

Original Research Article

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Effect of Soil Physico-Chemical Properties on Rhizome Rot Disease of Ginger under Assam Condition

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ABSTRACT

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Rhizome rot of ginger is both seed (rhizome) and soil borne disease and soil plays an important role in the disease incidence and severity. Soil physico chemical properties play an important role in disease severity of rhizome rot of ginger. Correlation studies of six soil physico-chemical parameters with disease incidence (DI) showed that Potash (K_2O) content in soil was found exhibit significant negative correlation (-0.78). A ready to use regression equation has been developed to predict the incidence of rhizome rot disease in ginger with R^2 value of 61 per cent.

Introduction

Ginger is one of the earliest known oriental spices and is being cultivated in India both as fresh vegetable and as a dried spice, since time immemorial. Ginger is cultivated almost all over the world, covering a total area of 310.5 thousand ha with a production of 1683 thousand metric tonnes (Anon., 2011). India, China, Nepal, Nigeria and Thailand are the top five ginger producing countries, of which India is the largest producer with a production of 702 thousand tonnes accounting 34.6% of the total world output (Anon., 2014a). In India, ginger is cultivated in almost all the states and the major ginger growing states are

Karnataka, Kerala, Andhra Pradesh, Himachal Pradesh, Assam, Meghalaya and other North Eastern states. Among the ginger growing states in India, Assam ranks 1st in production (122.3 thousand MT) followed by Karnataka (Anon., 2014b).

The congenial climatic conditions of the state favour cultivation of ginger and is mainly cultivated in hilly terrains of Karbi Anglong, Golaghat, Sivasagar, Tinsukia and Udalguri districts (Hazarika and Kakoti, 2013) though the cultivation of ginger has well been adopted in the plains also. Production of ginger, however, is largely affected by diseases caused by bacteria, fungi, viruses,

mycoplasma and nematodes. Among different fungal diseases of ginger, rhizome rot has been considered to be the most destructive disease and is one of the most important production constrains in ginger growing countries (Dohroo, 2005 and Stirling *et al.*, 2009). Rahman *et al.*, (2009) reported that over the years, wilt and rhizome rot disease have affected ginger crop in many NE states resulting a decline of the ratio of seed rhizome to harvested rhizome from 1:8 to 1:4. In Assam, the crop loss was recorded up to 100 per cent in severe cases (Anon., 2007).

Rhizome rot of ginger is both seed (rhizome) and soil borne disease and soil plays an important role in the disease incidence and severity. Soil physic-chemical properties play an important role in disease severity (Sharma *et al.*, 2010 and Kim *et al.*, 2012). Several studies around the world revealed strong correlation of the disease with different soil physico-chemical properties like organic carbon (OC), soil pH, soil texture, electrical conductivity, nitrogen, phosphorus and potassium content of ginger growing soil. Literatures on effect of soil physico-chemical properties on incidence of rhizome rot of ginger is limited except the works of Sharma *et al.*, (2010) and Debnath *et al.*, (2011) and Kim *et al.*, (2012). Sharma *et al.*, (2010) reported a negative correlation of soil pH and organic carbon with rhizome rot incidence and these two factors may appear as the most effective associative factors influencing the disease incidence. Debnath *et al.*, (2011) reported that disease severity of rhizome rot disease of ginger may dependent primarily on organic carbon content of the soil. Difference in soil pH of diseased and healthy field was also observed by Kim *et al.*, (2012). Keeping the above points in view, the study was conducted to find the role of soil physico-chemical properties on incidence and severity of rhizome rot disease of ginger under Assam condition.

Materials and Methods

Different rhizome rot infested fields under major ginger growing areas covering all the Agro-climatic zones of Assam were considered in this study. Assam is divided into six Agro-climatic zones. They are: North Bank Plain zone (NBPZ), Upper Brahmaputra valley zone (UBVZ), Central Brahmaputra Valley zone (CBVZ), Lower Brahmaputra Valley zone (LBVZ), Hills Zone (HZ) and Barak Valley zone (BVZ). Eleven (11) soil samples from different rhizome rot infected soil were collected depending on varying disease incidence during 2014. Disease incidence in the rhizome rot infested field was recorded by random samples taken from five different spots of each 2 m² area. The per cent disease incidence (DI %) of the specific site was calculated following the procedure given below.

$$DI \quad (\%) = \frac{\text{Number of clumps wilted}}{\text{Total number of clumps present in the marked area}} \times 100$$

