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Fusarium Wilts Controlling Revealed Physiological and Biochemical Variations in Tomato (*Lycopersicon esculentum* L.) Cultivar

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ABSTRACT

The objective of the present investigation was to evaluate the effect of new fungicides on wilt incidence and yield of tomato. The experiment was carried out following standard randomized complete block design at the rate of three replications with eighteen new fungicides on BARI Tomato 14 variety. New fungicides significantly enhanced plant height (Magvit 80 WP: 57.44 cm), number of branches (Wonderful 80 WP: 11.67), number of fruit branches (Gunzim & Provax: 10.33), number of fruits (Provax: 40.33) and weight of fruits (Provax: 1209.90 g). The lowest wilt incidence and highest plant survival were recorded in Provax which was statistically similar to Gunzim, Ranazim 50 WP, T. Bendazim, One Sighn, Larkzim 50 WP, Descozim, Biozim 50 WP, Rexizim 50 WP, Sarazim and Rajvit. The highest incidence and the lowest plant survival were recorded in untreated control which was not statistically similar to other fungicides. Provax treated plots gave the highest (39.31 t/ha) yield, which was statistically identical to Gunzim, Ranazim 50 WP, T. Zeb, T. Bendazim, One Sighn, Larkzim 50 WP, Descozim, Biozim 50 WP, Rexizim 50 WP, Sarazim and Rajvit and untreated control gave the lowest yield which was not statistically identical to other fungicides.

KEY WORDS: FUSARIUM WILT, TOMATO, MORPHOLOGICAL CHARACTERIZATION, FUNGICIDES.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is the second most important vegetable crop next to potato (De et al., 1996; Amini 2009). It originally came from tropical area from Mexico to Peru. Tomato has achieved tremendous popularity throughout the world over the last century. It is one of the most widely grown vegetables, which is grown mainly in the open-field for home use and local markets (Kamal et al., 2009; Hossain et al., 2014). It is important cash crop grown by both small scale farmers and commercial growers for fresh market and processing industry (Lemma et al., 1992). It is beneficial to human health being rich in minerals, vitamins, essential amino acids, sugars and dietary fibers (Miller et al., 1986 Misra et al., 2008). It is popular delicious vegetable in Bangladesh. Bangladesh has got tropical and sub-tropical climate suitable for cultivation of tomato. But tomatoes are parasitized by a number of pathogens, including *Fusarium oxysporum sp lycopersici* causal agent of fusarium wilt. Some fungal seed borne pathogens have ability to kill the seedling or plants and substantially reduce the productive capacity (Assefa et al., 2015; Mane et al., 2020).

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Among them most important fungus reported are *Fusarium solani* and *F. oxysporum* (Mane et al., 2018). *Fusarium* wilt is one of the most devastating diseases of crops of Solanaceae family in Bangladesh. It is one of the important disease causing yield reductions in the field (Ferniah et al., 2014). *Fusarium* wilt, caused by the soil-born fungus *Fusarium oxysporum*, initially causes a yellowing and wilting of lower leaves on infected plants. *Symptoms* can be seen on a single branch, or on several branches on one side of the plant, or on all the lower branches. Since *Fusarium* wilt is a serious threat a strategic crop in Bangladesh, effective control measures are searched. Several disease management strategies are available e.g. cultural technique, biological control, resistant cultivars, crop rotation and chemical control (Kamal et al., 2009, Assefa et al., 2015).

However, all management strategies were unproved in all ways due to highest resistance ability of the fungus. Even though, resistant cultivars are the most effective measure of controlling *Fusarium* wilt, but new races of the pathogen appear to overcome resistance genes in currently grown cultivars (Sanogo et al., 2003). In order to prevent and control the wilting of seedling and adult plant and to protect the crop plants against pathogens, chemical control methods were in practice in Bangladesh. Therefore, in the present research investigation, new fungicides on BARI Tomato 14 variety were selected as an effective candidate because of their unknown facts and mechanism of action with respect to the crop immunity and productivity under field condition.

