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LATENT INFECTION OF HOLLOW STALK DISEASE IN *MOTIHARI* (*NICOTIANA RUSTICA*) TOBACCO AS INFLUENCED BY DATES OF PLANTING, IRRIGATION METHODS AND CHEMICAL APPLICATION

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Hollow stalk disease caused by *Erwinia carotovora sub sp. carotovora* is a serious endemic disease of *Motihari* tobacco (*N. rustica*) in *terai* agro-ecological region of North Bengal. Preliminary observations at Central Tobacco Research Institute Research Station's farm indicated latent infection of hollow stalk in apparently healthy *Motihari* tobacco plants in variable proportions (0.5 to 100%) in pith tissues of the stem once they were split open. Latent infection in apparently healthy plants might lead to severe crop losses in case of high humidity caused as a result of high rainfall and waterlogging of fields. The present investigation is aimed to study the extent of hollow stalk latent infection in *Motihari* tobacco due to the influence of i) different dates of planting (early, normal and late planting), ii) irrigation methods (channel irrigation and traditional farmer's practice of hand sprinkling of water) and iii) chemical paste/slurry application (bordeaux mixture, blitox). Yield (cured leaf) and quality (first grade leaf) of leaf under different treatments were reported.

INTRODUCTION

In India, tobacco is a leading commercial crop grown in 0.45 M ha of area (accounting for only 0.31% of net cultivated area in the country) with 750 M production (Krishnamurthy and Narasimha Rao, 2010). India stands second in tobacco production and exports in the world. *N. rustica* tobacco popularly known as *Motihari* tobacco is cultivated in Cooch Behar and Jalpaiguri districts, in *terai* zone of West Bengal. Characteristically *Motihari* tobacco is of chewing type and is consumed as *khaini*, *guakhu*, *gutka*, *khada masala*, hookah paste and powder. *Motihari* tobacco grown in 12,000 to 14,000 ha of cultivable land in *terai* zone of North Bengal followed by *Jati* tobacco with 2,000-4,000 ha. Important field diseases of *Motihari* tobacco are brown spot (*Alternaria alternata*), bacterial wilt (*Ralstonia solanacearum*), hollow stalk (*Erwinia carotovora* sub. sp. *carotovora*) and cucumber mosaic virus (CMV).

In FCV tobacco (*N. tabacum*) hollow stalk disease has been reported from U.S.A. and Canada (Lucas, 1975) whereas in India this disease has been reported in *N. rustica* tobacco only from *terai* region of North Bengal (CTRI, 2005, 2006; Roy *et al.*, 2008). Appearance of hollow stalk is observed at topped stem end and de-suckered points of leaves, however, it may begin at stem wounds formed at any part of the plant (Lucas, 1975). The hollow stalk disease is caused by *Erwinia carotovora* sub sp. *carotovora* (syn. *Pectobacterium carotovorum* sub sp. *carotovorum*) which causes soft rot of tissues by producing extra-cellular enzymes including polygalacturonases, pectic lyases, cellulases and phosphatidases (Beraha and Garber, 1971). As a result of collapse of the tissue, the top leaves wilt and the infection spreads downwards and leaves droop, hang down or fall off. Bacterial soft rot of plants is of worldwide occurrence and the destructive soft rot caused by the genus *Erwinia*, of these *Erwinia carotovora* is the most prevalent (Tseng, 1976).

Preliminary observations at Central Tobacco Research Institute Research Station's farm indicated the latent infection of hollow stalk in the apparently healthy *Motihari* tobacco plants in variable proportion (0.5 – 100%) in pith tissues of stem once they were split open. The pathogen might cause serious loss in the field, if proper care is not taken in advance to manage the latent infection of plants. The presence of latent infection in apparently healthy plants might lead to full blown expression of the disease leading to crop losses in the event of high humidity caused due to heavy rainfall and waterlogging of fields. The present investigation aimed to study the effect of dates of planting, irrigation methods and chemical application on the extent of latent infection, yield and quality of *Motihari* tobacco.