Since ginger plant are not very deep rooted or more confined in surface soils only, soil samples were collected randomly from a depth of 0-30 cm. The soil physico-chemical parameters considered for this study were organic carbon, pH, electrical conductivity, available nitrogen, available phosphorus and available potassium content of the selected sites. along with disease incidence. Electrical Conductivity (EC) and pH were estimated through Systronics electrical conductivity meter and pH meter (model number 303 and 335 respectively). For soil fertility analysis, organic carbon was estimated by method given by Walkley and Black (1934). Nitrogen was estimated by Alkaline Potassium Permanganate Method (KMnO₄) method given by Subbiah and Asija (1956). Phosphorous estimation was done by the method given Bray and Kurtz, 1945 and

Potassium was estimated by standard procedure given by Baruah and Bathakur (1997). Correlation as well as regression analyses were performed considering different soil physico-chemical parameters as independent variables and disease incidence (DI) as dependent variables.

Results and Discussion

It was observed that rhizome rot varied significantly among the six Agro-climatic zones of the state. Highest disease incidence (80%) was recorded at Tezigaon (UBVZ) whereas lowest (5%) being observed at Boko (LBVZ) (Table 1). Variation in the soil organic carbon was observed among the different locations.

Highest organic carbon (0.79%) was recorded in Jorhat (UBVZ) and the lowest (0.48%) was recorded in Sonari (UBVZ) in the same zone. All the soil samples were found as acidic with soil pH ranged from 4.90 to 5.88. Very little variations in electrical conductivity (EC) were observed which ranged from 0.02- 0.04.

Analysis of the major soil nutrients from different ginger growing areas showed that available nitrogen and available potash in different locations varied between 271 and 383 kg/h and 200 and 342 g/kg respectively. Available phosphorus was found to remain more or less same at all the locations. Soil sample with highest Potash (342 g/kg of soil) was recorded in Boko (LBVZ) with whereas lowest (200 g/kg of soil) was recorded at Tezigaon (UBVZ).

Ginger is a nutrient exhausting crop. Nagarajan and Pillial (1979) observed the nutritional uptake of the crop. They reported that ginger crops are N and K exhausting, intermediary in case of P and Mg removal and the least in case of Ca removal. Correlation as well as regression analyses were performed

between disease incidence (DI) and different soil physico-chemical parameters (Table 2 & 3) to study the relationship of the soil parameters with disease incidence. Correlation studies showed that except pH, all the other parameters (Table 2) were negatively correlated. It was observed that the correlation between K₂O content and DI was statistically significant.

Multiple regression analysis was performed with disease incidence and soil physico-chemical parameters following step-wise regression method to find the most important parameters contributing to disease incidence. Analysis was done in XLSTAT software where the parameters having significant level at 10 per cent were considered in developing the model.

It appeared that K₂O content was found to be the single most determinant factor in developing the disease with R² value of 0.612. Soil parameters having correlation among themselves were not considered to avoid the effect of multi-collinearity. The regression equation developed to predict the incidence of rhizome rot disease in ginger is as follows.

$$\text{Disease Incidence (DI in \%)} = 105.811 - 0.2658 * \text{K}_2\text{O}, R^2=0.612$$

The regression model between actual and predicted disease incidence is shown in Fig. 1.

Correlation studies of soil physico-chemical parameters with disease incidence (DI) showed that Potash (K₂O) content was found to be the most important determinant factor contributing more than 61% of the disease incidence. Nwaogu and Ukpabi (2010) reported that increasing level of K fertilization, especially at ≥ 50 kg/ ha, enhanced suppression of pre-harvest yellow leaf spot disease of ginger and the post-harvest rotting of stored fresh ginger rhizomes.

Table.1 Physico-chemical properties of soil and per cent rhizome rot incidence in ginger

Location/ Agroclimatic zones	OC (%)	pH	EC (mmhos/cm)	N (Kg/ha)	P ₂ O ₅ (ppm)	K ₂ O (g/kg soil)	DI (%)
Tezigaon (UBVZ)	0.75	5.01	0.030	370	30	200	80 (63)
Jorhat (UBVZ)	0.79	5.38	0.040	370	28	307	10 (18)
Sonari (UBVZ)	0.48	5.15	0.030	271	24	212	40 (29)
BNCA (CBVZ)	0.58	5.88	0.035	310	26	219	70 (57)
Lakhimpur (NBPZ)	0.70	5.28	0.025	383	27	285	30 (33)
Tezpur (CBVZ)	0.52	5.82	0.020	299	26	214	50 (45)
Boko (LBVZ)	0.68	5.40	0.040	348	31	342	5 (13)
Diphu (HZ)	0.65	4.90	0.030	365	29	267	45 (42)
Karimganj (BVZ)	0.50	5.50	0.040	295	24	263	50 (45)
Nagaon (CBVZ)	0.60	5.10	0.040	312	26	243	30 (33)

