EVALUATION OF PEPPER GENOTYPES AGAINST PHYTOPHTHORA BLIGHT DISEASE

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ABSTRACT

Pepper (Capsicum annuum L and C. fruitescens L.) is an important high value crop grown for vegetable and for spice purposes. Phytophthora blight caused by Phytophthora capsici Leonian is a serious disease of pepper causing foliar blight, fruit rot and crown/root rot phases. Crown/root rot phase is the most devastating phase of the disease. Experiments were conducted with the objective to find resistant/tolerant varieties against phytophthora blight disease. Seedling evaluations were carried out in inoculated conditions under screenhouse during 2007-2009. Inoculum of zoospore suspension of 10^{4-5} spore/ml was used at the rate of 25 ml per plant at 5 week old stage of seedling. Based on the terminal disease incidence (5-7 weeks after inoculation), NS 1701, Chandani, Tara, Angarika and Premium were found resistant in seedling assay. During 2010 and 2011, on-farm evaluation of selected genotypes (11-13) was carried out in the farmers' field with the history of Phytophthora blight in chilli pepper. The experiment was conducted in two replications each with 16 plants. NS 1701, Tara, Angarika and Chandani were found resistant. Other genotypes NS 214, NS 1101, Goli and Premium were moderately resistant. Lesser fruit rot was found in Angarika, NS 1701, Long Wei and Pusa Jwala compared to other varieties. Those resistant to moderalely resistant genotypes could be used as one of the tools of integrated disease management of phytophthora blight in disease prone areas to minimize crop/yield losses.

Key words: Incidence, genotypes, blight, crown/root rot

INTRODUCTION

Pepper (*Capsicum annuum* L and *C. fruitescens* L.) is an important high value crop grown for vegetable and for spice purposes. Phytophthora blight caused by *Phytophthora capsici* Leonian is one of the most wide spread and serious threats to pepper cultivation all over the world (Leonian, 1922; Barksdale et al., 1984). Foliar blight, fruit rot and crown /root rot are the three phases of Phytophthora blight disease. Among them crown/ root rot is the most devastating phase which could cause the complete loss of the crop. Soil borne nature, high inoculum pressure, aggressiveness of the pathogen, high precipitation during cropping period, existence of physiological races, increased resistance of the pathogen to chemical fungicides and susceptibility of the crop are the factors that affect the epidemic outbreak of disease in the field. Rapid epidemic outbreak of this disease is favored by its spread through several mechanisms such as root growth to inoculum, inoculum movement to roots, root to root contact, and splashing of propagules from soil (Ristaino and Johnston, 1999). Failure to controlling Phytophthora blight may be due to combinations of high inoculum density and virulence of the pathogen (Bowers and Mitchell, 1991), insensitivity to fungicides (Parra and Ristaino, 1998; Pennisi et al., 1998) and in its rapid increase in population in the presence of high rainfall or irrigation (Ristaino, 1991).

In Nepal, this disease is prevalent in most of the pepper cultivating areas and has been appearing in devastating form causing huge losses in bell, hot and akbare pepper cultivation. Pepper cultivation is very limited or stopped because of severe crop loss due to this disease. Relying on only one control method may not manage this disease effectively (Johnston, 1997). Cultural control was considered to be the primary method of control, but it might not be successful in reducing loss at high soil moisture conditions. Crop rotation is another option, which may also not be useful enough in the areas where intensive cropping of vegetable crops and small land holdings of the farmers exist. Due to its complex pathosystem most of the disease management strategies are needed to integrate into a system to minimize crop losses caused by Phytophthora blight (Johnston, 2001).

Use of varietal resistance is one of the effective measures of integrated disease management of Phytophthora blight disease caused by *P. capsici*. In this regard, it is the most easy, cheap and effective control measures to

combat with this disease and this would also help reduce the use of pesticides. However, most of the pepper cultivars currently grown are susceptible to *P. capsici.* Considering all these factors, the present study was carried out to determine the sources of resistance and to select genotypes resistant or tolerant to Phytophthora blight disease of pepper.

MATERIALS AND METHODS

The experiments were conducted both in inoculated conditions under screenhouse at Khumaltar and in the farmers's field conditions at Sonakothi, Lalitpur.

Seedling Assay:
The trial was conducted during 2008 and 2009 in inoculated conditions under screen house. Seedlings were raised in sterilized soil on plastic trays and transplanted in 3" plastic pots. Twenty five milliliter of zoospore suspension (10^{4-5}spores /ml) was drenched in each pot at 5 weeks old stage of seedlings. The number of genotypes included was 17 to 18 and the number of seedlings per genotypes was 20-60 based on the germination. Disease symptom appeared one week after inoculation. Observation continued for 5 weeks after inoculation.

