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Effect of dates of transplanting on little leaf of brinjal

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Abstract
Brinjal or eggplant (*Solanum melongena* L.) belongs to the family *Solanaceae* which contains 75 genera and over 2000 species. Phytoplasmal little leaf disease is commonly encountered disease symptoms were leaf curling or cupping, reduced leaf size, reduced the petiole length, proliferation of auxiliary shoots, flowers malformed into leaf like structures (phyllody), yellowing and stunted plants growth and death of little leaf infected brinjal plants. The economical important capable of causing yield losses up to 40 percent. Present investigation carried out in *Kharif*, 2018 for management of brinjal little leaf disease under field condition. Brinjal little leaf phytoplasmal disease has been emerging as a threat to brinjal cultivation in Marathwada region of the state of Maharashtra. Insect vector, *Hishimonus phycitis* (leaf hopper) transmit this disease. Hence, to manage this disease by adjustment of brinjal transplanting dates should be followed. Result on management of brinjal little leaf disease indicated that, the crop transplanted late after 05th August was found to be suffered less with leaf hoppers, phytoplasmal little leaf disease with high economical fruit yield than transplanted earlier i.e., on 6th July and 16th July. Correlation between leaf hopper population and phytoplasma disease incidence was positively significant. Also, the correlation between leaf hopper and temperature was positively significant.

Keywords: Brinjal little leaf, management, Transplanting dates, Leaf hopper, Correlation

Introduction

Brinjal is a self-pollinated, annual herbaceous plant (2n=24 chromosoms). Brinjal is the most popular and widely grown vegetable crop of both tropics and sub-tropics of the world. It is being grown extensively in India, Bangladesh, Pakistan, China, Philippines, France, Italy and United States. India is the centre of origin. It is highly productive and find its place as the poor man's vegetable (Som and Maity, 2002) [13]. In India, immature fruits of brinjal are consumed as a cooked vegetable in various ways (Rai *et al.*, 1995) [11] and fruits are rich source of minerals like Ca, Mg, P and fatty acids. Besides, it is used as fresh vegetable and known to have some medicinal properties in curing diabetic patients, asthma, cholera, bronchitis, diarrhoea and other complaints (Tomar and Kalda, 1998) [14]. Eggplant is very low in calories and fats but rich in soluble fibers. 100 g provides just 24 calories but contributes about 9% of RDA (Recommended Daily Allowance) of fiber. It contains good amounts of many essential B-complex vitamins such as pantothenic acid (Vitamin B_5), pyridoxine (Vitamin B_6), thiamin (Vitamin B_1) and niacin (Vitamin B_3), total water-soluble sugars, free reducing sugars and amide proteins (Gopalan *et al.*, 2007) [3].

The brinjal plants infected by phytoplasmas exhibited an array of symptoms that suggest profound disturbances in the normal balance of plant hormones or growth regulators. Symptoms included virescence (the development of green flowers and the loss of normal flower pigments), phyllody (the development of floral parts into leafy structures), sterility of flowers, proliferation of auxiliary or auxiliary shoots resulting in a witches'-broom appearance, abnormal elongations of internodes resulting in slender shoots, generalized stunting (small flowers and leaves and shortened internodes), discolorations of leaves or shoots, leaf curling or cupping, bunchy appearance of growth at the end of the stems and generalized decline (stunting, dieback of twigs and unseasonal yellowing or reddening of the leaves) (Lee *et al.*, 2000) [9]. The phytoplasmas infecting brinjal were transmitted by leaf hopper (*Hishimonus phycitis*) and by grafting (Chen *et al.*, 2002) [2]. Brinjal little leaf disease incidence was up to 45% with the yield per plant reduced by 90% (Kelly *et al.*, 2009) [5].

Brinjal crop cultivation is increasing day by day in India especially, in Maharashtra State. Little leaf of brinjal can be minimized by adjusting transplanting time, to avoid main flights of insect vector i.e., leaf hoppers (Khandelwal, 2018) [6]. Brinjal little leaf phytoplasmal disease has been emerging as a threat to brinjal cultivation in Marathwada region of the state of Maharashtra. It is serious problem in all varieties considering economic importance of disease and very few information available on management of disease therefore the present investigation carried out for management of brinjal little leaf disease.

