)	9.72(3.18)	9.03(3.06)	83.80	84.47	84.13	5.33	5.47	5.40
Mustard cake	9.72(3.18)	11.11(3.39)	10.42(3.29)	81.90	82.57	82.23	5.23	5.43	5.33
Groundnut cake	11.11(3.30)	11.11(3.30)	11.11(3.30)	80.57	81.90	81.23	5.20	5.37	5.28
Control	25.00(5.04)	27.78(5.31)	26.39(5.18)	72.87	70.53	71.70	4.47	4.33	4.40
Sem	0.29	0.25	0.23	1.39	1.42	1.34	0.44	0.42	0.42
CD at 5%	0.85	0.74	0.69	4.14	4.23	3.99	1.31	1.25	1.23
CV	14.12	11.73	11.16	2.86	2.94	2.76	13.06	12.68	12.59

**Note: Data in parenthesis are square root transform value*

Table-3 Effects of organic amendments on yields of tomato against collar rot disease caused by *Sclerotium rolfsii*

Treatment	Disease Incidence (%)			Yield (Tone)			Percent Increase yield over control		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Poultry manure	11.11(3.39)*	12.11(3.48)	11.61(3.45)	22.03	21.83	21.93	9.51(3.12)*	9.97(3.18)	9.74(3.15)
Goat Manure	18.06(4.27)	19.44(4.42)	18.75(4.35)	21.72	21.60	21.66	7.94(2.90)	8.80(3.04)	8.37(2.97)
FYM	15.28(3.91)	16.67(4.05)	15.97(3.98)	21.77	21.74	21.76	8.18(2.94)	9.52(3.16)	8.85(3.05)
Vermicompost	12.50(3.75)	12.50(3.57)	12.50(3.57)	21.97	21.94	21.96	9.21(3.11)	10.51(3.31)	9.86(3.21)
SMS	13.89(3.73)	15.28(3.94)	14.58(3.84)	21.87	21.70	21.79	8.71(3.03)	9.32(3.13)	9.02(3.08)
Neem Cake	6.94(2.70)	8.33(2.91)	7.64(2.81)	22.96	22.83	22.90	14.13(3.79)	14.99(3.90)	14.56(3.85)
Sesamum cake	8.33(2.91)	9.72(3.18)	9.03(3.06)	22.79	22.72	22.76	13.27(3.69)	14.46(3.85)	13.86(3.77)
Mustard cake	9.72(3.18)	11.11(3.39)	10.42(3.29)	22.56	22.53	22.54	12.13(3.52)	13.47(3.72)	12.80(3.62)
Groundnut cake	11.11(3.30)	11.11(3.30)	11.11(3.30)	22.29	22.19	22.24	10.79(3.32)	11.77(3.47)	11.28(3.39)
Control	25.00(5.04)	27.78(5.31)	26.39(5.18)	20.12	19.85	19.99	0.00(0.71)	0.00(0.71)	0.00(0.71)
Sem	0.29	0.25	0.23	0.28	0.27	0.27	0.21	0.20	0.22
CD at 5%	0.85	0.74	0.69	0.83	0.79	0.79	0.61	0.58	0.64
CV	14.12	11.73	11.16	2.21	2.11	2.11	11.83	10.80	12.04

**Note: Data in parenthesis are square root transform value*

different treatments and the interval between first incidence and final incidence of the disease were also recorded. Apparent infection rate of spread of the disease was calculated according to the following formula [14].

$$r = \frac{2.3}{t2 - t1}\left\{Log\left(\frac{X2}{1 - X2}\right) - Log\left(\frac{X1}{1 - X1}\right)\right\}$$

Where,

r = Apparent infection rate at exponential growth stage

t1 = First day of observation

t2= Last date of observation

X1 = Production of the disease on first day of observation

X2= Production of the disease on last day of observation

The mean of area under disease progress curve (AUDPC) for each replicate was calculated as suggested by Pandy, *et al*., [15].

AUDPC= D [1/2 (Y1+Yk) + (Y2+Y3+.....+Yk-1)]

Where D= Time interval; Y1= First disease incidence; Yk= Last disease incidence; Y2, Y3,.....Yk-1= Intermediate disease incidence.

