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FIELD SCREENING OF SOME TOMATO GENOTYPES AGAINST LEAF MINER UNDER WEST BENGAL CONDITIONS

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ABSTRACT
A field experiment was conducted to screen out six important tomato genotypes for resistance/ tolerance against leaf miner and their natural enemies under West Bengal conditions. Six tomato genotypes *viz*. Patherkuchi, Ruby, NS501, Roja cherry, Romeo and Priya were screened against leaf miner (*Liriomyza trifolii* Burgess). Genotypes were designated as less susceptible (LS), moderately susceptible (MS), highly susceptible (HS) and tolerant /resistant (T/R) types depending on their reactions to insect infestation. The pest first appeared on the crop in fourth week of January and the peak was reached in the second to third week of March. The maximum (r= -0.333) and minimum relative humidity(r= -0.347) along with rainfall (r= -143) showed negative correlation maximum temperature (r= 0.863), minimum temperature (r= 0.824) and sunshine hour (r=0.215) favoured the population build up. Results showed that none of test genotypes were found either as tolerant or resistant against leaf miner. In terms of relative susceptibility, the tomato genotypes could be arranged in the following sequence (higher to lower): NS 501> Romeo> Ruby> Priya> Roja> Patherkuchi. Here Patherkuchi (18.11%) was found less susceptible and others were moderately susceptible (Ruby, Roja cherry, Romeo and Priya) to highly susceptible NS501 (43.04%). The outcome of the present study could be useful for using less susceptible and moderately susceptible genotypes for incorporation in the crop rotation scheme. Further, the less susceptible variety (Patherkuchi) may be further characterized using molecular tools.

KEYWORDS: Tomato genotypes, insect pests, natural enemies, resistance.

INTRODUCTION
Tomato is one of the member of nightshade family (along with aubergines, peppers and chillies), tomatoes are in fact a fruit, but their affinity for other savoury ingredients means that they are usually classed as a vegetable. Tomatoes originated in western South America, crossed the Atlantic to Spain with the conquistadors in the 16th century, but only finally caught on in northern Europe in the 19th century (Acquaah, 2002). A tomato is the edible, often red fruit from the plant *Solanum lycopersicum*, commonly known as a tomato plant. The tomato is consumed in diverse ways, including raw, as an ingredient in many dishes, sauces, salads, and drinks. The fruit is rich in lycopene, which may have beneficial health effects. Tomato consumption has been associated with decreased risk of breast cancer (Zhang *et al*., 2009), head and neck cancers (Freedman *et al.,* 2008) and might be beneficial for reducing cardiovascular risk associated with type 2 diabetes (Shidfar *et al*., 2011). However, like all other vegetable crops, tomato also faces some production hurdles due to unfavourable temperature, moisture-stress, cracking, pollination, pests etc. but the problem posed by pests is very critical. At times, it may become very critical and if emergency measures are not contemplated, the entire yield may have to be compromised. Tomatoes are subject to attack by quite a large spectrum of insect pests along with leaf miner (*Liriomyza trifolii* Burgess) from the time of seed emergence to harvest. To avoid the crop loss, onus primarily fell on the exploitation of chemical method (Anonnymous, 2011; Raddy, 2010; Sukla and Prabhakar, 1987; Musuna, 1983). But it has got a large array of non-target impacts and that makes it unfit to be adopted as a steady option. To obtain an acceptable yield level and cost-benefit ratio, the pest problem needs to be effectively addressed. Present-day –pest-management emphasizes on a holistic approach that cares for the plant, pest, beneficial organisms as well as the environment. Hence, the rationale should emphasize on the principle of "live and let live". It allows sustainability and stability to the entire crop ecosystem and eventually ensures good yields. Resistance technology occupies an important place in the present day rational pest management strategies. A genotype exhibits tolerance or resistance by any of the three basic resistance mechanisms: preference-nonpreference, antibiosis and tolerance. Keeping this option of utilizing resistance technology in mind some tomato germplasms were screened for their relative tolerance/susceptibility to the leaf miner of the region.