Material and Methods

Experimental site

The field experiment was conducted during Kharif- 2018, on the experimental farm of the Department of Plant Pathology, College of Agriculture, Latur to assess the effect of five dates of transplanting of brinjal var. Gaurav on leaf hoppers population, little leaf disease incidence and fruit yield with following details of experiment.

The experiment was laid out in Randomized Block Design (RBD) with four replications and five treatments i.e., D_1 (6th July), D_2 (16th July), D_3 (26th July), D_4 (5th August) and D_5 (15th August) at spacing of 0.6 x 0.6 m2 and size of plot was 3 x 3 m^2 with 25 plants per treatment plot.

Observations recorded

Observation on vector population, little leaf disease incidence and fruit yield were recorded.

Vector population

Leaf hoppers count was done early in the morning on top, middle and bottom leaves of the randomly selected 10 leaves of brinjal plants/ treatment/ replication. After 10 days of transplanting, at an interval of 10 days.

Little leaf disease incidence

Similarly, on all those brinjal plants selected for recording leaf hopper, the observations on little leaf disease incidence were recorded, starting from its first appearance at an interval of 10 days and continued till final picking of the fruits.

Fruit yield

Fruits were harvested regular intervals and cumulative fruit yield (kg/ ha) was computed.

Influence of weather parameters

For the purpose, the observations recorded on the different dates of transplanting experiment on leaf hoppers population and little leaf disease incidence. Recorded the weather parameters *viz*., rainfall (mm), number 28 of rainy days, temperature (maximum and minimum), relative humidity (a.m. and p.m.) separately and correlation between leaf hopper population and weather was worked out.

The data generated on experiments conducted was statistically analyzed (Panse and Sukhatme, 1963) [10]. The standard error (SE) for vector population, disease incidence was calculated and critical difference (CD) at 5% level of significance was worked out. The percent data was transformed to angular values.

Result and Discussion

The effect of different dates of brinjal transplanting on leaf hoppers population dynamics, little leaf disease incidence and fruit yield of brinjal, during Kharif, 2018-19 and the in thereof are highlighted here following subheads.

Effect on leaf hopper population dynamics

The results (Table 1, Fig. 1) on leaf hopper population dynamics as influenced by different dates of transplanting revealed that the transplanting dates significantly influenced the population of leaf hoppers on brinjal crop, recorded for 18 times. In all the treatments, leaf hopper count was less and there after it increased steadily and fluctuated. Most vulnerable stage for leaf hoppers infestation was after 90 days of transplanting (flowering stage) and it later decreased with crop maturity. In early transplanting dates, flowering stage synchronized with main flight of leaf hoppers which increased leaf hopper population. Hence, leaf hopper population was maximum in early transplanted than late transplanted crops. Maximum average number of leaf hoppers were recorded in D_1: 6th July (1.47/ leaf), followed by D_2: 16th July (1.45/ leaf), D_3: 26th July (1.39/ leaf), D_4: 05th August (1.19/ leaf) and D_5: 15th August (1.30/ leaf). These results were conformity with the results of Kumar (2012) [8] and Khandelwal (2018) [6].

Effect on little leaf disease incidence

The results (Table 2, Fig. 2) revealed that the disease incidence began after 60 days of transplanting i.e., at early flowering stage and thereafter increased. However, little leaf disease incidence was highest on 180 days after transplanting (26.00%) in D_1: 6th July transplanted crops, followed by the crop transplanted on D_2: 16th July (18.00%) and D_3: 26th July (11.00%). It indicated that early transplanted brinjal crop suffered more from little leaf disease, which might be due to congenial weather parameters. Thus, indicating that to minimize little leaf disease incidence, brinjal crop must be transplanted late during, August month. Similar influence of the transplanting/ sowing of brinjal and sesame crops on phytoplasmal diseases were also reported earlier by Hosseini *et al.* (2015) [4] in sesame and Rao *et al*. (2010) [12] in brinjal.

