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Organic management of soft rot of ginger (*Zingiber officinale*) in Sikkim Himalayan region

R GOPI[1], H KALITA[2] and R K AVASTHE[3]

ICAR Research Complex for NEH Region, Sikkim Centre, Tadong, Gangtok 737 102

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ABSTRACT

Soft rot is one of the most important diseases of ginger (*Zingiber officinale* Rose.) in Sikkim. Experiment was conducted during 2011-12 and 2012-13 to study the effect of various organic treatments on the incidence of soft rot, germination and yield of ginger. In the survey the highest incidence of soft rot was observed in South district 30.0 and 25.7%, respectively, during 2011-12 and 2012-13, whereas lowest incidence of disease was observed in North district (10.0 and 9.7%, respectively). In the *in vitro* study, garlic @ 10% concentration was found to be the most effective in reducing the growth of the soft rot pathogen with 62.3% inhibition. Among the 10 selected *Trichoderma* isolates, *Trichoderma harzianum* collected from Todaybusty, South Sikkim was the most effective in reducing the *Pythium aphanidermatum* colony growth (72.0%). Among the treatments evaluated against the soft rot, the hot water treatment @ 47°C for 30 min + *T. harzianum* + three periodic drenching of COC @ 0.3 % at 20 day interval was found effective with the lowest average per cent incidence (16.7 and 15.0) followed by hot water treatment @ 47°C for 30 min + neem cake @ 2 tonnes/ha + COC 0.3%. The hot water treatment @ 47°C for 30 min + *T. harzianum* + COC @ 0.3 %, recorded maximum germination (91.3 and 90.3%) and highest yield (158 and 126 q/ha)

Key words: Ginger, Management, *Pythium*, Sikkim, Soft rot

Ginger is cultivated in several parts of the world. In India, ginger is produced in Odisha, Kerala, Karnataka, Arunachal Pradesh, West Bengal, Sikkim and Madhya Pradesh (Kumar *et al*. 2008). Ginger (*Zingiber officinale* Rosc.), is one of the most important spice crops of Sikkim followed by large cardamom. It is cultivated in 9 300 ha producing 52 110 tonnes of fresh ginger in Sikkim (Anonymous 2014). It is cultivated as a monocrop or intercropped with maize and mandarin orange in Sikkim. There are various diseases like soft rot (*Pythium* spp), bacterial wilt (*Ralstonia solanacearum*), leaf spot (*Phyllosticta zingiberi*) and Fusarium yellow (*Fusarium* spp.), have been reported in Sikkim (Avasthe *et al*. 2014). Among them, soft rot is a major disease causing heavy yield loss to ginger crop worldwide. Soft rot is caused mostly by *Pythium aphanidermatum* but other species like *P. deliense, P. myriotylum*, *P. pleroticum*, *P. vexans* and *P. ultimum* were also reported by many workers from different states (Sarma 1994). This pathogen is both seed and soil borne (Bhai *et al*. 2005). The pathogen causes yellowing of leaves and rotting of rhizome in infected plant (Bhai *et al*. 2005). Rajan *et al*. (2002) reported that soft rot pathogen caused 85.36% death of inoculated plants under pot culture study in Sikkim. Srivastava (1994) reported 40-50% or even more loss of yield in case of poorly managed soil in Sikkim. Disease management involves measures that effectively suppress the pathogen through cultural, biological and chemical methods (Dake and Edison 1988, Sarma 1994).The entire spectrum of commercial ginger germplasm available today is highly susceptible to this disease. Various systemic chemicals like Carbendazim (0.1%), Ridomil MZ (0.2%), Topsin M (0.2%) are used to control the disease. The chemicals are costly and also hazardous to the environment as well as the quality of the ginger (Tarafdar and Saha 2007). It may lead to development of resistance in the pathogen when compared to contact fungicides like copper and sulphur compounds. Keeping these facts in view, the present study was undertaken to study the effect of botanicals, biocontrol agents and organically permitted fungicides on soft rot pathogen *Pythium aphanidermatum* and effect of different organic treatments on the incidence of soft rot, germination per cent and yield of ginger under field conditions.

