Management of rhizome rot disease of ginger using eco-friendly natural products

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ABSTRACT
Rhizome rot caused by *Pythium* spp and *Fusarium* spp is one of the most devastating diseases of ginger in most of the ginger growing areas of the Nepal. Realizing the context for development of alternative control strategies to reduce dependency on synthetic fungicides, a field experiment on management of rhizome rot disease of ginger using eco-friendly natural products was conducted at GRP, Kapurkot, Salyan during 2012/2013. Fresh and fermented extract of *Artemisia vulgaris* Linn (Titepati), *Urtica dioica* (Sisnoo), *Zanthoxylum armatum* DC. (Timbur), *Allium cepa* L., (Onion), *Allium sativum* L. (Garlic), *Capsicum annuum* L. (Chili), *Nicotiana tabacum* (Tobacco) along with Jeevatu (a mixed product of beneficial microbes) and biofit were tested in the experiment. Experiment was conducted in the naturally inoculated sick plot in RCB design with eight treatments replicated thrice. Each experimental plot area was 3m x 1.5m (4.5m²). Observation on plant number, tiller clump1, plant height, disease incidence, fresh rhizome yield, disease rhizome yield and mother rhizome yield were recorded and evaluated using statistical analysis tool MSTAT-C. Fresh rhizome yield for all the treatments were found lower than national average. Jeevatu (5%) treated plot had highest fresh rhizome yield (7.70 m t ha⁻¹) followed by (onion+garlic+chili) + urine (1:3) fermented extract (4.88 m t ha⁻¹). Similarly, rhizome rot scale (1.66), disease incidence (41.96%) and the diseased rhizome yield (0.74 m t ha⁻¹) was shown least on jeevatu treated plot. Highest disease rhizome yield (2.37 m t ha⁻¹) was obtained in the treatment titepati + urine (1:2) fermented extract followed by control (2.07 m t ha⁻¹).

Key words: Anti fungal, Botanical extract, Ginger, Rhizome rot.

INTRODUCTION
Ginger (*Zingiber officinale* rose L.) is a very important rhizomatous spice crop which belongs to family Zingiberaceae. It has also been used as antimicrobial, antioxidant, anti-inflammatory agents. Nepal occupies fourth position in terms of ginger production in the world after India China and Indonesia, respectively (Poudyal, 2011). Demand of ginger is increasing each year throughout the world due to its diverse products and medicinal value (FAO, 2009). The national average productivity of ginger in Nepal is low (11.40 mt ha⁻¹) as compared to its production potentiality. There are more than dozens of diseases affecting ginger but rhizome rot is one of the most destructive diseases of ginger worldwide (Dohroo, 2005) with losses up to 50–90%. Rhizome rot of ginger caused by pathogens like *Pythium aphanidermatum, Fusarium solani* etc are major constraints for the production of healthy rhizome, sometimes causing total failure of crop (Fageria *et al.*, 2006; Poudyal, 2012). Symptoms may occur at any stage of crop growth, in mature plants, infection takes place through roots or via the collar region, with the first aboveground symptoms being leaf yellowing at the tips of lower leaves and the collapse of affected shoots. Belowground, water-soaked lesions appear on the developing rhizome near the base of affected shoots, and under suitable environmental conditions, the rhizome then rots rapidly and is eventually destroyed (Dohroo, 2005). Chemical control of this pathogen is not economical because of high cost of chemicals, breakdown of resistance, environmental pollution, toxicological problems, deleterious effect to non target beneficial soil micro-organism and ultimately the choice of the consumers for the organic product. The problems associated with the use of hazardous chemicals for plant disease control has received increasing attention worldwide because it causes health hazards, environmental pollution, pathogens become resistant to chemical pesticides and ecological imbalances may occur (Fry 1982). The presence of antifungal compounds in higher plants has long been recognized as an important factor in disease resistance (Mahadevan, 1982). They are far low toxic to non-target organisms, biodegradable and environmentally safe (Neupane, 2003). Such compounds, being biodegradable and selective in their toxicity, are considered valuable for

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controlling some plant diseases (Singh and Dwivedi, 1987). Although there is a growing interest in the use of medicinal plants to control the plant diseases, only about 2,400 plant species among more than 250,000 higher plants have been screened for the phytoactivity (Oluwalana and Adekunle, 1998; Oluwalana et al., 1999; Khafagi and Dewedar, 2000). Plant metabolites and plant based pesticides appear to be one of the better alternatives in plant disease management, as they are known to have minimal harmful impact on the environment and danger to consumers in contrast to the synthetic pesticides (Varma and Dubey, 1999). The popularity of botanical pesticides is once again increasing and some plant products are being used globally as green pesticides as the plant extracts are biodegradable. Biological control comprises various technologies of which one option is the use of botanical products. Many kinds of plant species and technologies have been used in the production of botanical pesticides. *Azadirachta indica* and *Agave americana* were most effective in reducing mycelial growth of *Fusarium oxysporum f.sp. zingiberi* and *P. aphanidermatum* (Sharma, 1998). Some but not many of the plant-based pesticides have already become established plant protection products (Isman, 2006). Thus the natural products including botanicals and beneficial micro-organisms may offer a practical and economical alternative for eco-friendly management of this disease. Nowadays, the pesticide residues in the agricultural commodities are issue in food safety aspects by several imported countries. In the future the use of pesticides will be tightly regulated because of well-documented environmental risks in the use of synthetic chemicals.