On-farm evaluation:
The trial was conducted in naturally infested field at Sonakothi, Lalitpur during 2010 and 2011. Some selected genotypes from seedling assay and some other genotypes (based on the availability of seeds) were included in the experiment, such as 13 and 10 genotypes respectively. Rod row design was adopted. Each replication contained two rows each measuring three meters. Seedlings were raised at Khumaltar. Seedlings of 45 days old from the date of seeding were transplanted in first week of June. Each row received eight plants. Chemical fertilizer used was 100:60:60 NPK/ha and compost used was 20 mt/ha. Other agronomical practices were given as per need. Disease scoring was continued for 6 weeks after disease symptoms appeared.

Foliar blight severity was assessed using 1-5 scale modified from Ristaino (1991), where 1 stands for 'no disease' and 5 for 'death of the plant'. Crown/root rot incidence was assessed on the basis of survival percent. Based on terminal disease score at 7 weeks after disease symptom appeared, the genotypes were categorized into Resistant (0-20% incidence), Moderately resistant (21-50%), Moderately susceptible (51-80%) and Susceptible (81-100%) according to AVRDC (Mycology, 2000). Recording of rotted fruits and yield at harvest in multiple harvests were taken. Area under disease progress curve of crown/root rot was calculated according to Shanner and Finney (1977). Similarly, disease progress curve was drawn for some promising genotypes.

RESULTS AND DISCUSSION

Use of varietal resistance is one of the effective measures of integrated disease management. As Phytophthora blight is the most devastating disease of pepper, cultural measures are the primary methods of managing this disease, but it may not give satisfactory results under conditions of high soil moisture. In such conditions, use of fungicides may reduce disease to some extent. Plant resistance suppresses the amount of initial disease and/or the rate of epidemic development. Therefore, varietal resistance either resistant or tolerant is important for successful management of this disease. Germplasm screening in the field with natural infection would be more reliable and also applicable to most of the diseases (Dorrance and Inglis, 1997).

Seedling screening:
Seedling screening is quick and reliable technique in which each and every plant receive equal amount of inoculum. During experiment, diseases appeared one week after inoculation under screen house conditions. Based on the disease incidence percent, five weeks after inoculation, the genotypes were categorized according to the disease reaction.

Data presented in table 1 showed that, in 2008, most of the genotypes were moderately resistant to both foliar blight as well as crown/root rot phase of the disease. Disease started from crown rot and progressed upward in the stem killing entire plant at later stages. According to the disease reaction category, of the 19 genotypes, seven were resistant, nine moderately resistant, two moderately susceptible and one was susceptible. Similarly, during 2009, most of the genotypes were susceptible. Of the 17 genotypes tested, three were resistant, two moderately resistant, two moderately susceptible and ten genotypes susceptible to crown/root rot phase (table 2).

In both the years, same genotype set could not be included in the experiment due to unavailability of seed of most of the genotypes and also due to poor seed germination. Genotypes like Angarika, NS 1701 and Chandani were moderately resistant or resistant in both the years. All three were F1 hybrids.

Table 1: Seedling evaluation of different pepper varieties against crown/root rot caused by *Phytophthora capsici* under Screen house conditions, 2008.

S.No	Varieties	Severity index 1-5 scale	Crown/root rot incidence %	Disease reaction
1	Tara	1.8	20.00	R
2	Premium	1.4	10.00	R
3	Anna No.3	2.09	27.27	MR
4	NS 1701	1.43	13.04	R
5	California Wonder	4.14	78.57	MS
6	Sagar	3.27	59.09	MS
7	Karma 757	1.0	0.00	R
8	Fire Bomb	2.4	48.00	MR
9	Chinese1	1.84	24.00	MR
10	Chinese 2	1.08	20.00	R
11	Chandani	2.08	26.92	MR
12	Agnirekha	2.04	29.17	MR
13	Sikha	1.75	25.00	MR
14	NS 632	4.47	86.67	S
15	Bioreal Wonder	1.0	0.00	R
16	Angarika	1.3	7.69	R
17	Hot green	2.47	46.67	MR
18	California Wonder (Royal)	2.71	42.86	MR
19	Santia long	2.07	26.67	MR

Table 2: Seedling evaluation of different pepper varieties against crown/root rot caused by *Phytophthora capsici* under Screenhouse conditions 2009.