Table 1: Leaf hopper population dynamics as influenced by different dates of transplanting of brinjal

Sr. No.	Transplanting dates	Number of leaf hoppers/leaf* at DAT																		Avg. Population/ leaf
		10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	
1.	D_1 (6th July)	0.60	1.08	1.33	1.63	1.78	1.78	1.83	1.98	2.13	1.93	1.88	1.65	1.48	1.38	1.20	1.18	1.03	0.73	1.47
2.	D_2 (16th July)	0.80	0.93	1.28	1.55	1.73	1.80	1.98	2.03	2.10	1.63	1.58	1.48	1.33	1.30	1.28	1.20	1.18	1.03	1.45
3.	D_3 (26th July)	0.73	0.95	1.23	1.48	1.68	1.80	1.88	2.00	2.03	1.53	1.48	1.45	1.40	1.25	1.13	1.13	1.08	0.83	1.39
4.	D_4 (5th August)	0.75	0.90	1.03	1.23	1.45	1.53	1.68	1.73	1.83	1.53	1.33	1.18	1.03	1.00	0.93	0.83	0.83	0.75	1.19
5.	D_5 (15thAugust)	0.78	0.88	1.13	1.33	1.53	1.78	1.75	1.88	1.98	1.55	1.48	1.28	1.23	1.13	1.08	1.03	0.98	0.63	1.30
S.E. ±		0.03	0.03	0.05	0.07	0.06	0.05	0.05	0.06	0.05	0.08	0.09	0.08	0.08	0.07	0.06	0.07	0.06	0.07	-
C.D. (P= 0.05)		0.10	0.11	0.10	0.10	0.09	0.11	0.12	0.13	0.11	0.08	0.08	0.12	0.06	0.07	0.05	0.08	0.07	0.08	-