MATERIALS AND METHODS

Surveys were conducted for soft rot during 2011-12 and 2012-13 in different ginger growing areas of Sikkim. Infected ginger plants along with rhizome were collected. Tissue bits were surface sterilized with 5% sodium hypochlorite for 5 min and subsequently three washings

[1]Scientist (SS) (e mail: ramaraj.muthu.gopi2@gmail.com), [2]Principal Scientist (e mail: drhkalita@yahoo.co.in), [3]Joint Director (e mail: ravisikkim@yahoo.co.in).

with sterile distilled water. Then, they were placed on potato dextrose agar medium (PDA) supplemented with pimaricin, vancomycin and PCNB and incubated at the laboratory conditions at 25 ± 1°C for five days. The fungi were purified separately by transferring the tip of the mycelia into PDA slants and maintained as stock cultures for further studies.

Fresh plant parts of different plant species were collected and washed with distilled water, shade dried and crushed in sterile water @ 1 gm/ml of water. This constituted 100% of the extract. The plant extracts of 5 and 10% was prepared by adding appropriate amount of the extract in PDA. *In vitro* antifungal efficacy of crude aqueous extracts against *Pythium aphanidermatum* was determined by Poisoned Food Technique (Groover and Moore 1962). Radial growth of mycelium was measured 5 days after inoculation. Experiment was repeated twice and mean of the readings were taken for calculations. The per cent inhibition of the fungus in treatments was calculated using the following formula: Inhibition of mycelial growth (%) = (C–T/C) ×100 where,'C' is average diameter of fungal colony in control plates.'T' is the average diameter of fungal colony in poisoned plates (Gupta and Tripathi 2011).

Rhizosphere soil from healthy ginger plants was collected from different locations. The identified *Trichoderma* antagonists were isolated by serial dilution technique using *Trichoderma* selective medium (TSM). The cultures were maintained on PDA at pH 6.0 at 28±1°C. Sub culturing was done periodically to maintain the purity of the cultures. Dual culture method was performed for screening the antifungal efficacy of *Trichoderma* isolates against soft rot pathogen. Three replicated plates for each treatment was maintained and incubated at 25±1°C. I= C.T/C x 100, where, I is the per cent inhibition and C and T are the radial growth of the pathogen in control and treatment, respectively.

Field experiments were carried out during 2011-12 and 2012-13 at ICAR Sikkim Centre, Tadong, Gangtok, in naturally infected field to evaluate the efficacy of different treatments against soft rot disease. Experiment was laid out in RBD design along with 10 treatments and each treatment was replicated thrice. Other standard organic practices like weeding, irrigation, manuring to raise the crop were followed as per recommendations. A highly susceptible ginger cultivar, *Bhaisey* was planted by maintaining a spacing of 50 × 20 cm plant to plant and row to row in a plot size of 6 m^2. The treatment consisted of garlic bulb extract @ 10% (rhizome treatment + soil drenching), talc based *Trichoderma harzianum* (rhizome treatment 5% + soil application), chilouney (*Schima wallichii*) leaf extract @ 10% (rhizome treatment+ soil drenching), neem cake @ 2 tonnes/ha, hot water treatment (HWT) @ 47°C for 30 min, HWT followed by three periodic drenching of COC @ 0.3% + *Trichoderma harzianum* (2.5 kg/50 kg of FYM), HWT + neem cake @ 2 tonnes/ha followed by periodic drenching of COC @ 0.3%, COC @ 0.3% (rhizome treatment + soil drenching) and untreated control and Ridomil (rhizome treatment and drenching) as positive control. Plant extracts were used for both rhizome treatment and soil drenching. Rhizomes were dipped for 30 min in different plant extracts, biocontrol and COC before planting. The treated rhizomes were shade dried overnight at room temperature before planting. The plant extracts, biocontrol agents and COC were drenched thrice starting with the disease initiation at 20 days interval. The observations on germination per cent, per cent disease incidence and yield of different plots were recorded. The per cent disease incidence was calculated by counting the diseased and healthy plants. The data obtained in the study for various parameters were subjected to ANOVA for a Completely Randomized Design (CRD) and Randomized Block Design (RBD).

