INTEGRATED MANAGEMENT OF BACTERIAL WILT AND ROOT KNOT NEMATODE OF TOMATO

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ABSTRACT

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The field experiment was conducted at Agricultural Research Station, Burirhut, Rangpur to find out the efficacy of poultry refuse (PR) integration with stable bleaching powder (SBP) or $CaNO_3$ and Furadan 5G for the management of bacterial wilt (*Ralstonia solanacearum*) and root-knot disease *(Meloidogyne incognita)* of tomato. Soil was treated with PR @ 3 t/ha 3 weeks before transplanting, stable bleaching powder @ 20 kg/ha was applied during final land preparation and Furadan 5G @ 20 kg/ha on the day of transplanting of tomato seedlings and $CaNO_3$ was used as soil drenching 10 days after seedling transplanting. Considerable reduction of root-knot and bacterial wilt diseases and increase in plant growth as well as fruit yield were recorded. The most effective treatment was PR + stable bleaching powder + Furadan 5G followed by PR + $CaNO_3$ + Furadan 5G for the management of bacterial wilt and root knot nematode diseases of tomato.

Key words: Poultry refuse, stable bleaching powder, Furadan, $CaNO_3$, *Meloidogyne incognita*, *Ralstonia solanacearum* tomato.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is a member of Solanaceae family is a widely grown nutritious in Bangladesh (Haque *et al.* 1999). It is one of the most popular and important commercial vegetable crops grown throughout the world including Bangladesh. It ranks next to potato and sweet potato in respect of vegetable production and consumption in the world (FAO 1997; Hossain *et al*. 2010). The average yield of tomato in Bangladesh is 14.05 t/ha (BBS 2017) which is quite low as compared to that of other tomato producing countries in the World (Anonymous 1998). Several yield limiting factors of tomato are enumerated. Among them diseases caused by fungi, bacteria, nematodes and viruses play major role. The root-knot disease caused by *Meloidogyne incognita* and bacterial wilt caused by *Ralstonia solanacearum* are soil borne pathogens and major limiting factor in the production of tomato throughout the country (Mian 1986; Agrios 1997). These diseases are widely distributed in tropical, subtropical and some warm temperate regions of the world with a host range of 44 plant families (Ji *et al*. 2005; Hayward 1991). The estimates of yield losses caused by *R. solanacearum* on tomato vary from 15- 95% (Hayward and Hartmann 1994; Kuku *et al.* 1996). The average losses of tomato yield due to root-knot nematode infestation are 20.6% (Sasser, 1989). It causes about 40% yield loss of tomato in Bangladesh and about 46.2% in India (Mohsin 1987). Various strategies of controlling bacterial wilt disease e.g. intercropping, rotation and soil amendment has been reported (Sun and Huang 1985; Michel *et al*. 1997; Sood *et al*. 1998) but result from these studies are variable and not always effective against wilt diseases (Hayward 1992). For controlling root-knot nematodes, application of nematicides (Hossain *et al.* 1989), organic soil amendments (Faruk *et al.* 2001; Bari *et al.* 2004), cultural, physical measures and biological measures (*Trichoderma* spp, *Pacecilomyces lilacinus, Pasturia penetrans* and *Pseudomonas aeruginosa*) (Rao *et al*. 1997; Reddy *et al.* 1998 and Siddiqui *et al.* 1999) are practicing. Due to lack of resistant cultivars, wide and indiscriminate use of chemical to control the diseases cause environmental pollution and hazardous to human health (Kaur and Arora 1999; Akinpelu 2001; Wachira *et al*. 2009). In these circumstances, the present study has been undertaken to develop an eco-friendly integrated management practices against root knot and bacterial diseases of tomato.