MATERIALS AND METHODS

Three sets of experiments were carried out in RBD design on latent infection of hollow stalk of *Motihari* tobacco *viz*., three dates of planting (early, normal and late), two irrigation methods (channel irrigation and hand sprinkling of water) and two chemical applications (bordeaux mixture and blitox) along with check during crop season of 2004-05 and 2005-06 at the farm of Central Tobacco Research Institute Research Station, Dinhata, Cooch Behar district, West Bengal. The experiment on different dates of planting and chemical application in *Motihari* tobacco was conducted with seven replications in each with plot size of 5.4 m^2 and 20 plants/plot. In the study on effect of irrigation methods on latent infection, yield and quality of *Motihari* tobacco, a total of 14 replications were maintained with plot size of 5.4 m^2 and 20 plants/ plot. The variety Dharla was transplanted in the field in a staggered manner in seven replications in each for early (last week of November), normal (first week of December) and late (3rd week of December) planting. Recommended agronomic package of practices were followed. The topped and de-suckered points of leaf were smeared/coated immediately with Bordeaux mixture (10 g powdered copper sulphate: 10 g lime: 100 ml water) and blitox (10 g in 20 ml of water). After two days of chemical application, the plants were irrigated at two levels i.e. channel irrigation and hand sprinkling of water. The natural infection of hollow stalk was recorded. The harvesting and curing operations were carried out as per standard protocol, cured and first grade leaf yield was recorded. After of harvest, the left over stems in the experimental field were split open and the extent of latent infection was recorded in terms of per cent soft rot pith tissues.

RESULTS AND DISCUSSION

Latent infection in *Motihari* tobacco

Latent infection of hollow stalk was significantly higher in the year 2005-06 than 2004-05 (Table1). In respect of two years mean of planting dates, significantly least infection was recorded in early planting followed by normal and late planting. The interaction of planting dates and year showed significantly low disease reaction was recorded in normal planting (2.12%) during 2004-05 followed by early planting during 2005-06 (3.27%). Highest disease reaction was recorded in late planted crop during both the years (14.01 and 17.68 % in 2004-05 and 2005-06, respectively).

Chemical application (Table 2) indicated that the slurry/paste application of bordeaux mixture (5.65%) was significantly effective in containing latent infection of hollow stalk compared to blitox (8.60%). However, the disease reaction in blitox was significantly lower compared to control (12.36%). The efficacy of bordeaux mixture was found to be significantly higher (4.5 and 6.8%) than blitox and control in chemicals x year interaction. The slurry/paste application of bordeaux mixture or blitox is necessary and will minimize the latent infection in plants since the wounds created at the topped end or de-suckered points of leaf are

Table 1: Hollow stalk latent infection as affected dates of planting in *Motihari* tobacco

Planting dates /Hollow stalk latent infection (%)				
Year	**Early planting**	**Normal planting**	**Late planting**	**Mean**
2004-05	4.74	2.12	14.01	6.96
2005-06	3.27	11.25	17.68	10.73
Mean	4.00	6.68	15.84	
	Planting dates	**Year**	**Planting dates x Year**	
SEm±	**0.27**	**0.22**	**0.38**	
CD (P=0.05)	**0.81**	**0.67**	**1.15**	
CV (%)	**11.53**			

vulnerable site of entry for the bacterial pathogen dwelling in soil (Lucas, 1975; McIntyre *et al.*, 1978).

The latent infection under channel irrigation and traditional practice was at a par (Table 3). The interaction between irrigation methods and years, the disease reaction was at par in 2004-05 (7.40 and 6.52%) and 2005-06 (11.07 and 10.40%) for channel irrigation and traditional practice. Thus, the results indicated that irrigation methods do not have significant impact in increasing or decreasing latent infection in plants.

The chemicals after their application at topped end and de-suckered points of leaf should be allowed to dry at the site of application in plants and irrigation should be avoided immediately Since *E. carotovora* sub sp. *carotovora* is a wound parasite, therefore, entry of the pathogen in the field crop is possible as a result of injury created during inter-cultural operations, topping, de-suckering and insect damage. The pathogen multiplies and remains latent, and full blown expression of the disease is expected in the event of high rainfall and waterlogging of soils.