RESULTS AND DISCUSSION

Surveys were conducted at different villages covering all four districts of Sikkim, viz. AhoYangtham, Sajong, Rey, Assam Lingzey, Pacheykhani, Sirwani, Ranka and Rumtek of East Sikkim, Chukung, Gyalsing, Hee-Bermiok and Soreng of West Sikkim, Kabi, Hee-Gyathang, Pashingdong Mangan and Lingdong of North Sikkim and Bermiok, Namchi, Namthang, Tarku, Todaybusty of South Sikkim. Disease incidence was recorded in almost all the surveyed fields of all four districts. The highest incidence of rhizome rot was observed in South district 30.0% and with 25.7%, respectively, in 2011-12 and 2012-13, whereas the lowest incidence of disease was observed in North district (10.0 and 9.7%, respectively). The high incidence might be attributed to heavy rains, improper drainage and virulent nature of pathogen, besides the use of infected rhizomes for cultivation by farmers (Dohroo *et al*. 2015). The infected rhizomes were collected from different ginger growing areas of the state. The fungal pathogen was isolated on Potato Dextrose Agar (PDA) medium and identified as *Pythium aphanidermatum*. Pathogen produced cottony, colourless, coenocytic, profused aerial mycelium with sporangia.

The fungicidal activity of some plant extracts in controlling *Pythium* spp. has been well documented both *in vitro* and *in vivo* conditions (Parveen and Sharma 2014). Plant extracts like garlic (*Allium sativum*), onion (*A. cepa*), titepati (*Artemisia vulgaris*), chilouney (*Schima wallichii),* banmara (*Chromolaena odorata),* tulsi (*Ocimum sanctum*), marigold (*Tagetes erecta*), pudina (*Mentha arvensis*) and *Lantana camara* at 5 and 10% concentration were tested against *Pythium aphanidermatum* by Poisoned Food Technique *in vitro*. It was found that garlic @ 5 and 10% concentration were found to be most effective (Table 1) in reducing the growth of the soft rot pathogen with 44.3 and 62.3% inhibition, respectively. Antifungal properties of *A. sativum* reported by many workers (Singh *et al*. 1979, Singh and Singh 1980). Kurucheve and Padmavathi (1997) reported that *Allium sativum* bulbs (10%) recorded the minimum mycelial growth (176.0 mg). Sivaprakash *et al*. (2012) reported that among the plant species tested, bulbs of *A. sativum* (10%) and *Allium cepa* var. *aggregatum* (20%), leaves of *Lawsonia inermis, Piper betle* (20% each), *Eucalyptus globulus* and *Vitex negundo* (40% each) exhibited complete inhibition of the mycelial growth

Table 1 *In vitro* efficacy of plant extracts on the *Pythium aphanidermatum*

Common	Botanical name	Per cent inhibition over control	
		5%	10%
Onion	*Allium cepa*	29.3(32.7)	40.7(39.6)
Titepati	*Artemisia vulgaris*	23.0(28.6)	29.3(32.8)
Banmara	*Chromolaena odorata*	19.7(26.2)	26.7(31.0)
Chilouney	*Schima wallichii*	41.0(39.8)	56.0(48.5)
Garlic	*Allium sativum*	44.3(41.7)	62.3(52.2)
Tulsi	*Ocimum sanctum*	26.3(30.8)	35.0(36.3)
Marigold	*Tagetes erecta*	15.3(23.0)	24.3(29.5)
Pudina	*Mentha arvensis*	12.3(20.5)	19.7(26.3)
Lantana	*Lantana camara*	29.0(32.6)	37.0(37.5)
LCD (P= 0.05)		4.6	4.4

Table 2 *In vitro* efficacy of *Trichoderma* spp. against *Pythium aphanidermatum*

Trichoderma isolates	Place of collection	Per cent inhibition over control(%)
Trichoderma harzianum	Todaybusty	72.0(58.1)
Trichoderma asperellum	Bermiok	62.3(52.2)
Trichoderma harzianum	ICAR	45.7(42.5)
Trichoderma harzianum	Pangthang	54.0(47.3)
Trichoderma harzianum	Tarku	52.7(46.5)
Trichoderma harzianum	Namthang	50.0(45.0)
Trichoderma harzianum	Hee-gyathang	49.7(44.8)
Trichoderma harzianum	Pacheykhani	44.0(41.5)
Trichoderma harzianum	ICAR	48.3(44.0)
Trichoderma harzianum	ICAR	50.7(45.4)
LCD (P= 0.05)		4.9

of *P. aphanidermatum*. Zagade *et al*. (2012) reported that the Zimmu (*Allium sativum* L. × *Allium cepa* L.) leaf extract had significant inhibitory effect against mycelial growth of *P. aphanidermatum*.

