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Adeptness of bio-intensive approach against vascular bacterial wilt in Purulia district of West Bengal

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ABSTRACT

Vascular bacterial wilt being an impediment of brinjal (*Solanum melongena* L.) production under the acidic soil condition of Purulia district of West Bengal resulted in 20-30% yield loss every year. The present participatory action research was aimed to study the (i) adeptness of integrated module of prophylactic soil disinfection and bio-control, (ii) only prophylactic soil disinfection, and (iii) only curative soil disinfection over uprooting and destruction of diseased plants (farmers' practice). Results indicated all the management approaches under study performed significantly superior to farmers' practice in terms of reduction in disease severity (32.8-43.6%), yield increase (20.9% - 26.8%) and benefit-cost ratio. Integrated approach was the best approach followed by prophylactic and curative soil disinfestations. Thus, for the present micro-level situation vascular bacterial wilt malady can be addressed by prophylactic application of lime at 500 kg/ha and bleaching powder 20 kg/ha in the soil four weeks before transplanting followed by seed dressing with 20g bioinoculant formulation per kg seed, pre-transplanting seedling root treatment with 20g bioinoculant formulation per litre and spot soil application of 7 days old mixture of bioinoculant formulation and well rotten cow-dung manure (1:40 w/w) or need based curative application of bleaching powder at 20 kg per ha through every irrigation.

Keywords: Bleaching, lime, management, participatory research, *Pseudomonas fluorescens*, *Ralstonia solanacearum, Solanum melongena*

Introduction

Brinjal (*Solanum melongena* L.) is widely cultivated both in the *kharif* and *rabi* seasons at irrigated bunded uplands (locally known as "*Baid*") of Purulia district with average area of 2800 ha, with a productivity of 18.5 tha^{-1}. Under Purulia condition, brinjal is affected by several insect pests and diseases including brinjal shoot and fruit borer, little leaf, bacterial wilt, phomopsis blight etc. Among these problems, bacterial wilt caused by *Ralstonia solanacearum* is most important. A quantum of plant population is killed every year by the pathogen resulted in heavy yield loss to the extent of 30% under Purulia conditions. Acidic soil reaction provides a favourable survival condition for the pathogen in soil. Till date, there are no varieties developed that could be used as completely resistant to the disease. At the same time, a sound disease management option is still a mess due to wide range of adaptability of the pathogen towards edapho-climatic condition (Shekhawat et al. 1978), high degree of variability and genetic diversity (Fegan & Prior 2005), long-term survival ability with unique survival strategy under adverse conditions (Grey & Steek 2001), wide host range (Hayward 1964) and some specific cultural practices of West Bengal, India (Ghosh 2005). Thus, site-specific, appropriate and biointensive strategies for management is needed to be explored against this dreaded disease. Biointensive management strategy has been evolved that stands on the exploitation of planned biodiversity with every possible assistance for preferential adaptation over altered biodiversity in the changing ecological niche. These assistance either in terms of manipulation of soil properties and/or reactions by means of organic/inorganic soil amendment or by using novel plant 'variety' having unique rhizosphere exudates that promote the native biological consortia and demote the pathogen as-and-when required basis. Obviously, biointensive management could be employed relatively site specific small-scale farms where all the ecological aspects are more or less homogeneous (Ghosh et al. 2015a). Ghosh & Mandal (2009) found that well decomposed cowdung at land preparation, planting material treatment with carbendazim + streptocycline, stable bleaching powder (1%) drenching along with protective banding with well-decomposed cowdung, oilcake, SSP and MOP (20:5:3:1) were the best treatments. The roots of most plants have a relationship with certain beneficial bacteria (e.g. fluorescent Pseudomonads) of nutritive and spatial competence in the rhizosphere (Jagadeesh et al. 2001). Chakraborty & Kalita (2012) used indigenous strain of *Pseudomonas fluorescens* as potential biocontrol agent against bacterial wilt of brinjal. They also showed that bacterial wilt incidences lowest when cell suspension of *P. fluorescens* applied by root and soil treatment. Ghosh (2012) and Ghosh et al. (2015a) found that application of bleaching powder (20 kg/ha) followed by lime (500 kg/ha), one month before transplanting, were most effective treatments in terms of disease reduction up to 44.91% and 28.04%, respectively over the Farmers' Practice. The aforesaid milieu led this demand driven participatory action research to be laid to test the hypothesis of biointensive approach of management will reduce the disease severity and loss due to bacterial wilt over over uprooting and destruction of diseased plants (Farmers' Practice) and thereby maximize yield of brinjal and increase B:C ratio (BCR) under the farmers' field condition of Purulia district of West Bengal. Therefore, the objective of the present study was (i) to study the effect of various treatments on temporal disease incidence pattern and disease severity (ii) to study the effect of various treatments on yield and return per rupee investment.