MATERIALS AND METHODS

Field experiment: The experiment was conducted at the Agricultural Research Station, Burirhut, Rangpur during 2011-2012 to find out the effective management practices against bacterial wilt and root-knot nematode of tom

×3.75 m. Thirty days old tomato seedlings var. Ratan was used as planting materials. There were ten treatments which were T_1 = Poultry refuse (@ 3 t/h) + Stable bleaching powder (@ 20 kg/h) + early sowing (Middle of October), T_2 = Poultry refuse (@ 3 t/h) + $CaNO_3$ (@ 1% solution) + early sowing, T_3 = Poultry refuse (@ 3 t/h) + Stable bleaching powder (@ 20 kg/h) + Furadan (5G@ 20 kg/h) + early sowing, T_4 = Poultry refuse (@ 3 t/h) + $CaNO_3$ (@ 1% solution) + Furadan5G (@ 20 kg/h) + early sowing, T_5 = Control-1, T_6= Poultry refuse (@ 3 t/h) + Stable bleaching powder (@ 20 kg/h) + late sowing (1st week of December), T_7 = Poultry refuse (@ 3 t/h) + $CaNO_3$ (@ 1% solution) + late sowing, T_8 = Poultry refuse (@ 3 t/h) + Stable bleaching powder (@ 20 kg/h) + Furadan 5G (@ 20 kg/h) + late sowing, T_9 = Poultry refuse (@ 3 t/h) + $CaNO_3$ (@ 1% solution) + Furadan5G (@ 20 kg/h) + late sowing and T_{10} = Control-2. The experiment was laid out in RCBD with three replications. Requisite quantity of partially decomposed poultry refuse was added to the soil 3 weeks before transplanting for proper decomposition. Stable bleaching powder was applied during final land preparation, Furadan 5G was added at the time of seedling transplanting and $CaNO_3$ was used as soil drenching after 10 days of transplanting. Fertilizers were added during final land preparation, weeding and irrigation were done as and when necessary.

Data collection and analysis: Data on different parameters viz. disease incidence, gall index, seedling mortality, shoot height, shoot weight, root length, root weight and yield of tomato were recorded. Bacterial wilt incidence was recorded from seedling to maturity stage of the crop. Root knot disease severity was recorded according to Zeck (1971) during final harvesting of tomato. The percent data were converted into arcsine transformation values before statistical analysis. Data were analyzed statistically by using the MSTAT-C program. The treatment effects were compared by applying the least significant different (LSD) test at P=0.05 level.

RESULTS AND DISCUSSION

Severity of bacterial wilt and root gall: The severity of bacterial wilt and root gall was greatly reduced due to integration of PR, SBP, $CaNO_3$ and Furadan 5G over control (Table 1). The maximum bacterial wilt incidence of 45.33% and 32.33% was recorded in control-1 and control-2 plots, respectively. Integration of different treatment reduced 50.74-75.00% bacterial wilt incidence compared to control. The highest bacterial wilt reduction occurred at T3 (PR + SBP + Furadan + ES) treatment followed by T8 (PR + SBP + Furadan + LS) and T4 (PR + $CaNO_3$ + Furadan + ES) treatments, where the reduction were 75%, 73.18% and 70.59%, respectively.

Table 1. Effect of integrated management approaches o bacterial wilt and root knot diseases of tomato

Treatments	Bacterial wilt incidence (%)	Reduction of Bacterial wilt incidence over control (%)	Gall index (0-10 scale)	Reduction of gall index value over control (%)
T1=PR+SBP+ES	18.00	60.29	2.10	50.58
T2=PR+$CaNO_3$+ES	22.33	50.74	2.50	41.18
T3=PR+SBP+Furadan+ES	11.33	75.00	1.80	57.65
T4=PR+ $CaNO_3$ +Furadan+ES	13.33	70.59	1.75	58.82
T5=Control-1	45.33	-	4.25	-
T6=PR+SBP+LS	10.33	68.05	2.00	42.86
T7=PR+$CaNO_3$+LS	11.67	63.90	1.60	54.28
T8=PR+SBP+Furadan+LS	8.67	73.18	1.10	68.57
T9=PR+ $CaNO_3$ +Furadan+ES	12.67	60.81	1.30	62.86
T10=Control-2	32.33	-	3.50	-

PR= Poultry refuse, SBP= Stable bleaching powder, ES=Early sowing, LS= Late sowing

Average gall index of 4.25 and 3.50 was recorded in the control-1 and control-2 plots, respectively. Gall index was reduced to 41.18% to 68.57% due to integration of different treatments as compared to control. The maximum reduction (68.57%) was obtained with T8 (PR +SBP + Furadan 5G+LS) followed by T9 (PR + $CaNO_3$+ Furadan 5G +LS), T4 (PR + $CaNO_3$+ Furadan 5G +ES) and T3 (PR + SBP + Furadan 5G +ES) where the reduction was 62.86%, 58.82% and 57.65%, respectively over controls.