Rhizosphere soil from different ginger growing areas of Sikkim was collected and *Trichoderma* was isolated from the rhizosphere soil. Among them 10 *Trichoderma* isolates were selected for studying the *in vitro* efficacy of antagonists against *Pythium aphanidermatum* (Table 2). The *Trichoderma harzianum* collected from Today busty was the most effective in reducing the *Pythium aphanidermatum* colony growth (72.0%). Many microbial antagonists have been reported to possess antagonistic activities against plant fungal pathogens (Manasa *et al*. 2013). Dohroo *et al*. (2015) also reported that among the various biocontrol agents evaluated against *Pythium aphanidermatum*, *T. harzianum* was the most effective in reducing the growth of the pathogen. *T. harzianum* isolated from Sikkim was found effective in control of ginger diseases (Rajan *et al*. 2002). Kannahi *et al*. (2016) reported the effectiveness of various *Trichoderma* species like *T. koningii*, *T. virens*, *T. harzianum* and *T. viride* on the *Pythium aphanidermatum* under *in vitro* conditions.

Under field conditions, 10 different treatments were evaluated against soft rot of ginger during 2011-12 and 2012-13. The disease incidence and the effect of germination by the various treatments were studied. In the year 2011-12, among the treatments studied, HWT+ *Trichoderma harzianum* (2.5 kg/50 kg of FYM) followed by three periodic drenching of COC 0.3% recorded the highest germination (91.3%). The lowest germination was observed in untreated control (71.3%). In 2012-13 also, HWT+ *Trichoderma harzianum* (2.5 kg/50 kg of FYM) followed by three periodic drenching of COC @ 0.3% showed highest germination (90.3%).

Among the treatments evaluated, the HWT+ *Trichoderma harzianum* (2.5 kg/50 kg of FYM) followed by three periodic drenching of COC @ 0.3% was effective with lowest per cent incidence of disease 16.7% and 15.0%, respectively for the year 2011-12 and 2012-13 and followed by HWT + neem cake @ 2 tonnes/ha followed by periodic drenching of COC @ 0.3% with 21.3 and 20.7% (Table 3). The treatments were found significant and highest yield of 158 and 126 q/ha, respectively, for the year 2011-12 and 2012-13 was recorded in ginger treated with HWT+ *T. harzianum* (2.5 kg/50 kg of FYM) followed by three periodic

Table 3 Effect of different organic treatments on the germination, yield and disease incidence in ginger

Treatment	Germination (%)		Per cent incidence		Yield (q/ha)	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Garlic 10%	88.0(69.9)	89.0(71.0)	36.3(37.1)	38.3(38.2)	75	62
Chilouney 10%	87.7(69.5)	77.0(61.4)	43.3(41.2)	45.3(42.3)	50	47
Neem cake 2 tonnes/ha	83.0(64.9)	80.0(63.4)	30.0(33.2)	33.3(35.2)	54	47
Trichoderma harzianum 5% + 2.5 kg/ha soil application	82.0(57.7)	85.7(67.9)	31.0(33.8)	27.3(31.5)	96	92
Hot water treatment (HWT)	84.3(66.8)	83.3(66.0)	25.7(30.4)	22.0(27.9)	93	56
HWT+ *T.harzianum*+COC 0.3%	91.3(91.3)	90.3(71.9)	16.7(24.1)	15.0(22.7)	158	126
HWT+ neem cake+COC 0.3%	91.0(72.6)	88.00(69.8)	21.3(27.5)	20.6(27.0)	114	104
COC 0.3%	84.7(67.1)	88.00(69.8)	22.3(28.2)	23.3(28.9)	103	95
Ridomil 0.1%	88.0(69.8)	90.00(71.6)	11.3(19.5)	11.00(19.35)	164	142
Control	71.3(57.7)	75.3(60.3)	57.7(49.4)	54.7(47.7)	43	39
LCD (P= 0.05)	4.5	5.0	3.9	3.0	12	11

drenching of COC @ 0.3% followed by HWT + neem cake 2 tonnes/ha followed by periodic drenching of COC @ 0.3% (114 and 104 q/ha). The results were in line with the findings of Dohroo *et al*. (2015) who reported that the application of hot water rhizome treatment at 47ºC for 30 min in combination with *T. harzianum* followed by three drenching of Mancozeb was most effective in limiting the disease. Amaresh *et al*. (2004) also reported that the application of 2 tonnes neem cake/ha and seed treatment with 0.3% copper oxychloride on occurrence of rhizome rot of ginger caused by *P. aphanidermatum* was effective and increased crop yield.