*=Average of four replications; DAT= Days after transplanting

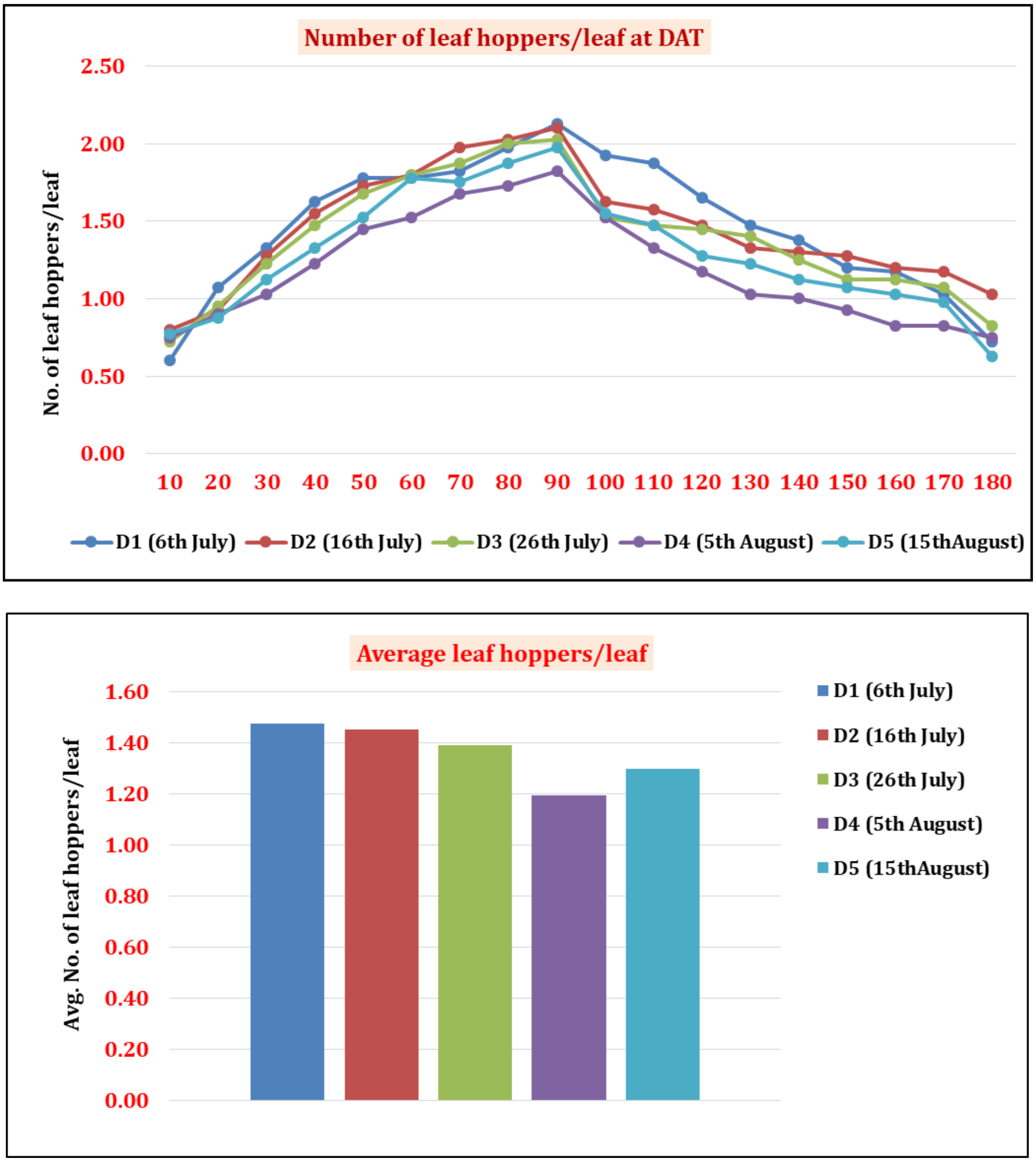
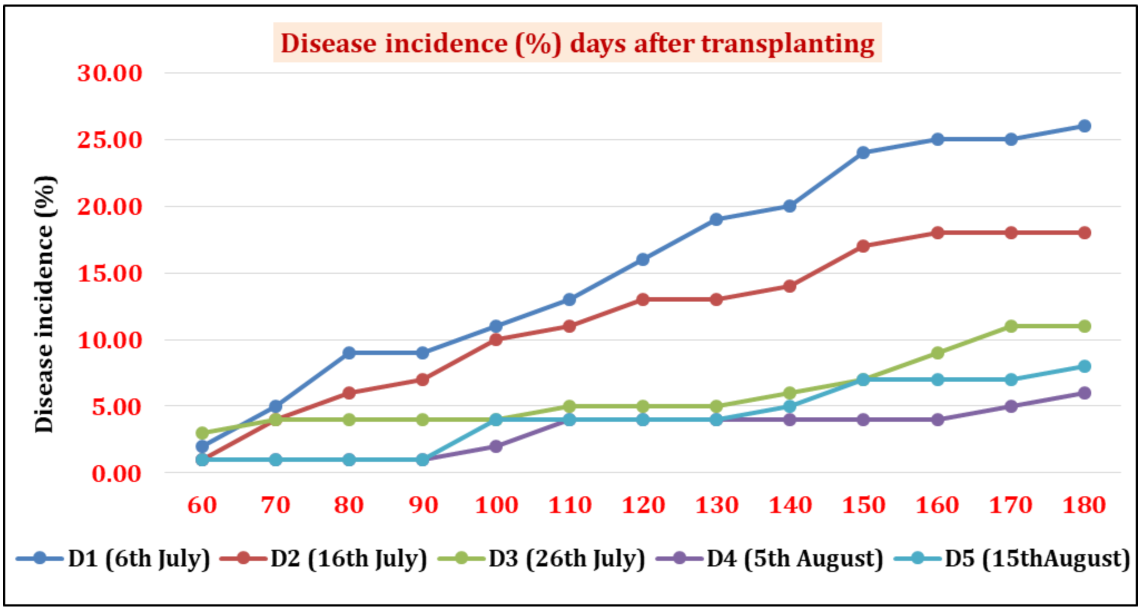


Fig 1: Leaf hopper population dynamics as influenced by different dates of transplanting of brinjal.