Shoot growth: Average shoot length of tomato under control-1 and control-2 was 53.93 and 54.73 cm/plant, respectively (Table 2). The highest shoot length 63.73 cm/plant was obtained from T8 treatment (integration of PR + SBP + Furadan 5G +LS) followed by T7 (62.60 cm/plant) (PR + $CaNO_3$ +LS) and T6 (61.80

cm/plant) (PR+ SBP +LS). The least effective treatments to increase shoot length was T2 (56.52 cm/plant) (PR + $CaNO_3$ +ES) (Table 2).

The shoot weight of tomato was only 125.67 and 132.67 g/plant under control-1 and control-2, respectively. It increased with the used of organic soil amendments and range from 173.33 to 370.00 g/plant. The highest shoot weight was achieved from T8 (PR + SBP + Furadan 5G +LS) followed by T3 (PR + SBP + Furadan 5G +ES) and T6 (PR + SBP +LS). The least effective treatment to increase shoot weight was T2 (PR + $CaNO_3$+ ES) which was followed by T1 (PR + SBP +ES) and T4 (PR + $CaNO_3$+ Furadan 5G +ES) (Table 2).

Table 2. Effect of integrated management approaches on vegetative growth of tomato

Treatment	Shoot Length (cm)	Shoot Weight (gm)	Root Length (cm)	Root Weight (gm)
T1=PR+SBP+ES	59.72 b	173.67 e	28.13 bcd	22.00 c
T2=PR+$CaNO_3$+ES	56.53 c	173.33 e	29.33 abc	20.33 c
T3=PR+SBP+Furadan+ES	60.60 b	368.67 ab	30.33 abc	28.00 b
T4=PR+ $CaNO_3$ +Furadan+ES	60.33 b	200.33 d	30.67 abc	21.33 c
T5=Control-1	53.93 d	125.67 f	24.87 d	15.00 d
T6=PR+SBP+LS	61.80 ab	366.33 ab	32.07 ab	22.33 c
T7=PR+$CaNO_3$+LS	62.60 ab	313.67 c	29.25 abc	27.67 b
T8=PR+SBP+Furadan+LS	63.73 a	370.00 a	33.20 a	38.00 a
T9=PR+ $CaNO_3$ +Furadan+ES	60.67 b	350.67 b	30.07 abc	31.33 b
T10=Control-2	54.73 cd	132.67 f	26.80 cd	23.67 c

PR= Poultry refuse, SBP= Stable bleaching powder, ES=Early sowing (Middle of October), LS= Late sowing (1st week of December)

Root growth: Significantly higher root growth of tomato was obtained from T8 and T6 as compared to control. The minimum root length of 24.87 and 26.80 cm/plant was recorded under control-1 and control-2, respectively (Table 2). The least effective treatment to increase root length was T1 (PR + SBP +ES) (Table 2). Root weight was 15.00 g/plant under control-1. The highest root weight 38.00 g/plant was achieved by T8 (PR + SBP + Furadan 5G +LS) treatment followed by T9 (PR + $CaNO_3$+ Furadan 5G +LS) and T3 (PR + SBP + Furadan 5G +ES). The rest of the treatment showed least effective to increase root weight.

Crop yield: Integration of organic soil amendments gave appreciable increase in fruit number/plant, fruits weight/plant and fruit yield per hectare (Table 3). Fruit number per plant was 27.33 and 31.00 under control-1 and control-2, respectively. Per plant fruit number increased to 32.33 to 40.00 due to different treatments but their effect was statistically similar. Fruits weight per plant was 1.46 kg/plant and 1.57 kg/plant under control-1 and control-2 treatments, respectively. It was increased 1.57 to 1.92 kg/plant due to different treatments. Significantly higher and statistically similar fruits weight per plat was achieved from T8 (PR +SBP + Furadan 5G+LS) and T9 (PR + $CaNO_3$+ Furadan 5G +LS) treatments.