Therefore, there is an urgent need to develop alternative control strategies to reduce dependency on synthetic fungicides for managing the rhizome rot disease of ginger. Realizing the context, a field experiment was conducted for the management of rhizome rot disease of ginger using eco-friendly natural products.

**MATERIALS AND METHODS**

**Experimental Site:** The experiment was carried out during 2012/2013 at Ginger Research Program, Kapurkot (1480masl), Salyan district of Nepal for the management of rhizome rot disease of ginger using eco-friendly natural products. Experiment was conducted in the naturally inoculated sick plot.

**Sources of experimental materials:** Fresh or dried plant materials were used as a source for the extraction of fresh and fermented extract. Selected fungicidal plant materials namely *Artemesia vulgaris Linn* (*titepati*) leaves, *Urtica dioica* (*sisnoo*) stem and leaves, *Allium cepa* L., (*onion*) bulb, *Allium sativum* L. (*garlic*) bulb, *Capsicum annuum* L. (*chili*) fruit, *Zanthoxylum armatum* DC. (*timbur*) fruit were collected locally from Kapurkot area where the plants are available and cow urine was also obtained from the nearby area, whereas tobacco (*Nicotiana tabacum*) leaves, biofit and jeevatu were purchased from the market. Jeevatu is a mixed product of some beneficial microbes (*Lactic acid bacteria, Azotobacter*, Phosphorus solubilizing bacteria, Potasolubilizing bacteria, *Trichoderma*, Photosynthetic bacteria and yeast) formulated by Nepalese Farming Institute. It is non-poisonous to its users and thus safer to ecosystem services (Poudyal, 2012). Ginger variety Kapurkot Aduwa-1 produced at Ginger Research Programme, Kapurkot was used for planting.

**Experimental plot and plant geometry:** Experiment was laid out in RCB Design with eight treatments replicated thrice. Each experimental plot area was 3m x 1.5m (4.5m²) with row to row and plant to plant spacing of 30cm x 30cm respectively.

**Methods of plant extract preparation:** Commonly used botanicals namely *Artemesia vulgaris* Linn (*titepati*) leaves, *Urtica dioica* (*sisnoo*) stem and leaves, *Allium cepa* L., (*onion*) bulb, *Allium sativum* L. (*garlic*) bulb, *Capsicum annuum* L. (*chili*) fruits, were collected and washed thoroughly with tap water and cut into small pieces of about 2 mm x 2 mm in size and steeped in cow urine in a ratio 1:2 for both the botanical i.e. *titepati* (*Artemesia vulgaris* Linn) + urine and *sisnoo* (*Urtica dioica*) + urine where as mixture of same amount (by weight in kg) of *Allium cepa* L., (*onion*) + *Allium sativum* L. (*garlic*) + *Capsicum annuum* L. (*chili*) were macerated in a grinder and the grinded mixture was steeped at 1:3 proportions cow urine in a airtight clean plastic container and stirred well and covered it for 15 days at room temperature (25±2°C) for fermentation.
Similarly Nicotiana tabacum (tobacco) leaves (in kg) were mixed with water (in litre) at 1:8 proportions and Zanthoxylum armatum DC. (Timbur) fruit powder (in kg) and water (in litre) at 1:3 proportions in a clean plastic bucket, after steeping extract was obtained by squeezing and straining the content through a mosquito net. Both fresh and fermented extracts thus obtained were considered to be 100% in strength (stock solution) and sprayed immediately after dilution with water at 50% strengths. In case of biofit, solution was prepared by mixing with water @ 2.5gm l⁻¹ and jeevatu solution was prepared by mixing one litre of jeevatu in to 19 l of water.

**Application of the treatment:** Rigorous care has been done during the crop period, mulching immediately after planting and manual weeding was done during germination, 30 and 60 days after germination (DAG) respectively. Application of the solution in the field was started from one month after germination and continued for three times at fortnight interval. Application was done as soil drenching @ 5 l plot⁻¹ (100 ml plant⁻¹). 30 mt ha⁻¹ FYM and 75:50:50 kg NPK ha⁻¹ fertilizers were applied.

**Laboratory test:** Infected rhizome was collected, cut into small pieces, surface sterilized with 1% sodium hypo chlorite solution for 1 minute, washed thrice with sterilized distilled water and transferred aseptically on to the moist paper containing petriplates and Fusarium oxysporum incubated at 25±2°C for 48 hours in an incubator. Growth of pathogen was observed under stereo microscope and the pathogen was transferred into PDA test tube slants. Conidia from pure culture observed under compound microscope and identified as Fusarium oxysporum based on morphology of conidial shape.