Results and Discussions

Effects of soil organic amendments on collar rot disease incidence

The effect of soil organic amendments on collar rot disease incidence has been presented in [Table-1]. Among the nine organic amendments, neem cake treated plots showed lowest disease incidence (6.94 % and 8.33 %) in two year of evaluation, which followed by Sesamum cake (8.33% and 9.72%), mustard cake (9.72% and 11.11%),groundnut cake (11.11% and 11.11%), poultry manure (11.11% and 12.11%), vermicompost (12.50% and 12.50%), Spent mushroom substrate (SMS) (13.89% and 15.28%) respectively whereas highest disease incidence of 15.28% and 16.67% recorded in farm yard manure (FYM) treated plots, in two year of experiments. The apparent rate of infection ("r" value) and disease progress (AUDPC value) is increase with in accordance to increasing of disease incidence. The highest "r" value and AUDPC value (0.03398 and 1875.1 in 2014-15 and 0.03532 and 2083.3 in 2015-16) recorded in goat manure treated plots, whereas lowest (0.02142 and 458.5 in 2014-15 and 0.02105 and 583.6 in 2015-16) in neem cake treated plots. The control plots showed 25.00 % and 27.78 % of disease incidence with highest apparent rate of infection of 0.03658 and 0.04009 as well as highest AUDPC value of 2833.4 and 3083.4 in two year respectively. Pooled analysis of two-year data also revealed the same trends. Among the treated plots lowest disease incidence was recorded in neem treated plots with an incidence of 7.64 % and the apparent rate of infection and AUDPC value was 0.02123 and 521.05 whereas highest incidence was taking place in plots, treated with goat manure where disease incidence was 18.75 % and the apparent rate of infection and AUDPC value was 0.03465 and 1979.2 respectively. Among the all organic amendments, cakes were showed best result in respect of disease control potentiality though all organic amendments showed significant reduction of disease incidence except goat manure in respect to control. Similar observations were also made by Gurjar, *et al*., [16] who reported that, collar rot of chilli caused by *Sclerotium rolfsii* and studied the effect of organic amendments like FYM, vermicompost, cotton oil, mustard oil, castor oil, neem oil and groundnut oil against the disease. All amendments were found significantly superior compared to control. Neem cake was found most effective with the least disease incidence of 18.50 per cent. Organic amendments viz., oil cake extracts of Neem, Groundnut, Karanj, Castor, Sunflower and FYM applied in soil were reported fungitoxic/ fungistatic against soil borne plant pathogens like *S. rolfsii*, *R. solani*, M. phaseolina, *S. sclerotium* and *Fusarium* spp. Like Soybean, Sunflower, Cotton, Sesamum, Groundnuts, Safflower, Fenugreek, etc. earlier by several workers [17-22].

Effects of organic amendments on plant growth and vigour of tomato against collar rot disease

The effects of organic amendments on plant height and primary branches of tomato against collar rot disease caused by *Sclerotium rolfsii* have been tabulated in [Table-2]. All organic amendment significantly increased the plant height and the number of primary branches per plant in comparison to untreated control. Among the treated plots, in first crop growing season (2014-15 year) highest plant height (89.47 cm) and highest number of primary branches (6.77 nos.) have been noticed in vermicompost amended plots whereas lowest plant height (80.57 cm) and lowest number of primary branches (5.20 nos.) has been observed in Groundnut cake treated plots. In second successive crop growing season (2015-16), as like first year vermicompost amended plots were showed highest plant height (88.47 cm.) and highest number of primary branches per plants (6.80 nos.) and also the lowest plant height (81.90 cm) and lowest number of primary branches per plants (5.37 nos.) recorded in Groundnut cake treated plots among the treated plots. The pooled analysis of two successive growing seasons also showed the same trends. It was confirmatory from the pooled analysis that the organic amendments have plant vigour increasing potentiality by reducing the disease proneness of soil through increasing the beneficial antagonistic micro flora of rhizospheric zone of soil as well as increasing tilt of soil. These higher growth and plant vigour may be due to the nutrient elements along with other growth promoting substances provided by different organic components used. Organic manure also increase vigour and hardness on the plant were reported due to both micronutrients (building blocks of plant enzymes, vitamins and hormones) and the organic chelating agents that make them available other humic substances [23]. Organic manure has various advantages like increasing soil physical properties, water holding capacity, organic carbon content apart from supplying good quality of nutrients [24]. Thus, organic source played very important role in plant growth and development. Vermicompost refers to high grade organic manure which is rich in plant nutrients and an excellent growth promoter for plants. It contains 9.15-17.98 % organic carbon, 1.75-2.50 % nitrogen, 1.55-2.25 % phosphorus, 1.25-2.0 % potassium, calcium, magnesium and sulphate 3 - 5 times better than FYM [25]. Cheuk [26] also reported significant increase in tomato yield with compost amendment. Besides, significant yield increase in eggplant was observed as a result of disease suppressiveness and growth promoting effect of compost [27].