Copper oxychloride was found most effective in the control of root rot and mortality in ginger (Rajan *et al*. 2002) due to various pathogens including *Pythium* spp. Lalfakawma *et al*. (2014) reported that the highest yield (3.55 kg/plot) was observed in plots with copper oxychloride rhizome seed treatment followed by copper oxychloride + neem extract rhizome seed treatment. In the field experiment, seed of rhizomes dipped in copper fungicides like 0.2% copper oxychloride, 1% Bordeaux mixture were effective in the reduction of ginger rhizome rot caused by *P. aphanidermatum* and increased yield (Jayasekhar *et al*. 2001). The effect of hotwater treatment in the management of ginger rhizome rot was reported by various workers (Dominques 2006, Dohroo *et al*. 2015). Basistha and Homan (2015) also reported the effectiveness of hot water treatment @ 50ºC for 30 min and *Trichoderma* seed and soil treatment on controlling soft rot in ginger.

The effectiveness of biocontrol agents in the management of rhizome rot has been well documented (Dohroo *et al.* 2012, Subba 2009). Rajan *et al*. (2002) also reported that *T. harzianum* controlled rhizome rot, root rot and mortality caused by both fungal and bacterial pathogens. Anup and Bhai (2014) reported the promising *Trichoderma* isolates for the management of rhizome rot of turmeric. In our study, it was observed that the individual effect of *T. harzianum*, hot water treatment or COC was lesser than the combined effect. Dohroo *et al*. (2015) also reported that rhizome seed treatment either alone with cow urine or hot water was ineffective in limiting rhizome rot in ginger. The plant extracts which were more effective under *in vitro* conditions were found to be less effective under field conditions. This may be due to high rainfall in Sikkim favours fast multiplication and spread of the pathogen and also makes the plant extracts less effective.

Among the treatments tested against soft rot or rhizome rot disease of ginger, seed treatment with hot water (47ºC for 30 min) and *T. harzianum* (2.5 kg/50 kg FYM/ ha) and soil application of copper oxychloride @ 0.3% were found effective in eco-friendly disease management with maximum fresh rhizome production. Therefore, both seed and soil treatments along with fungicide application will be the best option for the management of soft rot in ginger. These treatments could be combined to give more encouraging result in soft rot control in field conditions besides increased germination.

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REFERENCES

Amaresh Y S, Raveendra B H and Divatar A B. 2004. Effect of organic amendments on rhizome rot of green ginger (*Zingiber officinale* R.). *Advanced in Plant Science* **17**(2): 537–9.

Anonymous. 2014. Indian Spices Statistic. Ministry of Commerce and Industry, Govt. of India.

Anoop K and Bhai R. 2014. Evaluation of antagonistic potential of indigenous Trichoderma isolates against *Pythium aphanidermatum* (Edson) fitz. causing rhizome rot in turmeric (*Curcuma longa* L.). *Journal of Science* **4**(2): 99–105.

Avasthe R K, Pradhan Y and Bhutia Khorlo. 2014. *Handbook of Organic Crop Production in Sikkim,* p 408. Sikkim Organic Mission, Government of Sikkim, Gangtok, Sikkim and ICAR Research Complex for NEH Region, Sikkim Centre, Gangtok, Sikkim, India.

Basistha A and Homan R. 2015. Evaluation and selection of appropriate management package of ginger rhizome rot disease in field condition. *IOSR Journal of Agriculture and Veterinary Science* **8**(6): 53–6.

Bhai R S, Kishore V K, Kumar A, Anandaraj M and Eapen S J. 2005. Screening of rhizobacterial isolates against soft rot disease of ginger (*Zingiber officinale* Rosc.). *Journal of Spices and Aromatic Crops* **14**(2): 130–6.

Dake G N and Edison S. 1988. Survey for disease incidence in major ginger growing areas of Kerala during 1984 and 1985. *Journal of Plantation Crops* **16:** 55–7.

Dohroo N P, Kansal S and Ahluwalia N. 2012. Status of soft rot of ginger (*Zingiber officinale* Roscoe). Department of Vegetable Science Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh.

Dohroo N P, Kansal S and Ahluwalia N. 2015. Studies on eco-farmer-friendlly practices for management of soft rot of ginger (*Zingiber officinale*). *Indian Phytopathology* **68**(1): 93–6.