Table 2: Effect of different dates of transplanting on brinjal little leaf disease incidence

Sr. No.	Transplanting dates	Disease incidence (%) days after transplanting												
		60	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**
1	D_1 (6th July)	2.00 (5.77) ^{a}	5.00 (11.10) ^{a}	9.00 (17.39) ^{b}	9.00 (17.39) ^{b}	11.00 (19.18) ^{c}	13.00 (20.97) ^{c}	16.00 (23.23) ^{b}	19.00 (25.76) ^{b}	20.00 (26.51) ^{b}	24.00 (29.30) ^{b}	25.00 (29.99) ^{c}	25.00 (29.99) ^{d}	26.00 (30.64) ^{d}
2	D_2 (16th July)	1.00 (2.89) ^{a}	4.00 (9.88) ^{a}	6.00 (13.99) ^{b}	7.00 (15.21) ^{b}	10.00 (18.35) ^{bc}	11.00 (19.31) ^{bc}	13.00 (20.97) ^{b}	13.00 (20.97) ^{b}	14.00 (21.71) ^{b}	17.00 (24.25) ^{b}	18.00 (24.94) ^{c}	18.00 (24.94) ^{c}	18.00 (24.94) ^{c}
3	D_3 (26th July)	3.00 (6.99) ^{a}	4.00 (9.88) ^{a}	4.00 (9.88) ^{ab}	4.00 (9.88) ^{ab}	4.00 (9.88) ^{ab}	5.00 (12.76) ^{ab}	5.00 (12.76) ^{a}	5.00 (12.76) ^{a}	6.00 (13.99) ^{a}	7.00 (15.21) ^{a}	9.00 (17.00) ^{b}	11.00 (19.18) ^{b}	11.00 (19.18) ^{b}
4	D_4 (5th August)	1.00 (2.89) a	1.00 (2.89) ^{a}	1.00 (2.89) ^{a}	1.00 (2.89) ^{a}	2.00 (5.77) ^{a}	4.00 (9.88) ^{a}	4.00 (9.88) ^{a}	4.00 (9.88) ^{a}	4.00 (9.88) ^{a}	4.00 (9.88) ^{a}	4.00 ((9.88) ^{a}	5.00 (12.76) ^{a}	6.00 (13.99) ^{a}
5	D_5 (15th August)	1.00 (2.89) a	1.00 (2.89) ^{a}	1.00 (2.89) ^{a}	1.00 (2.89) ^{a}	4.00 (9.88) ^{ab}	4.00 (9.88) ^{a}	4.00 (9.88) ^{a}	4.00 (9.88) ^{a}	5.00 (12.76) ^{a}	7.00 (15.21) ^{a}	7.00 (15.21) ^{ab}	7.00 (15.21) ^{ab}	8.00 (16.43) ^{ab}
S.E. ±		0.40	0.84	1.53	1.60	1.80	1.91	2.54	3.02	3.10	3.76	3.88	3.69	3.67
C.D. (P= 0.05)		6.13	6.28	4.73	4.69	5.29	4.57	5.02	4.65	3.92	3.62	4.12	2.68	2.57

Figures in parentheses are arcsine transformed values; Values followed by similar alphabets are statistically non-significant by ANOVA.