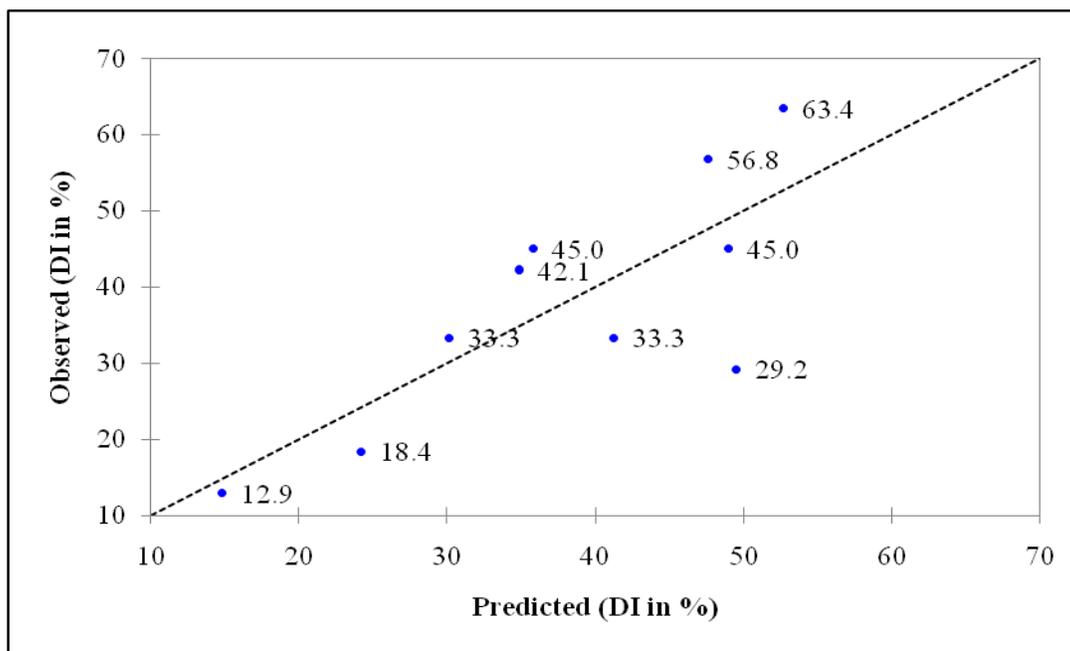
(Figure in parenthesis is angular transformed value)

Table.2 Correlation matrix

Variables	OC%	pH	EC	N	P ₂ O ₅	K ₂ O	Disease Incidence %
OC%	1.0000	-0.4209	0.1675	0.9256	0.7953	0.4583	-0.1808
pH		1.0000	-0.3322	-0.3524	-0.4566	-0.2238	0.2720
EC			1.0000	-0.0306	0.0224	0.4793	-0.3686
N				1.0000	0.8035	0.4773	-0.0949
P ₂ O ₅					1.0000	0.4842	-0.1728
K ₂ O						1.0000	-0.7821*
DI %							1.0000

* Values in bold are different from 0 with a significance level alpha=0.05

Fig.1 Predictive model between actual and predicted disease incidence



Li *et al.*, (2010) reported that ginger is sensitive to potash and needs a large amount of available soil Potassium. The demand of Potassium fertilizer was found to be at peak during active growth period of the crop. They also reported that Potassium is the important limiting factor for ginger production in China. Similar observations were also reported by Srinivasan *et al.*, (2012) from India. They reported that Potash is one of the most important limiting factor for poor production of ginger in India as the crop removes a large amount of soil Potash (up to 500 kg/ha). This study also indicated the important role of K₂O.

Rhizome rot of ginger is both seed (rhizome) and soil borne disease and soil plays an important role in the disease incidence and severity. Correlation studies between six different physico-chemical parameters of soil with disease incidence (DI) from eleven rhizome rot infected sites showed that Potash (K₂O) content was found to be the determinant factor contributing more than 61% of the disease incidence.

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