MATERIAL AND METHODS

Host plant and field area: Tomatoes plants are highly susceptible to fungal diseases were grown in the field of Regional Agricultural Research Station, BARI, Ishurdi, Pabna. BARI Tomato 14 variety was used as test plant which was brought from local market. The experimental land was well ploughed and properly leveled before bed preparation. Weeds and stubbles were removed from the field. Cow dung @ 10 t/ha, Urea @550 kg/ha, TSP @ 450 kg/ha and MP @ 250 kg/ha were applied (Sanogo et al., 2003).

Field experiment: The experiment was carried out following randomized complete block design with three replications. Total of eighteen new fungicides were selected for the experiment and study were designed according to the standard alignments. The new fungicides are depicted in table 1. The treatments were applied in pits of tomato plant ten days after crop plantation. Size of the plots was 2.0 m × 1.2 m and plant spacing was 60 cm × 50 cm. Fusariam inoculum was mixed with soil before two weeks of plantation of tomatoes for establishment of fungi. Intercultural operations were done as per needed and to maintain the normal hygienic condition of crop in the field. Wilt incidence, number of healthy plant, plant height, number of branches/plant, number of fruit branches/plant, number of fruits/plant, weight of fruits/plant yield (t/ha) were recorded (Goldberg 2010).

Statistical analysis: The disease of tomato field percentage of infected plants and percentage of damaged plants was recorded by adopting the grading formula. The percentage of infected and damage plants were calculated by the formula:

$$\text{Disease incidence (\%)} = \frac{\text{Total No. of infected plants}}{\text{Total No. of plants}} \times 100$$

The recorded data were analyzed statistically to find out the level of significance and the variations among the respective data were compared following Duncan's New Multiple Range Test (DMRT) according to standard data.

RESULTS AND DISCUSSION

In the present investigation, the effects of eighteen new fungicides on BARI Tomato 14 variety were evaluated at Regional Agricultural Research Station, BARI, Ishurdi, Pabna. The effect showed by the new fungicides which were resulted into the enhanced growth of the tomato plants, in which fungicides promoted different traits in tomato plants such as number of branches, number of fruit branches, number of fruits and weight of fruits. It happened due to more efficient genes available in the tomato plants and triggering by new fungicides, ultimately plants depicted more competitive in suppressing wilt incidences caused by the soil-born fungus *Fusarium oxysporum*. The *Fusarium* wilt caused by *F. oxysporum* sp. lycopersici is one of the serious diseases of tomato responsible for serious economic losses (Mane et al., 2018). The list of eighteen new fungicides is presented in table 1.

Table 1. List of new fungicides used on wilt incidence and yield of tomato

Treat ments	Fungicides	Efficient (g/L)	Concen trations
1	Gunzim	Carbendazim	2
2	Wellvit 80 WP	Sulphar	2
3	Wonderful 80 WP	Sulphar	2
4	Ranazim 50 WP	Carbendazim	2
5	Zafer 80 DF	Sulphar	2
6	T. Zeb	Sulphar	2
7	T. Sulphar	Sulphar	2
8	T. Bendazim	Carbendazim	2
9	Zeesul 80 WG	Sulphar	2
10	One Sighn	Carbendazim	2
11	Larkzim 50 WP	Carbendazim	2
12	Magvit 80 WP	Sulphar	2
13	Descozim	Carbendazim	2
14	Biozim 50 WP	Carbendazim	2
15	Rexizim 50 WP	Carbendazim	2
16	Sarazim	Carbendazim	2
17	Rajvit	Sulphar	2
18	Provax 200	- 2	

The lowest wilt incidence (4.64%) and highest plant survival (95.76%) were recorded in Provax which was statistically similar to Gunzim, Ranazim 50 WP, T. Bendazim, One Sighn, Larkzim 50 WP, Descozim, Biozim 50 WP, Rexizim 50 WP, Sarazim and Rajvit and the highest incidence was (40.90%) and the lowest plant survival (59.10%) was recorded in untreated soil as control which was not statistically similar to other fungicides. The results are depicted in table 2. The variability among five isolates of *Fusarium solani* causing root rot of mulberry and found that five *Fusarium solani* isolates resulted 40.00-55.00 mm radial mycelial growth at 7 days after inoculation (Ferniah et al., 2014), while others measured 30 mm radial growth of *Fusarium oxysporum* f. *sp. phaseoli* after 72 hrs of inoculation (Yadeta et al., 2013). It was also recorded that fungal colonization by the inducer microorganism was necessary before resistance could be realized (Mane et al., 2020).