Yield and quality of *Motihari* tobacco

Cured leaf yield: The results on the mean of years indicated that cured leaf yield was significantly higher under early planting (1830 kg/ha) compared to normal and late planting (Table 4). The interaction between planting dates and years revealed that the cured leaf yield was at a par in early (1552 kg/ha) and normal planting (1503 kg/ha) during 2004-05. In 2005-06, the yield under early planting (2108 kg/ha) was found to be maximum and significantly higher than rest of the treatments. The interaction between irrigation methods and years significantly highest yield was

Table 2: Hollow stalk latent infection as affected by prophylactic application of chemicals on *Motihari* tobacco

	Chemicals /Hollow stalk latent infection (%)			
Year	**Bordeaux mixture**	**Blitox**	**Control**	**Mean**
2004-05	4.50	8.02	8.35	6.96
2005-06	6.8	9.18	16.36	10.78
Mean	5.65	8.6	12.36	
	Chemicals	**Year**	**Chemicals x Year**	
SEm±	0.25	0.21	0.35	
CD (P=0.05)	0.75	0.62	1.06	
CV (%)	10.63			

Table 3: Hollow stalk latent infection as affected by methods of irrigation in *Motihari* tobacco

Year	**Irrigation methods /Hollow stalk latent infection (%)**		
	Channel irrigation	**Traditional practice**	**Mean**
2004-05	7.40	6.52	6.95
2005-06	11.07	10.40	10.73
Mean	9.23	8.46	
	Irrigation methods	**Year**	**Interaction**
SEm±	**0.30**	**0.34**	**0.43**
CD (P=0.05)	**NS**	**1.00**	**1.27**
CV (%)	**18.13**		

Table 4: Influence of planting dates on cured leaf yield (kg/ha) of *Motihari* tobacco

	Planting dates			
Year	**Early planting**	**Normal planting**	**Late planting**	**Mean**
2004-05	1552	1503	1283	1446
2005-06	2108	1810	1521	1813
Mean	1830	1657	1402	
	Planting dates	**Year**	**Planting dates x Year**	
SEm±	**42.84**	**34.98**	**6.59**	
CD (P=0.05)	**127.30**	**103.94**	**180.00**	
CV (%)	**9.84**			

Table 5: Influence of chemical application on cured leaf yield (kg/ha) of *Motihari t*obacco

	Planting dates			
Year	**Bordeaux mixture**	**Blitox**	**Control**	**Mean**
2004-05	1537	1455	1347	1446
2005-06	1891	1830	1717	1813
Mean	1714	1643	1532	
	Chemicals	**Year**	**Chemicals x Year**	
SEm±	**33.10**	**27.03**	**46.83**	
CD (P=0.05)	**98.38**	**80.28**	**139.10**	
CV (%)	**7.60**			

obtained under channel irrigation (1923 kg/ha) during 2005-06 compared to rest of the treatments.

Effect of chemical application on cured leaf yield for the years 2004-05 and 2005-06 was given in Table 5. The mean of two years results indicated that cured leaf yields under Bordeaux mixture (1714 kg/ha) and blitox (1643 kg/ha) were at a par and significantly higher than control (1532 kg/ha). The interaction between years and chemical treatment, the cured leaf yield during 2005-06 was significantly higher in each treatment compared to 2004-05.

The mean of two years results (Table 6) revealed cured leaf yield was significantly lower in traditional practice of irrigation (1569 kg/ha) than channel irrigation (1690 kg/ha). Cured leaf yield obtained under mean of two irrigation methods was significantly higher in 2005-06 (1813 kg/ha) than 2004-05 (1446 kg/ha). The interaction between irrigation methods and year revealed that significantly highest yield was obtained under channel irrigation (1923 kg/ha) during 2005-06 compared to rest of the treatments. During 2004-05 the cured leaf yield under channel irrigation (1456 kg/ha) and traditional practice were at a par.