MATERIALS & METHODS
The experiment was set up at A-B Block Research Farm, B.C.K.V., Kalyani, Nadia, West Bengal. The studies were conducted during January 2013 – April 2013. Standard agronomic practices were followed to ensure optimal crop growth. The entire study was conducted under unsprayed condition. The site is situated at 22.980 N latitude and 88.480 E longitude and 9.75 m above mean sea level. During the study period, maximum temperature ranged between 24.44 - 36.76^{o}C and minimum temperature varied from 7.59 - 23.24oC. Winter is very short and mild in this

region. The area comes under genetic new alluvial zone plains. The soil is sandy loam type and slightly acidic (pH 6.5), low in organic carbon (0.54%) and available nitrogen (0.69%).The available phosphorus (30.0 kg/ha) and potassium (240 kg/ha) contents are medium. Seeds of six genotypes of tomato including five commercial varieties and one pure line were tested for their resistance/tolerance to important insect pests. Natural enemies found in the tomato ecosystem were also included in the study. The morphological characters of the genotypes are listed in table below. The experiment was set out in randomized block design with six treatments and four replications. Each variety was considered as a treatment.

Raising the crop

The seeds were sown in nursery bed on 1st January following standard norms and 30 day-old-seedlings were transplanted at a spacing of 75cm ×75 cm in plots of 3m × 3 m. Each entry was replicated four times. Fertilizers were applied @120:50:50 (N: P: K). Nitrogen was applied in 3 split doses, first one at the time of transplanting, second one at 30 days after transplanting and last one 30 days after first top dressing. Full dose of P and K was given at the time of transplanting.

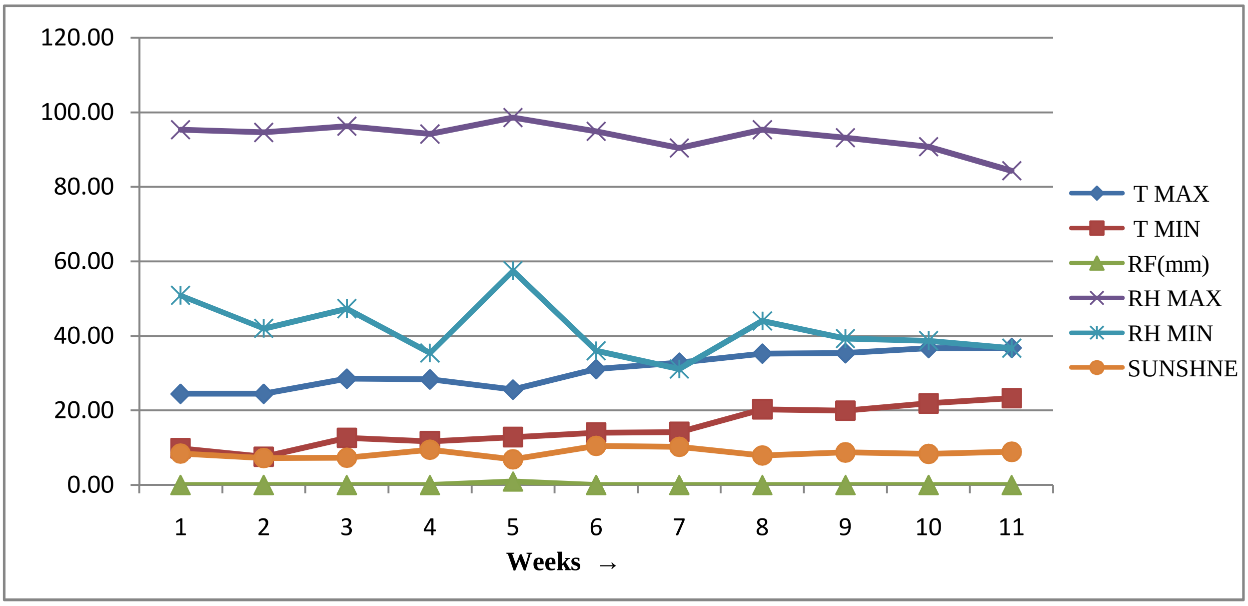
Method of observation

Data were collected from randomly selected plants at an interval of seven days starting from 27January 2013 to 30 April 2013.Four plants were randomly selected from each replication for observations on leaf miner. To assess the damage (percentage) by leaf miner, all the leaves of the four sampled plants /replication were observed. Numbers of the natural enemies were also counted from randomly selected 4 plants/replication. The natural enemies were – 3 species of spiders, 4 species of coccinellids and 1 species of hover fly.