Dominques F. 2006. 'Physical and biological control of *Fusarium oxysporum* f sp *Zingiberi* in ginger'. Master's thesis, Universidade de sao Paulo, Brazil, 246 p.

Groover R K and Moore J D. 1962. Toxicometric studies of fungicides against the brown rot organism *Sclerotinia fructivola* and *S. laxa*. *Phytopathology* **52**: 876–80.

Gupta S K and Tripathi S C. 2011. Fungitoxic activity of *Solanum torvum* against *Fusarium sacchari. Plant Protection Science* **47**(3): 83–91.

Jayasekhar M, Joshua J P and Pillai O A A. 2001. Management of rhizome rot of ginger caused by *P. aphanidermatum*. *Madras Agrilculture Journal* **87**(1/3): 170–1.

Kannahi M U, Dhivya and Senthil Kumar R. 2016. Biocontrol efficacy of *Trichoderma* sps against rhizome rot disease of *Zingiber officinale* Rosc. *International Journal of Pharmaceutical Sciences Review and Research* **36**(1): 63–6.

Kumar A, Reeja S T, Bhai R S and Shiva K N. 2008. Distribution of *Pythium myriotylum* Drechsler causing soft rot of ginger. *Journal of Spices and Aromatic Crops* **17**(1): 5–10.

Kurucheve V and Padmavathi R. 1997. Fungitoxicity of selected

plant products against *Pythium aphanidermatum*. *Indian Phytopathology* **50**(4): 529–35.

Lalfakawma C, Nath B C, Bora, C. Srivastava S and Singh J P. 2014. Integrated disease management of *Zingiber officinale* rosc. Rhizome rot. *Bioscan* **9**(1): 265–9.

Manasa M, Kambar Y, Pallavi S, Vivek M N, Onkarappa R and Prashith Kekuda T R. 2013. Biocontrol potential of *Streptomyces* species against *Fusarium Oxysporum* f.sp. *Zingiberi* (causal agent of rhizome rot of ginger). *Journal of Advanced Scientific Research* **4**(4): 16–3.

Parveen T and Sharma K. 2014. Management of "Soft Rot" of ginger by botanicals. *International Journal of Pharmacy and Life Sciences* **5**(4): 3 478–84.

Rajan P P, Gupta S K, Sarma Y R and Jackson G V H. 2002. Diseases of ginger and their control with *Trichoderma harzianum*. *Indian Phytopathology* **55**(2): 173–7.

Sarma Y R. 1994. Rhizome rot disease of ginger and turmeric. *(In)* Advances in Horticulture, Vol.10. Plantation and Spices Crops, Part-2 pp 1 113–38. Chadha K L and Rethinam P (Eds.) Malhotra Publication House, New Delhi.

Singh H B and Singh U P. 1980. Inhibition of growth and sclerotium formation in *Rhizoctonia solani* by garlic oil. *Mycologia* **72**: 1 022–5.

Singh U P, Pathak, K K, Khare, M N and Singh R B. 1979. Effect of leaf extract of garlic on *Fusarium oxysporum* f.sp.*ciceri* and *Sclerotinia sclerotiorum* on gram seeds. *Mycologia* **71**: 556–64.

Sivaprakash K, Senthil M, Raja J, Kurucheve V and Sangeetha G. 2012. Evaluation of natural products for the management of damping-off of tomato incited by *Pythium aphanidermatum* (Edson) fitz. *Acta Phytopathologica et Entomologica Hungarica* **47**(1): 17–33.

Srivastava L S. 1994. Management of soft rot of ginger in Sikkim.*Plant Disease Research* **9**(2): 147–9.

Subba J R. 2009. Indigenous knowledge on bio-resources managementfor livelihood of the people of Sikkim. *Indian Journal of Traditional Knowledge* **8**(1): 56–64.

Tarafdar J and Saha N. 2007. Correlation study on population dynamics of ginger soft rot inciting pathogens under different organic amendments, disease incidence and its survival in Darjeeling hill soils. Proceedings of the 13th ISTRC Symposium, 2007, pp 165–9.

Zagade S N, Deshpande G D., Gawade D B, Atnoorkar A A and Pawar S V. 2012. Biocontrol agents and fungicides for management of damping off in chilli. *World Journal of Agricultural Sciences* **8**(6): 590.