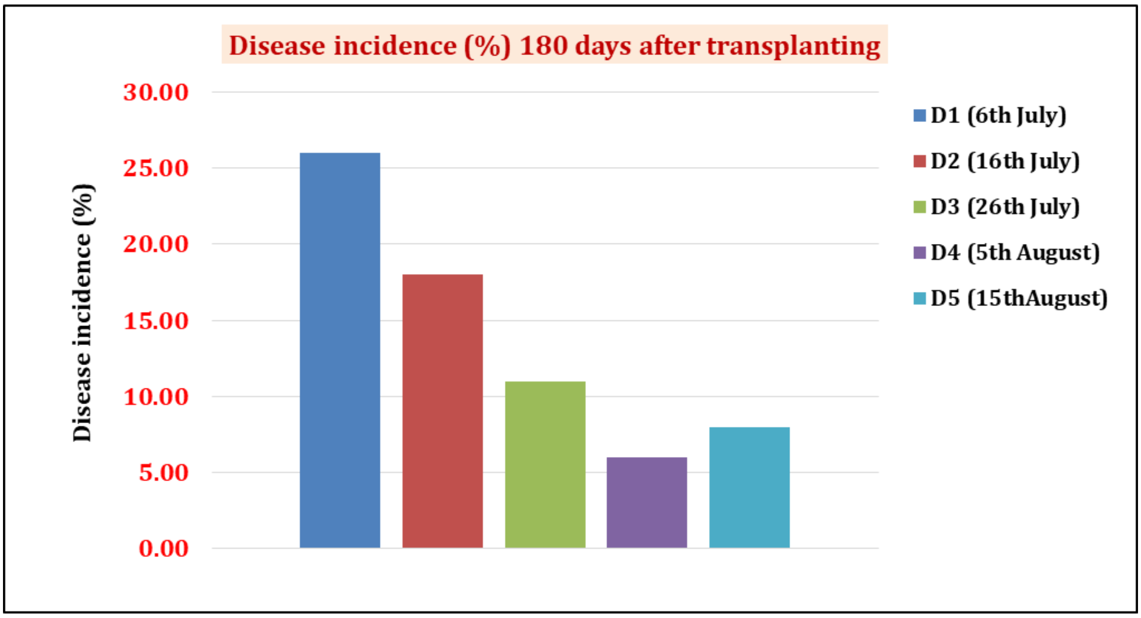


Fig 2: Effect of dates of transplanting on brinjal little leaf disease incidence

Effect of different dates of transplanting on leaf hopper population, disease incidence and fruit yield of brinjal

The results (Table 3 and Fig. 3) revealed that the leaf hoppers population, little leaf disease incidence and corresponding fruit yield significantly influenced by dates of transplanting and were inversely proportional. However, the crop transplanted late on 05th August (D_4) recorded highest fruit yield (1549 kg/ha), lowest little leaf disease incidence on 180 days after transplant (6.00%) and lowest average leaf hopper population (1.19 leaf hopper/ leaf), followed by D_5: 15th August (1533 kg/ha, 8.00% and 1.30 /leaf), D_3: 26th July (1521 kg/ha, 11.00% and 1.39 /leaf), D_2: 16th July (1415 kg/ha, 18.00% and 1.45 /leaf) and D_1: 6th July (1050 kg/ha, 26.00% and 1.47 /leaf), respectively of the fruit yield, disease incidence and leaf hopper population.

Table 3: Effect of different dates of transplanting on leaf hopper population, disease incidence and fruit yield of brinjal

Sr. No.	Treatments	Avg. No. of leaf hoppers/ leaf*	Disease Incidence (%) on 180 DAT*	Fruit Yield* (kg/ ha)
T_1	D_1 (6th July)	1.47	26.00	1050
T_2	D_2 (16th July)	1.45	18.00	1415
T_3	D_3 (26th July)	1.39	11.00	1521
T_4	D_4 (5th August)	1.19	6.00	1549
T_5	D_5 (15th August)	1.30	8.00	1533

*=Average of four replications; DAT: Date after transplanting

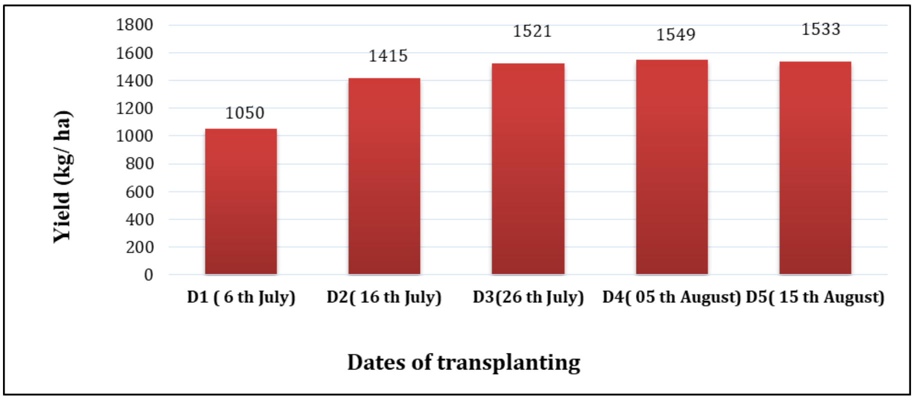


Fig 3: Brinjal fruit yield as influenced by different dates of transplanting.