The importance of a competence depth of the inducer was up to 8 cm in relation to infection of *Fusarium oxysporum* (Goldberg NP. 2010). Immunity of the tomato plants was enhanced due to new fungicides and vigour compared to the untreated control. The *Fusarium oxysporum*, *F. pallidoroseum* and *Rhizoctonia solani* were consistently associated with higher frequency with the diseased parts (Soboka et al., 2012).

The field experiment with three fungicides at 0.5% concentration in randomized block design where application of Bavistin showed up to 62.27% reduction of wilt infection in tomato plants (Ferniah et al., 2014; Abada et al., 2014). Meanwhile other projects revealed that coating of chickpea seeds with Carbendazim (0.2%) was more effective in reducing wilt and increasing seed yield by 25.9 to 42.6 percent (Hossain et al., 2014). But the management of wilt incidences and deficient plant traits is a challenge as it behaves differently from other fungi and is a soil borne-systemically infecting pathogen. Considering use of new fungicides in this study as innovative approach to manage phytopathogens, in order to manage fungal diseases, it is important to screen antifungal activity of such fungicides to confirm the effectiveness (Kamal et al., 2009).

Table 2. Effect of fungicides on wilt incidences and yield contributing characters of tomato plant

Treatments	Wilted plants (%)	No. of fruit branches/ plant	No. of fruits/ plant	Wt. of fruits/ plant (g)
Gunzim	5.87 g*	10.33	36.81 cde	1004.30 bcd
Wellvit 80 WP	16.03 bcd	9.00 ab	32.20 h	966.12 cd
Wonderful 80 WP	12.80 de	8.33 abc	33.00 gh	990.00 bcd
Ranazim 50 WP	6.43 g	7.67 bc	37.48 b-e	1134.30 ab
Zafer 80 DF	16.91 bc	8.00 bc	32.00 h	960.23 cd
T. Zeb	10.35 ef	7.67 bc	36.13 cde	1083.90 abc
T. Sulphar	16.69 bc	7.00 bc	32.93 gh	948.12 cd
T. Bendazim	6.70 g	7.00 bc	36.20 cde	1089.00 abc
Zeesul 80 WG	18.58 b	8.67 abc	33.67 fgh	990.00 bcd
One Sighn	5.73 g	8.00 bc	37.47 b-e	1104.00 abc
Larkzim 50 WP	4.89 g	7.00 bc	39.34 ab	1190.10 a
Magvit 80 WP	13.41 cde	8.00 bc	35.12 efg	1003.50 bcd
Descozim	7.32 fg	7.67 bc	35.85 def	1075.50 abc
Biozim 50 WP	5.55 g	7.67 bc	36.91 cde	1107.30 abc
Rexizim 50 WP	5.24 g	8.33 abc	37.90 bcd	1137.00 ab
Sarazim	6.91 g	8.00 bc	38.34 abc	1168.20 a
Rajvit	5.77 g	7.67 bc	39.33 ab	1176.67 a
Provax 200	4.64 g	10.33 a	40.33 a	1209.90 a
Control	40.90 a	6.67 c	27.78 i	850.63 d
CV (%)	13.33	14.43	2.67	7.65
LSD (P≥0.05)	3.284	1.928	2.118	134.5

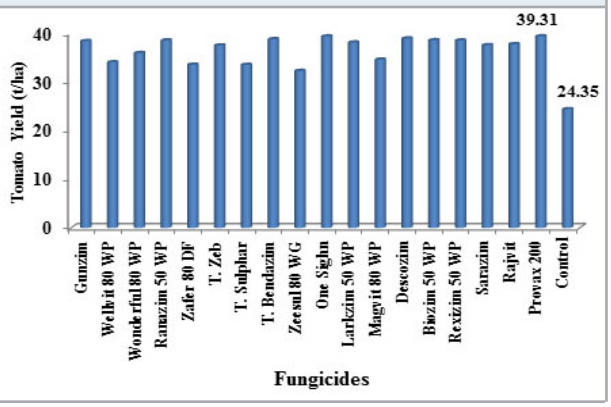
*In a column, similar letters do not differ significantly at 5% level of probability