Materials and methods

The present investigation was conducted in the command area of Krishi Vigyan Kendra, Kalyan, Purulia, West Bengal. Among fifty adopted villages, ten villages *viz*., Rahamda, Arjunjora, Sirkabad, Lakrakhonda, Simuduri, Jaspur, Madhubanpur, Padlara, Bandhgarh and Dumdumi were randomly selected for the study where vascular bacterial wilt was a predominant problem in brinjal. The farmers were selected through Farm Science Club meeting held at the villages. The selected farmers were imparted training on the respective technologies used in the trial at village level along with other farmers. The technique of application of bioinoculant as seedling treatment and soil spot inoculation as well as application of bleaching powder through irrigation water are comparatively new to the farmers. Therefore, the entire process of farmers' participation was continuously supervised during the course of the investigation. The critical inputs like commercial formulation of fluorescent Pseudomonads, bleaching powder and lime were procured for the selected farmers, while other inputs like well rotten cowdung, gunny bag, seed, fertilizer etc. were arranged by the participating farmers themselves. The treatments comprises of T1: Farmers' Practice [uprooting and destruction diseased plants – common measure practiced by the farmers of the concern locality anticipating to manage the disease], T2: Application of lime @ 500 kgha^{-1} + Bleaching @ 20 Kgha^{-1} in the soil 3 weeks before transplanting + seed treatment (at 20g/Kg seed) + pre-transplanting seedling root treatment (at 20g/L for 2 hrs and 30 min) with commercial formulation of *Pseudomonas fluorescens* + spot soil application of 7 day old mixture of well rotten cowdung manure : Commercial formulation of *Pseudomonas fluorescens*::40:1 (w/w) before transplanting. T3: Application of lime @ 500 Kgha^{-1} + Bleaching @ 20 Kgha^{-1} in the soil 3 weeks before transplanting, T4: Need based application of bleaching powder @ 20 Kgha^{-1} with every irrigation water following first appearance of the disease in the field. All the replications were periodically monitored to collect data on first appearance of the disease and their respective severity level at 15 days interval using disease rating scale proposed by Winstead & Kelman (1952). The terminal disease severity and cumulative marketable yield was considered for discrimination of treatment effects. The gross cost and gross return each treatments was determined on the basis of present market price and quantity of the input used in the experiment and gross market price of brinjal, respectively. The BCR was enumerated through the ratio of gross return to gross cost.

The experiment was carried out in a completely randomised experimental design with four treatments and 10 replications. The data obtained were statistically analysed by means of ANOVA using SPSS v.10 Statistical software. The estimate of discrimination among treatment effect size was determined using critical difference (CD) and Tukey's Honestly Significant Difference (HSD) Test at p≤ 0.05 level of significance.

Results and Discussion

The results presented in the Table-1 indicated that the integrated approach (T2) with prophylactic application of soil disinfectants (lime & bleaching) and bioinoculants (commercial formulation of *Pseudomonas fluorescens*) resolute the significantly best performance in terms of disease reduction (73%), yield maximization (68%) and higher BCR (39%) over Farmers' Practice. The three year pooled disease severity was at its highest in Farmers' Practice (42.81%). The performance of both prophylactic (T3: Application of lime @ 500 kgha^{-1} + Bleaching @ 20 Kgha^{-1} in the soil 3 weeks before transplanting,) and curative (T4: Need based application of bleaching powder @ 20 kgha^{-1} with every irrigation water following first appearance of the disease in the field) application of inorganic soil disinfectant were statistically at par and at the same time out yielded the Farmers' Practice (Table 1). The present findings also indicated that the disease severity highly negatively correlated with yield (Fig.1).

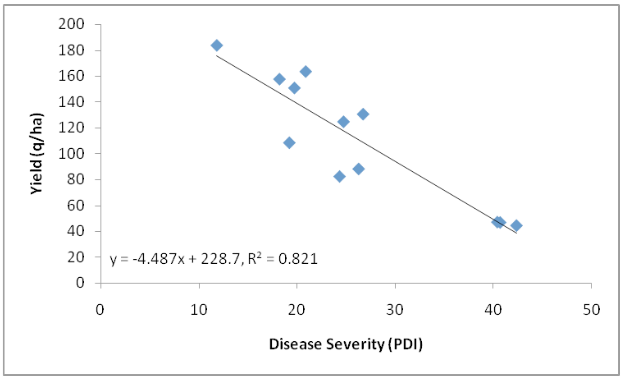

Fig 1. Effect of bacterial wilt disease severity on marketable yield of brinjal

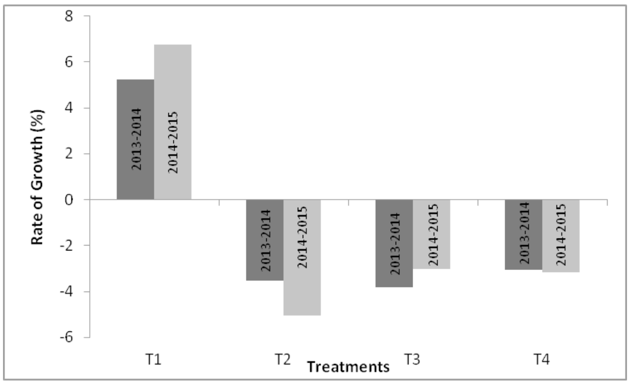

Fig 2. Year wise disease growth rate in the treatment plots

Table 1.
Performance of different approaches of management of vascular bacterial wilt disease of brinjal