Effects of organic amendments on yields of tomato against collar rot disease

The effects of organic amendments on yields of tomato against collar rot disease caused by *Sclerotium rolfsii*. has been presented in [Table-3]. In the crop growing season of 2014-15 year highest yield (22.96 tone/ha) was recorded in Neem cake treated plots where lowest disease incidence (6.94 %) was recorded and second highest yield (22.79 tonne/ha) was recorded in sesamum cake treated plots where the disease incidence was 8.33 %. Among the all organic amendments treated plots the lowest yield (21.72 tonne/ ha) was recorded in goat manure treated plots where the disease incidence was also recorded highest (18.06 %) though among the all treatments the control plots was showed lowest yield (20.12 tonne/ha) with highest disease incidence of 25.00 %. In the second crop growing season of 2015-16 year, like first season the neem treated plots showed best result in respects of yield performance as well as disease control potentiality though all treatments showed significant increases of yield in respect of untreated control plots. Neem cake treated plots showed highest yield (22.83 tonne/ha) with lowest disease incidence of 8.33 % followed sesamum cake treated plots and mustard cake treated plots with production of 22.72 tone/ ha and 22.53 tone/ha where disease incidence was recorded 9.72 % and 11.11 % respectively. Among the treatments control plots showed lowest yield of 19.85 tonnes/ ha with highest disease incidence of 27.78 %. The pooled analysis of two year data evidenced that the all organic amendments possess significant yield increasing potentiality by reducing the disease incidence of collar rot. Neem cake gives best yield performance as well as disease control potentiality. The pooled analysis also evidenced that the cakes has better yield increasing potentiality as well as disease reducing potentiality than the compost manure. Khan, *et al*., [28] stated that the liberation of ammonia from the decomposition of oil cakes meant for the inhibitory effect on pathogen activities and provide avenue for the better growth as well as the improvement of the tomato yield. The organic fertilizers provide the nutritional requirements of plants and also suppress the plant pest's populations. Additionally, they increase the microbial activity in soil, anion and cation exchange capacity, organic matter and carbon-content of soil. Organic fertilizers increase the yield and quality of agricultural crops in ways similar to inorganic fertilizers [11, 29-33].

Conclusion

Based on the investigation, it may conclude that amendments of soil with organic materials have tremendous effect on enhancing the tomato yield as it reduces the incidence of collar rot up to a considerable level. It also releases nutrients slowly and improve the soil health by increasing the beneficial soil micro-flora. This is an eco-friendly approach can be used as an alternative management strategy for combating the menace.

Application of research: The findings of this research will be applicable at farmer's level to sustainable manage the collar rots disease of tomato and also it will be play important role in organic farming.

Research Category: Organic amendments, sustainable management of tomato collar rot.

Abbreviations: FYM - Farm Yard Manure, SMS - Spent Mushroom Substrate, AUDPC - Area Under Disease Progress Curve, "r" value apparent rate of infection.