**Observation and analysis:** Observation on plant number, tiller clump¹, plant height, initial stand, final stand, diseased rhizome yield, rhizome rot scale, disease incidence were found statistically non significant. Fresh rhizome yield for all the treatments were found lower than national average. However, Jeevatu (5%) treated plot had highest fresh rhizome yield (7.70 mt ha⁻¹) followed by Allium cepa L., (onion) + Allium sativum L. (garlic) + Capsicum annuum L. (chili) (1:3) fermented extract (4.88 mt ha⁻¹). Similarly, least fresh rhizome yield (0.22 mt ha⁻¹) was obtained in the treatment Urtica dioica (Sisnoo) + urine (1:2) fermented extract. Highest disease rhizome yield (2.37 mt ha⁻¹) was obtained in the treatment titepati (Artemesia vulgaris Linn) + urine (1:2) fermented extract followed by control (2.07 mt ha⁻¹). However, rhizome rot scale (1.66), disease incidence (41.96%) and the diseased rhizome yield (0.74 mt ha⁻¹) was shown least on Jeevatu treated plot. The highest mother rhizome yield (2.51 mt ha⁻¹) was found in the treatments Allium cepa L., (onion) + Allium sativum L. (garlic) + Capsicum annuum L. (chili) + urine (1:3) fermented extract and biofit (2%) both. Not a single treatment was found effective in control or lowered the disease incidence because all the treatment had statistically similar results for disease incidence compared to control (47.43%).

Natural products with pesticidal activity which are easily biodegradable, eco-friendly and can be locally produced, especially for the farmers who cannot afford expensive synthetic pesticides are being explored. Plant extracts have been reported to act as elicitors or induce defense mechanisms (Vidyasekaran, 1999). Plants possessing chemical derivatives are being identified by several workers (Renu et al., 1980, Annapurna et al., 1983). In this piece of research work, though the efficacy of different treatments was not significantly different, as all the treatment are statistically at par for disease incidence compared to control (47.43%). Jeevatu (5%) treated plot gave significantly higher result in rhizome yield (7.70 mt ha⁻¹) followed by Allium cepa L., + Allium sativum L. + Capsicum annuum L. + urine (1:3 in liter) fermented extract (4.88 mt ha⁻¹). The better result due to the application of Jeevatu may be due to toxins produced by Jeevatu microbes, repellent effect, anti-feeding effect, direct invasion on pathogenic microbes and killing. Poudyal (2012) have also found completely curing of soft rot after 10 times soil drenching (drenching at the rate of twice a week) with Jeevatu and Jeevatu based organic manure in combination of water (1:3 in liters). Effectiveness of

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\text{Disease Incidence (%)} = \frac{\text{Number of infected plants}}{\text{Total Number of the plants}} \times 100
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First observation was done at tiller initiation stage (after four month of sowing) while second and third observation were done at active tillering (fifteen days after first observation) and at the beginning of rhizome bulking stage (fifteen days after second observation).

**RESULTS AND DISCUSSION**

All the traits such as tiller clump¹, plant height, initial stand, final stand, diseased rhizome yield, rhizome rot scale, disease incidence were found statistically non significant. Fresh rhizome yield for all the treatments were found lower than national average. However, Jeevatu (5%) treated plot had highest fresh rhizome yield (7.70 mt ha⁻¹) followed by Allium cepa L., (onion) + Allium sativum L. (garlic) + Capsicum annuum L. (chili) (1:3) fermented extract (4.88 mt ha⁻¹). Similarly, least fresh rhizome yield (0.22 mt ha⁻¹) was obtained in the treatment Urtica dioica (Sisnoo) + urine (1:2) fermented extract. Highest disease rhizome yield (2.37 mt ha⁻¹) was obtained in the treatment titepati (Artemesia vulgaris Linn) + urine (1:2) fermented extract followed by control (2.07 mt ha⁻¹). However, rhizome rot scale (1.66), disease incidence (41.96%) and the diseased rhizome yield (0.74 mt ha⁻¹) was shown least on Jeevatu treated plot. The highest mother rhizome yield (2.51 mt ha⁻¹) was found in the treatments Allium cepa L., (onion) + Allium sativum L. (garlic) + Capsicum annuum L. (chili) + urine (1:3) fermented extract and biofit (2%) both. Not a single treatment was found effective in control or lowered the disease incidence because all the treatment had statistically similar results for disease incidence compared to control (47.43%).

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Jeevatu for the management of root knot nematodes of tomato, club root of cauliflower, late blight of tomato were also reported by Paudel, K.B. and Paudel A. (2010).

Among several botanicals and bio control tested against rhizome rot disease of ginger Jeevatu followed by Allium cepa L., + Allium sativum L. + Capsicum annuum L. + urine (1:3 in liter) fermented extract was found effective in rhizome rot disease management.

Thus, this research work confirms that Jeevatu and Jeevatu based manure can significantly reduce the risk of rhizome rot disease in ginger and aid in increased rhizome production. This product can be efficiently used for rhizome treatment and soil drench as well to alleviate rhizome rot problem associated to multi-pathogenic complex.

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