Genotypes were designated as less susceptible (LS), moderately susceptible (MS), highly susceptible (HS) and tolerant /resistant (T/R) types depending on their reaction to insect infestation.

TABLE 1: Gross morphological characters of the tomato genotypes

Variety	Plant height (cm)	Plant canopy (cm)	Mean fruit number	Mean fruit weight (g)	Mean fruit diameter (cm)	Leaf character (glabrous or hairy)	Stem character (soft or compact)
Patherkuchi	98.58	50.83	21.62	43.48	4.06	glabrous	soft
NS501	88.33	45.42	32.58	43.71	4.26	hairy	compact
Romeo	87.83	45.83	38.22	41.00	3.92	hairy	compact
Ruby	68.75	38.25	33.29	31.42	3.61	glabrous	soft
Roja	78.75	36.25	70.58	5.65	2.14	hairy	compact
BSS908 Priya	79.68	40.67	32.22	34.80	3.69	glabrous	soft



Source: Dept. of Agril. Meteorology & Physics, B.C.K.V, Mohanpur, Nadia

FIGURE 1: Weekly average record of different meteorological parameters throughout the entire period of study -2013

RESULTS & DISCUSSION

Plants and insects are in an inseparable and continuous process of co-evolution system. Harmful insects are suppressed by either other insects or microbes or toxic mechanisms or by plant defense mechanisms. These ensure sustainability of crop yield and as well as a balance or homeostasis of the system. To feed the ever growing human population, emphasis has always been given on increased production. Modern-day-production system integrates improved seed or plant materials, new fertilizer regimes and mostly synthetic pesticide-based chemical protection technology to ensure a higher quantum of yield. Insect-plant-interaction is a dynamic relationship. Whenever a plant species is modified to evade or suppress pest attack, it triggers a set of change in the candidate pest and in turn, its immediate next-generation is likely to evolve with a newer mechanism that will help the species to overcome plant- defence barrier and feed on the plant. The special defence attribute of the genotype becomes redundant. For this reason, it is always very difficult to obtain a truly resistant crop cultivar or genotype. However, as long as plants remain, insect or insects will feed on them and from this complex frame, we have to extract better yields to feed the growing population. The present-day-protection concept emphasizes on the holistic approach which considers the pests, the crop, the environment and the natural enemies altogether. The cost factor also remains under the purview. In brief, this is the system approach in plant protection. This approach ensures better protection and at the same time, maintains the homeostasis at the best possible level. Among the different options available, host plant resistance is one of the effective tools for reducing insect damage. Each plant species has a unique set or collection of defense traits ranging from morphological to phytochemicals that have behavioral and physiological ramification for a potential herbivore consumer. Plant characteristics have been recognized for years as important resistance factors. Resistance mechanism in plants against insects may be due to one or more of Preference/non-preference, Antibiosis and Tolerance.

Hildebrand *et al.* (1993) and Raghava (2010) reported that antibiosis was the main mechanism of exhibiting tolerance to insect pests. Leite *et al.* (1999) on the other hand opined that relative tolerance/resistance of tomato genotypes comes from a combination different resistance mechanisms, i.e., morphological characters as well as chemical and physiological character of the genotypes. Gajendra *et al*. (1998) reported that Pusa Early Dwarf, Arka Vikas and Pusa Gaurva showed tolerance through preference-nonpreference mechanism. Ashfaq *et al.* (2012) reported that hair length and hair density on lower leaf surface, as well as thickness of leaf lamina significantly correlated with larval population and fruit infestation.

Tomato germplasms and leaf miner

Larvae mine on leaves between cuticular layer and upper epidermis of leaves and feed on green tissues making zig-zag silvery white lines which are visible on leaf surface as white thread-like lining. In severe infestation, leaves dry up and wither, growth of the plant gets severely restricted and in extreme case, plant may dry up.