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References

[1] Gogoi N.K., Phookan A.K. and Narzary B.D. (2002) *Indian Phytopathology*, 55(2), 238-240.
[2] Khan R.U. and Kolte S.J. (1989) *Indian Phytopathology*, 55 (1), 102-103.
[3] Madhavarao P. and Singh T.K.S. (1979) *Indian Phytopathology*, 32, 481-482.
[4] Hari B.V.S.C., Chiranjeevi V., Sitaramaiah K. and Subramanyam K. (1991) *Indian Journal of Mycology and Plant Pathology*, 21, 27-33.
[5] Mahato A. and Mondala B. (2014) *J. Chem. Bio. Phy. Sci. Sec. B*, 4 (4), 3334-3344.
[6] Punja Z.K. (1985) *Annual Review of Phytopathology*, 23, 97-127.
[7] Aycock R. (1966) *Tech. Bull. No.174. Agric. Expt. Station, North Carolina State University, Raleigh*. 202.
[8] Begum S.N., Chowdhury B.C. and Ahamed H.U. (1985) *1st National Conf. Plant Pathology, held at Bangladesh Agricultural Research Institute, Joydebpur, Gazipur,* 12.
[9] Davey C.B. (1996) *In: National proceedings, Forest and Conservation Nursery Associations; Landis TD, Douth DB (tech. cords). General Technical Report PNW-GTR-389, USDA Forest Service PNWRS, Portland, OR, USA pp*: 6-18.
[10] Lumsden D.R., Lewis J.A. and Papavizas G.C. (1983) In: *Environmentally Sound Agriculture (Ed.): W. Lockeretz, Praeger, New York*, 51-70.
[11] Bulluck L.R. and Ristaino J.B. (2002) *Phytopathology*, 92, 181-189.
[12] Linderman R.G. (1989) *Canadian Journal of Plant Pathology*, 11, 180-183.
[13] Gamliel A. & Stapleton J.J. (1993) *Phytopathology,* 83, 899-905.
[14] Vander Plank J. E. (1963) *Acad. Press, NY,* 349.
[15] Pandy H.N., Menon T.C.M. and Rao M.V. (1989) *Rachis*, 8 (2) 38-39.
[16] Gurjar R.B.S., Bansal R.K. and Gupta R.B.L. (2003) *Journal of Mycological Plant Pathology*, 33(3), 482.
[17] Gautam M. and Kolte S.J. (1978) *Indian Phytopath*. 31, 120-121.
[18] Waghe S.V. and Lanjewari R.D. (1981) Oilseeds J. pp. 66-73.
[19] Kulkarni S. A., Kulkarni S. and Kulkarni S. (1995) *Current Res., Univ. Agric. Sci. Bangalore*, 24(8), 135-136.
[20] Karthikeyan A. and Karunidhi K. (1996) Plant Dis. Res. 11(2),180-181.
[21] Johnson M., Subramanyam K., Balaguravaiah D. and Sudheer M. J. (2003) *Ann. Pl. Prote. Sci*., 11(1), 83-85.
[22] Patra S., Biswas M.K. and Mahato A. (2017) *Int. J. Pure App. Biosci*. 5(1), 526-529.
[23] Merill R., Hoberecht K. and McKeon J. (1998) *Organicteas from compost and Manures. Organic Farming Research Foundation. P.O. Box 440 Santa Cruz.*
[24] Amanullah M.M., Somasundaram E., Alagesan A. and Vaiyapuri K. (2006) *Internat. J. agric. Sci*., 3 (1), 181-186.
[25] Singh H.R. and Singh S.D. (2004) *Agrobios Newsletter*, 2(12), 21-22.
[26] Cheuk K. (2005) *Food Contaminants, and Agricultural Wastes*, 40(3), 449 - 461.
[27] Paplomatas J. (2005) *European J. Plant Pathol*, 112(2), 183-189.
[28] Khan M.W., Khan A.M. and Saxena S.K. (1973) *Acta Botanica Indica*, 1,49-54.
[29] Singh R.S. and Sitaramaiah K. (1970) *Int. J. Pest Manage*, 16(2), 287-297.
[30] Arancon N.Q., Edwards C.A., Bierman P., Metzger J.D., Lee S. and Welch C. (2004) *Pedobiologia*, 47(5-6), 731-735.
[31] Heeb A., Lundegardh B., Savage G. P. and Ericsson T. (2006) *J. Plant Nut. Soil Sci*.,169, 535-541.
[32] Liu B., Gumpertz M.L., Hu S. and Ristaino J. B. (2007) *Soil Biol. Biochem*., 39, 2302-2316.
[33] Tonfack L.B., Bernadac A., Youmbi E., Mbouapouognigni V. P., Ngueguim M. and Akoa A. (2009) *Fruits*, 64, p. 167–177.