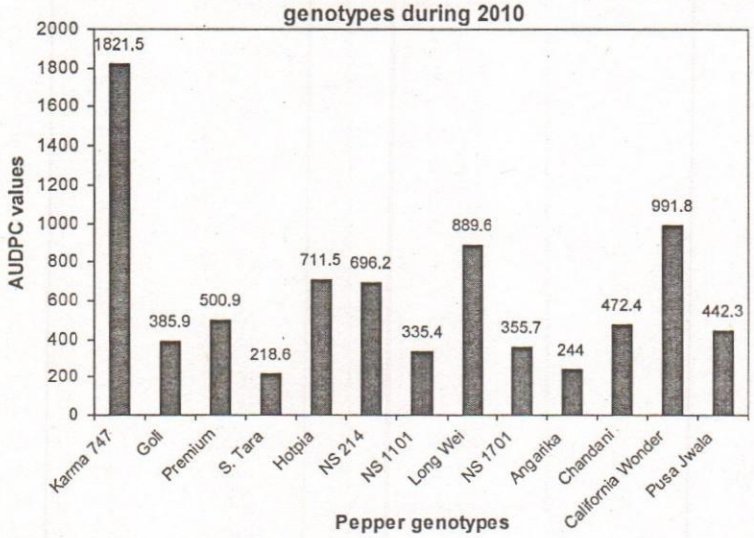
S.No	Genotypes	Crown/root rot incidence %	Disease reaction
1	Jare local	94.73	S
2	Yatsufusa	89.47	S
3	Dandicut	89.74	S
4	NS 1701	39.79	MR
5	Chandani F1	10.25	R
6	Daya seed	100.00	S
7	Local long green	94.44	S
8	Angarika	6.60	R
9	Hattisude	11.76	R
10	California wonder 2	100.00	S
11	Agnirekha	100.00	S
12	Pusa jwala	64.10	MS
13	Suryamukhi	23.33	MR
14	CH 1	80.00	MS
15	California wonder 4	100.00	S
16	Pida local	100.00	S
17	Milantar local	100.00	S

On farm evaluation:

Because of unavailability of the seed some of the genotypes could not be included in the second year of the experiment. The disease was more severe in 2011 than in 2010. Resistant genotype in 2010 reacted as moderately resistant in 2011. In 2010, of the 13 genotypes 4 genotypes were moderately resistant and 4 resistant (Chandani, Angarika, NS1701 and Super Tara) as shown in table 3. From yield point of view, Angarika was the best followed by Chandani, NS 1701, and Super Tara. However, yield data could not be taken in the following year of the experiment due to excess rain during flowering period. During 2011, of the 10 genotypes,

only Super Tara reacted resistant and Angarika and NS 1701 were moderately resistant. Other 5 genotypes were susceptible and 2 were moderately susceptible (table 3). Lesser fruit rot was observed in Angarika and NS 1701. In those varieties, the area under disease progress curve values were less compared to the susceptible variety, California Wonder (figure 1). Weekly disease progression was also slow in those varieties. Very slow disease progress was found in California Wonder for first four weeks but on the last fifth week, very fast progression was observed but remained almost stable in resistant or moderately resistant genotypes (figure 2). It was found that rapid disease progress and the severity was favored by high soil moisture and rainfall.

Figure 1. Area under disease progress curve values on different genotypes during 2010



Area under disease progress curve values on different pepper genotypes during 2010