The pest first appeared on the crop in fourth week of January. Results (Table 2) showed that the pest population reached its critical level during second to third week of March on most of the tomato genotypes. The maximum temperature(r= 0.863), minimum temperature(r= 0.824) and sunshine hour(r=0.215) showed positive correlation which means these met parameters helped the pest species to build up population. The maximum (r= -0.333) and minimum relative humidity (r= -0.347) along with rainfall(r= -143) were not helpful for the species and showed negative correlation.

Out of the six genotypes, Patherkuchi (18.11) showed lowest percentage of leafminer damage followed by Roja cherry (19.73) (Table 2). NS501 (20.77) showed maximum leaf miner infestation followed by Romeo (30.62).NS 501 appeared to be the most susceptible genotype suffering 43.04% leaf miner infestation. In terms of relative tolerance, the tomato germplasms can be arranged in the following sequence (higher to lower): Patherkuchi > Roja > Priya > Ruby > Romeo > NS 501.

TABLE 2: Mean per cent infested leaf by the leaf miner, *Liriomyza trifolii* (Burgess) on the tomato genotypes

Variety	Date of observation(at 7 days interval)											Mean
	27.1.13	03.02.13	10.02.13	17.02.13	24.02.13	03.03.13	10.03.13	17.03.13	24.03.13	31.03.13	07.04.13	
Patherkuchi	0.50	1.00	2.13	9.94	15.00	18.50	23.50	51.63	32.75	28.06	16.25	
	(5.72)	(6.96)	(9.20)	(18.62)	(23.17)	(25.81)	(29.19)	(46.23)	(35.20)	(32.26)	(24.15)	18.11
NS501	1.63	4.31	7.38	14.50	19.75	27.25	53.00	68.38	84.75	93.63	98.88	
	(8.36)	(12.65)	(16.28)	(22.69)	(26.55)	(31.59)	(47.04)	(56.12)	(67.67)	(77.87)	(86.37)	43.04
Romeo	1.31	3.06	6.38	11.44	15.19	28.56	57.63	78.63	60.56	46.06	28.00	
	(7.69)	(10.72)	(15.16)	(20.17)	(23.26)	(32.38)	(49.70)	(63.68)	(51.42)	(43.03)	(32.23)	30.62
Ruby	1.63	3.50	6.56	15.19	29.44	37.81	52.75	71.00	50.56	40.81	25.44	
	(8.36)	(11.43)	(15.16)	(23.31)	(33.14)	(38.23)	(46.88)	(57.92)	(45.61)	(39.99)	(30.60)	30.43
Roja	0.69	1.75	4.00	9.25	14.75	17.19	24.50	67.31	37.81	23.50	16.31	
(Cherry)	(6.25)	(8.56)	(12.17)	(18.11)	(22.99)	(24.87)	(29.84)	(55.48)	(38.22)	(29.29)	(23.78)	19.73
BSS908	1.56	4.19	7.88	11.19	15.00	20.25	28.00	69.75	51.69	37.75	20.75	
(Priya)	(8.25)	(12.50)	(16.77)	(19.95)	(23.14)	(27.06)	(32.25)	(57.56)	(46.26)	(38.18)	(27.44)	24.36
S.Em±	0.25	0.55	0.78	1.10	1.08	1.81	1.95	2.43	1.20	1.81	1.41	
CD(=0.05)	0.77	1.66	2.34	3.31	3.27	5.45	5.88	7.32	3.62	5.45	4.25	
CV=	7.65	11.77	12.31	11.98	9.55	13.49	11.14	9.67	5.67	9.31	8.43	

Figure in parenthesis signifies the transformation of original value

Tomato germplasms and natural enemies

Results showed that the tomato ecosystem supports a considerable number and population of natural enemy species. Several species of spiders, predatory coccinellids and one hover fly species were recorded during the course of investigation. The maximum (r=0.500) and minimum temperatures (r= 0.344) and sunshine hour(r=0.507) showed positive correlation with population development of the natural enemy complex whereas maximum (r=-0.028) and minimum relative humidity(r= -0.395) and rainfall(r= -040) showed negative correlation with them. The mean number of the natural enemies varied between 0.31 to 0.51 per plant.