Table 3. Effect of integrated management approaches on the yield of tomato

Treatment	No. of fruits/ plant	Weight of fruits/plant (Kg)	Yield (t/ha)	Yield increased over control (%)
T1=PR+SBP+ES	37.67 a	1.58 bc	45.67 bc	19.73
T2=PR+$CaNO_3$+ES	36.33 a	1.70 b	44.20 bc	17.05
T3=PR+SBP+Furadan+ES	38.33 a	1.57 bc	47.64 b	23.18
T4=PR+ $CaNO_3$ +Furadan+ES	40.00 a	1.76 b	46.80 b	21.67
T5=Control-1	27.33 b	1.46 c	36.66 d	-
T6=PR+SBP+LS	37.55 a	1.64 bc	47.00 b	20.96
T7=PR+$CaNO_3$+LS	32.33 b	1.72 b	44.31 bc	16.16
T8=PR+SBP+Furadan+LS	39.00 a	1.92 a	52.38 a	29.07
T9=PR+ $CaNO_3$ +Furadan+ES	37.60 a	1.82 a	48.80 ab	23.87
T10=Control-2	31.00 b	1.57 bc	37.15 d	-

PR= Poultry refuse, SBP= Stable bleaching powder, ES=Early sowing, LS= Late sowing

The lowest fruit yield of 36.66 and 37.15 t/ha was found under control-1 and control-2 treatments, respectively. The yield was increased 44.20-52.38 t/ha due to application of different treatments. The maximum yield was obtained from T8 treatment (PR +SBP + Furadan 5G+LS) followed by T9 (PR + $CaNO_3$+ Furadan 5G +LS). Treatment T8 (PR +SBP + Furadan 5G+LS) gave 29.07% higher yield compared to control followed by T9 treatment (PR + $CaNO_3$+ Furadan 5G +LS). However, all the treatments gave significantly higher yield compared to control.

The results of the present study demonstrated that soil amendment with poultry refuse, bleaching powder and Furadan 5G suppressed bacterial wilt and root-knot disease incidence and increasing plant growth parameters like shoot length, shoot weight, root length and root weight as well as yield of tomato compared to control. These results are in agreement with that of Orisajo *et al*. (2008) and Djeugap *et al.* (2014) who reported that poultry manure have a suppressive effect on root-knot nematodes and bacterial wilt incidence. Biswas and Singh (2008) studied the effect of soil rectification for control of bacterial wilt of tomato and they reported that soils treated with lime + bleaching powder reduced wilt incidence of tomato. Chen *et al.* (2000) reported that use of organic amendments in the form of manure and compost effectively decrease parasitic nematode populations and disease intensity on plants. Kishun (1981) conducted field trials to control bacterial wilt of tomato and reported that bleaching powder was most effective in decreasing bacterial wilt.

The improvement in plant growth through the incorporation of poultry refuse, bleaching powder and Furadan 5G may be attributed to the addition of nutrients to the soil. From the decomposition and the decomposed material poultry refuse may have direct killing or inhibiting effect on nematodes and bacteria. Nematicidal effects of organic amendments have been attributed to several factors including increase in facultative parasites due to their richness in organic matter and release of toxic substances during decomposition (Oka 2010; Sikora *et al*. 2007; Oka *et al.*, 2007). Farahat *et al*. (2010) also reported that efficacy of poultry manure against plant-parasitic nematodes may either be due to stimulation of specific micro-organisms that were capable of parasitizing eggs and juveniles or production of substances from decomposition of the manure which were toxic to the nematodes. Similar studies have also been done by Hassan *et al*. (2010) and reported that amending the soil with organic waste materials such as poultry refuse, rice husk and saw dust suppressed the populations of *Meloidogyne* spp. both in the soil and roots of tomato with simultaneous increase in the (2007) and Orisajo *et al.* (2008) also reported that application of soil organic amendments is not only beneficial to nematode management but also to plant growth and productivity. Therefore, it may be concluded that integration of poultry refuse with Furadan 5G and stable bleaching powder is the best treatment for reducing root knot nematode and bacterial wilt diseases and increasing plant growth as well as yield of tomato.

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