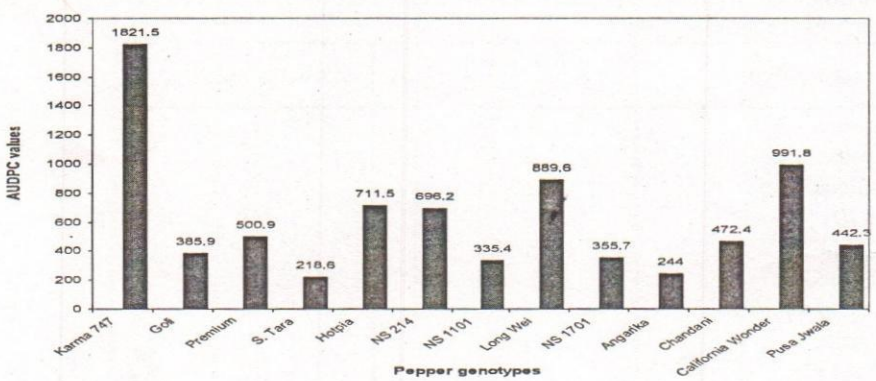


Figure 2. Crown/root rot disease progress curves on selected pepper genotypes

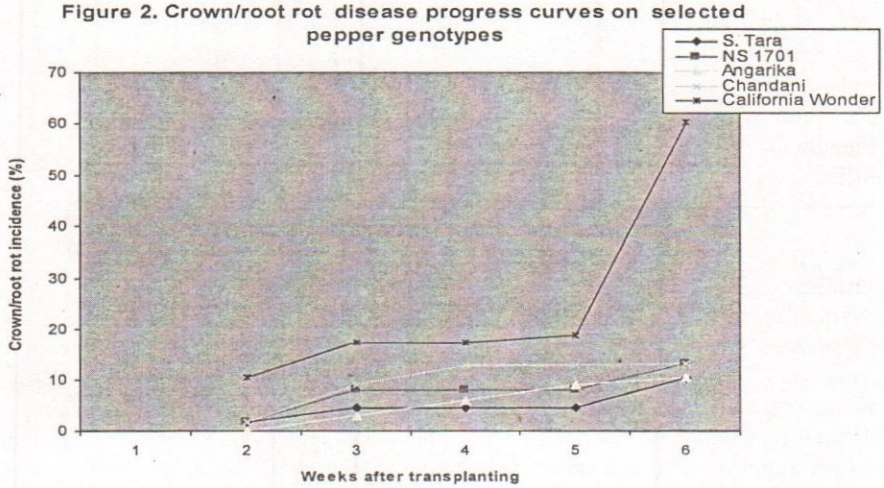


Table 3: On-farm evaluation of different pepper genotypes against Phytophthora blight disease during 2010 and 2011

S. No.	Genotypes	2010					2011		
		Foliar blight severity index (1-5)	Mean crown/ root rot Incidence %	Yield at harvest (Kg)/ ropani	Rotted fruits kg/ ropani	Disease reaction	Foliar blight severity index (1-5)	Mean crown/ root rot Incidence %	Disease reaction
1	Karma 747	3.5	70.58	195.00	17.58	S	4.0	72.59	S
2	Goli	1.0	24.99	533.33	25.83	MR	3.5	62.50	MS
3	Premium	2.2	30.62	568.67	52.5	MR	-	-	-
4	Super Tara	1.5	10.29	347.50	25.42	R	1.5	16.06	R
5	Hotpia	2.0	32.35	460.83	49.42	MR	3.8	88.39	S
6	NS 214	2.5	39.70	165.50	31.83	MR	-	-	-
7	NS 1101	1.5	47.05	488.33	32.08	MS	3.0	57.53	MS
8	Longwei	3.5	100.00	45.33	3.75	S	4.5	100.00	S
9	NS 1701	1.0	13.23	469.15	10.12	R	1.7	23.84	MR
10	Angarika	1.0	10.29	638.33	12.5	R	2.25	31.25	MR
11	Chandani	1.5	13.23	527.00	43.33	R	-	-	-
12	California Wonder	4.2	60.29	103.67	36.67	MS	5.0	100.00	S
13	Pusa Jwala	3.6	60.55	255.8	3.33	MS	4.75	97.83	S

Laboratory screening techniques of seedlings can assess resistance rapidly on large number of seedlings of various genotypes. Such an early selection process for susceptible genotypes may be useful and time saving to predict disease reactions under field conditions (Singh et al., 1997). Most of the commercial cultivars of pepper are susceptible to Phytophthora blight. Some cultivars may react differently to crown/root rot and foliar blight such as 'Paladin' which was resistant to crown/root rot but was susceptible to the foliar blight phase (Johnston et al., 2002).

Selection of resistance through screening is one of the techniques that determine resistant lines for breeding or for direct use if horticultural traits are found desirable. Present study on on-farm evaluation was supported by the view of Dorrance and Inglis (1997), who had mentioned that germplasm screening in the field with natural infection would be more reliable and also applicable to most of the diseases.

CONCLUSION

The genotypes identified as moderately resistant could be integrated with other management options to reduce disease in the field. It might also help in minimizing the fungicide applications. Resistant/tolerant genotypes such as Tara, Angarika, NS 1701 and Chandani could be used for the management of phytophthora blight in disease prone areas. Screening should be continued with new genotypes for sources of resistance or to determine resistant or tolerant genotypes that could be used directly by the farmers to combat with Phytophthora blight disease. Emphasis should be given on screening of local germplasms from different locations.

ACKNOWLEDGEMENTS

The author acknowledges all the personnel who are involved in the course of the experiment. She also expresses her thanks to the farmer who provided the field for the experiment.

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