Treatments	Disease severity (%)				Yield (q/ha)				BCR
	2013	2014	2015	Pooled	2013	2014	2015	Pooled	
T1 Farmers Practice	40.43 (39.48)^a	45.43 (42.38)^a	42.55 (40.72)^a	42.81	47.34^c	47.08^b	44.67^b	47.36	1.28
T2 Integrated Approach	11.86 (20.14)^c	11.44 (19.76)^c	10.86 (19.24)^c	11.39	108.5^a	150.70^a	183.53^a	147.57	2.11
T3 Prophylactic soil disinfection	18.24 (25.28)^b	17.54 (24.76)^b	17.01 (24.36)^b	17.70	82.5^b	124.72^a	157.24^a	121.49	2.06
T4 Curative Soil Disinfection	20.91 (27.21)^b	20.27 (26.76)^b	19.63 (26.30)^b	20.27	88.33^{ab}	130.53^a	163.36^a	127.40	2.07
CD at 5%	4.39	4.8	4.93	-	25.83	32.04	38.25	-	-

N.B. All the data presented in the table are the arithmetic mean of 10 replications. Figures in the parentheses are angular transformed value; data bearing same alphabets do not differ significantly on the basis of Tukey's HSD test at p≤0.05 level.

The analysis of year wise disease severity showed that year wise disease growth rate differed significantly among treatments. The Farmers' Practice (T1) led the increasingly positive disease growth rate over the years while in all the other three treatments have negative growth rate over the years. The integrated approach (T2) and curative soil disinfectant approach (T4) showed increasingly negative growth rate, while prophylactic soil disinfectant approach (T3) showed decreasingly negative growth rate (Fig. 2). The higher yield in the integrated approach is mainly due to delayed disease initiation around 60 days after transplanting and slower progress of the epiphytotic resulting in the lowest area under disease progress curve compared to Farmers' Practice and the initial active production phase (40-70 DAT) virtually escaped the damaging part of the epiphytotic (Fig. 3). While in Farmers' Practice, the disease initiation was observed around 30 days after transplanting having faster epiphytotic progress with an increase in increasing rate and invariably accumulated the highest area under disease progress curve resulted in a detrimental effect to the initial active production phase (40-70 DAT). Ghosh et al. (2015 a,b) showed that early disease initiation (before 45 DAT) in brinjal always have the most detrimental effect on the production, while disease initiation in between 45-75 DAT or later resulted break away from the threat of yield loss due to delayed initiation of the disease. Thus, growers faced least financial loss. The present findings obviously corroborate the result obtained by Ghosh et al. (2015 a,b). The delayed disease initiation may be attributed to the well known antagonistic ability of the fluorescent Pseudomonads in terms of physical barrier through formation of bio-film over the root surface, antibiosis and iron quenching properties through siderophore, etc.

It is evident from the present investigation, that integrated approach or curative soil disinfectant approaches can be considered effective in comparison to prophylactic soil disinfection approach and Farmers' Practice in terms of temporal variation in the rate of disease growth (%). It is well established that the continuous monoculture without taking any measure increase the disease proneness in a given piece of plot which support the increasingly positive disease growth rate in the Farmers' Practice. However, prophylactic soil disinfection followed by application of biological control agent along with organic manure and/or curative soil disinfection over the years definitely impose a negative effect on the disease proneness. Repeated application of soil disinfectants only in a given piece of land might have detrimental effect on soil biota and in long run, the pathogenic population of *R. solanacearum* utilise its unique survival strategy to escape the effect of soil disinfectant unless it is supplemented with organic matter and bioinoculants.

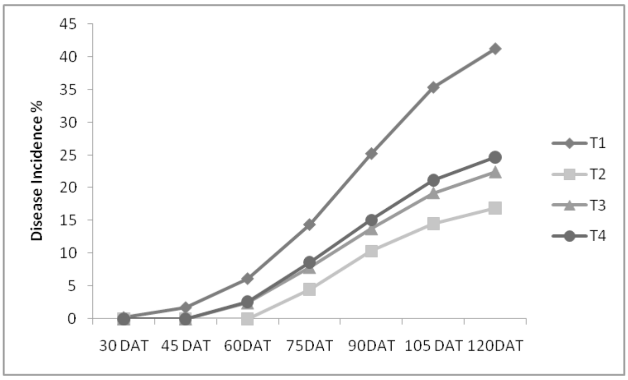

Fig 3. Growth stage-wise disease incidence (%) under various treatments.
(DAT = days after transplanting)

The present study on micro-level observation on vascular bacterial wilt malady in brinjal revealed that this wilt problem could be adequately addressed by prophylactic application of lime at 500 kg/ha and bleaching powder 20 kg/ha in the soil 4 weeks before transplanting followed by seed treatment at 20g/kg seed, pre-transplanting seedling root treatment at 20g/L and spot soil application of 7 days old mixture of 1 kg bioinoculant formulation along with 40 kg of well rotten cowdung manure or need based curative application of bleaching powder at 20 kg/ha through every irrigation.

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