Spiders, hover flies and coccinellids were counted altogether irrespective of the stages. The highest population mean was recorded in Ruby (0.51) followed by BSS 908 Priya (0.48) (Table 3). Whereas lower population was found on Romeo (0.31) and Roja cherry (0.31). In terms of preference of natural enemy, the tomato germplasms can be arranged in the following sequence (higher to lower): Ruby> BSS 908 (Priya) > Patherkuchi >NS 501> Romeo = Roja.

TABLE 3: Mixed population of the natural enemies (spiders, coccinellids and hover fly) in tomato ecosystem

Variety	Date of observation (at 7 days interval)											Mean
	27.1.13	03.02.13	10.02.13	17.02.13	24.02.13	03.03.13	10.03.13	17.03.13	24.03.13	31.03.13	07.04.13	
Patherkuchi	0.00	0.00	0.00	0.19	0.31	0.63	1.19	0.88	0.63	0.50	0.25	
	(4.05)	(4.05)	(4.05)	(4.74)	(5.16)	(6.08)	(7.45)	(6.71)	(6.08)	(5.74)	(4.97)	0.41
NS501	0.00	0.00	0.00	0.13	0.38	0.75	1.13	0.69	0.63	0.38	0.13	
	(4.05)	(4.05)	(4.05)	(4.51)	(5.35)	(6.25)	(7.23)	(6.25)	(6.08)	(5.35)	(4.51)	0.38
Romeo	0.00	0.00	0.00	0.00	0.13	0.44	0.69	1.00	0.69	0.38	0.06	
	(4.05)	(4.05)	(4.05)	(4.05)	(4.51)	(5.55)	(6.23)	(7.01)	(6.25)	(5.35)	(4.28)	0.31
Ruby	0.00	0.00	0.00	0.13	0.38	0.75	1.31	1.63	0.81	0.44	0.19	
	(4.05)	(4.05)	(4.05)	(4.51)	(5.35)	(6.40)	(7.73)	(8.38)	(6.57)	(5.55)	(4.74)	0.51
Roja	0.00	0.00	0.00	0.06	0.31	0.94	0.94	0.63	0.31	0.19	0.00	
(Cherry)	(4.05)	(4.05)	(4.05)	(4.28)	(5.16)	(6.84)	(6.87)	(6.08)	(5.16)	(4.74)	(4.05)	0.31
BSS908	0.00	0.00	0.00	0.25	0.63	1.38	1.25	0.88	0.56	0.31	0.00	
(Priya)	(4.05)	(4.05)	(4.05)	(4.97)	(6.08)	(7.87)	(7.59)	(6.73)	(5.91)	(5.16)	(4.05)	0.48
S.Em±	0.00	0.00	0.00	0.17	0.17	0.37	0.29	0.20	0.14	0.18	0.16	
CD(=0.05)	0.00	0.00	0.00	0.50	0.51	1.12	0.87	0.61	0.42	0.54	0.49	
CV=	0.00	0.00	0.00	8.27	7.19	12.82	8.99	6.55	5.25	7.53	8.12	

Figure in parenthesis signifies the transformation of original value

FIGURE 1 - Six genotypes of tomato

FIGURE 2 – Leafminer infested leaf

FIGURE 3 – Leaf miner

The susceptible genotype of the present study (NS 501) certainly does not have any of the resistance mechanisms. Hence, this is simply out of consideration. The best option is definitely the tolerant/resistant types but incidentally, in the present study, none was found. The most promising one in the present study was Patherkuchi. Genotypes Ruby, Romeo, Roja cherry, Priya were moderately susceptible and further studies can be initiated to explore their potentiality. The present study was confined to screening of some potential germplasms for resistance/tolerance and mechanism of resistance was not explored. It is implied that relative tolerance showed by an entry (Patherkuchi) was exerted by any or combination of the three standard resistance mechanisms, that is, preference-nonpreference, antibiosis and tolerance.

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