Tomato plant height was significantly influenced by the fungicides but not number of branches per plant. Magvit 80 WP treated plots gave the tallest plant (57.44 cm) which was followed by maximum fungicides treated plots and control treatment gave the smallest plants (48.22 cm). The maximum (11.67) number of branches per plant was obtained from Wonderful 80 WP and T. Bendazim and the minimum number (9.33) of branches

per plant was obtained from Ranazim 50 WP and T. Zeb. The results are depicted in Table 2.

The highest (10.33) number of fruit branches per plant was recorded in Gunzim and Provax which was followed by Wellvit 80 WP, Wonderful 80 WP, Zeesul 80 WG and Rexizim 50 WP, and the lowest (6.67) number of fruit branches per plant was recorded in untreated control. Provax 200 resulted the highest (40.33) number of fruits per plant which was statistically identical to Larkzim 50 WP, Sarazim and Rajvit, and untreated control resulted the lowest (27.78) number of fruits per plant which also was not statistically identical to other fungicides. The highest (1209.90 g) weight of fruits per plant was obtained from Provax treated plots which was followed by Ranazim 50 WP, T. Zeb, T. Bendazim, One Sighn, Larkzim 50 WP, Descozim, Biozim 50 WP, Rexizim 50 WP and Sarazim, and the lowest (850.63 g) weight of fruits per plant was obtained from control treatment. The results are depicted in Table 2. Provax treated plots gave the highest (39.31 t/ha) yield which was statistically identical to Gunzim, Ranazim 50 WP, T. Zeb, T. Bendazim, One Sighn, Larkzim 50 WP, Descozim, Biozim 50 WP, Rexizim 50 WP, Sarazim and Rajvit and untreated control gave the lowest (24.35 t/ha) yield which was not statistically identical to other fungicides. The results are depicted in Fig. 1.

Figure 1: Effect of Fungicides on yield of tomato



Tomato plant growth mainly depends upon storage substance like carbohydrates, which are mobilized in the outline of soluble sugars (Lemma et al., 1992). Tomato plant verities demonstrated variations in the composition of soluble sugar when subjected to different spells of pathogenic conditions (Mane et al., 2020). The drop in glucose, fructose and sucrose concentration and an increased accumulation of sorbitol level accounts a common response of tomato plants in response to pathogenic conditions (Mane et al., 2018).

The newly used fungicides played a very important role in the immunity system of tomato plants by increasing their carbohydrate level and other protein levels. It happened due to carbohydrate equilibrium showed by tomato plants after treatment therefore they showed effective growth of branches, fruit branches, fruits and weight of fruits. Others evaluated some fungicides thiram, emissan (2 methoxy ethyl mercury chloride), indofil M-45 80% WP (mancozeb + thiophanate-methyl), captaf 50% WP (captan) and bavistin 50% WP, alone or in combination for their effects on tomato foot rot in vitro (Sanogo et al., 2003, Mane et al., 2020). The present study highlights the efficiency of the tested new fungicides in inducing resistance against fungus *Fusarium oxysporum* in tomato plants after field trials. Although the complete mechanism of action of new fungicides is yet to be elucidated, the results confirm a new biological action of the new fungicides. The present investigation will help in understanding the pathogenesis and molecular basis of defense reactions in tomato plants against fungal infections and in the selection of traits in plant breeding programmes.

CONCLUSION

The present investigation revealed the efficiency of the Provax which gave the highest (39.31 t/ha) with lowest wilt incidence and highest plant survival. Gunzim, Ranazim 50 WP, T. Bendazim, One Sighn, Larkzim 50 WP, Descozim, Biozim 50 WP, Rexizim 50 WP, Sarazim and Rajvit are also performed better for controlling Fusarium wilt of tomato. Moreover, the activity of the fungicides was effective and successfully controlled the fusarium wilt of tomato. Overall, our findings have provided the basis for controlling the fusarium wilt of tomato to untangle the decreased yield of tomato.

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