First grade leaf yield: Mean of two years results (Table 7) indicated that first grade leaf yield was significantly higher under normal date of planting (1006 Kg/ha) followed by early (684 kg/ha) and late planting (542 kg/ha). The yield during 2005-06 (823 kg/ha) was significantly higher than 2004-05 (665 kg/ha). The interaction between planting dates and years, the first grade leaf yield was significantly higher under normal planting during 2005-06 (1179 kg/ha).The first grade leaf yield in *motihari* tobacco under the influence of slurry/paste application of chemicals (bordeaux mixture and blitox) along with check for the years 2004-05

Table 6: Influence of irrigation methods on cured leaf yield (kg/ha) of *Motihari* tobacco

Year	Irrigation methods		
	Channel irrigation	**Traditional practice**	**Mean**
2004-05	1456	1436	1446
2005-06	1923	1703	1813
Mean	1690	1569	
	Irrigation methods	**Year**	**Interaction**
SEm±	**31.05**	**29.23**	**43.91**
CD (P=0.05)	**92.25**	**86.87**	**130.5**
CV (%)	**18.10**		

Table 7: Influence of planting dates on first grade leaf yield (kg/ha) of *Motihari* tobacco

	Planting dates			
Year	**Early planting**	**Normal planting**	**Late planting**	**Mean**
2004-05	603	833	559	665
2005-06	766	1179	524	823
Mean	684	1006	542	
	Planting dates	**Year**	**Planting dates x Year**	
SEm±	**24.46**	**19.97**	**34.60**	
CD (P=0.05)	**72.69**	**59.35**	**102.8**	
CV (%)	**12.30**			

and 2005-06 is given in Table 8. The first grade leaf yield in bordeaux mixture was at par with blitox and both were significantly higher than control.

The first grade leaf yield under two irrigation methods for the year 2004-05 and 2005-06 is presented in Table 9. The mean of two years productivity of first grade leaf was significantly higher under channel irrigation (806 kg/ha) compared to traditional practice of irrigation (705 kg/ha). The interaction between the irrigation methods and years revealed that yield was at a par in channel and traditional practice of irrigation during 2004-05. During 2005-06, significantly highest yield was obtained under channel irrigation (923 kg/ha) compared to rest of the treatments.

Hollow stalk disease in *Motihari* tobacco (*N. rustica*) is endemic in *terai* region of North Bengal as the pathogenic propagules overwinters in soil. Survival of the pathogen is well documented in systematic studies on overwintering of the pathogen, seed infestation and pathogenicity of hollow stalk pathogen in FCV tobacco (McIntyre *et al.*, 1978). Proper care must be taken so as to avoid possible damage to plants as the natural openings of the wounds facilitates the entry of the pathogen in the plants (Lucas, 1975; Roy *et al.*, 2008) and its eventual progress in latent form or expression of the disease under favorable conditions. Normal planting of *Mmotihari* tobacco is recommended since recovery of first grade leaf is significantly higher compared to early and late planting.

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Table 8: Influence of chemical application on first grade leaf yield (kg/ha) of *Motihari t*obacco

	Chemicals			
Year	**Bordeaux mixture**	**Blitox**	**Control**	**Mean**
2004-05	693	656	646	665
2005-06	901	819	750	823
Mean	797	737	698	
	Chemicals	**Year**	**Chemicals x Year**	
SEm±	**32.24**	**26.33**	**45.6**	
CD (P=0.05)	**95.80**	**78.23**	**NS**	
CV (%)	**16.22**			

Table 9: Influence of irrigation methods on first grade leaf yield (kg/ha) of *Motihari* tobacco

Year	**Irrigation methods**		
	Channel irrigation	**Traditional practice**	**Mean**
2004-05	688	687	688
2005-06	923	723	823
Mean	806	705	
	Irrigation methods	**Year**	**Interaction**
SEm±	**19.31**	**25.93**	**27.31**
CD (P=0.05)	**57.37**	**77.04**	**81.15**
CV (%)	**13.53**		

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