Correlation between leaf hopper population and brinjal little leaf disease incidence at different dates of transplanting: The results (Table 4 and Fig. 4) revealed that the population of the insect vector leaf hoppers/ leaf as influenced by the transplanting dates was significant effect on little leaf incidence.

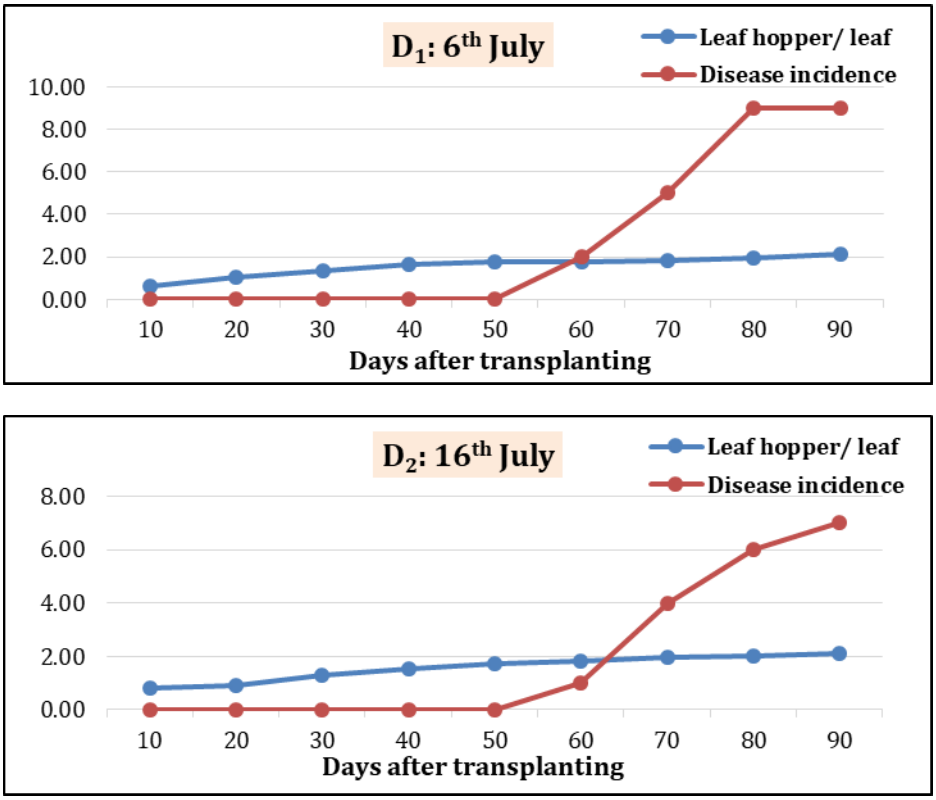
Table 4: Correlation between leaf hopper population and brinjal little leaf disease at different dates of transplanting

Sr. No.	Dates of transplanting	Correlation coefficients
1.	D_1 (6th July)	0.690*
2.	D_2 (16th July)	0.747*
3.	D_3 (26th July)	0.811**
4.	D_4 (5th August)	0.842**
5.	D_5 (15th August)	0.857**

**Correlation is significant at 1%
* Correlation is significant at 5%

In all five dates of transplanting little leaf disease incidence was found positively and significantly correlated with leaf hopper population/ leaf up to 90 days after transplanting. It is indicated that, the little leaf of brinjal increases with increase in leaf hopper population.

Similar results were recorded earlier by Chatterjee *et al.* (2018), who reported positive correlations between leaf hopper population and little leaf disease incidence on brinjal. Kumar (2015) [7] observed that the high population densities of *H. phycitis* leaf hopper in eggplant fields from July to October 2014 was also followed by record of increasing incidence of brinjal little leaf symptoms which indicates potentiality of *H. phycitis* as a natural vector of brinjal little leaf phytoplasma.



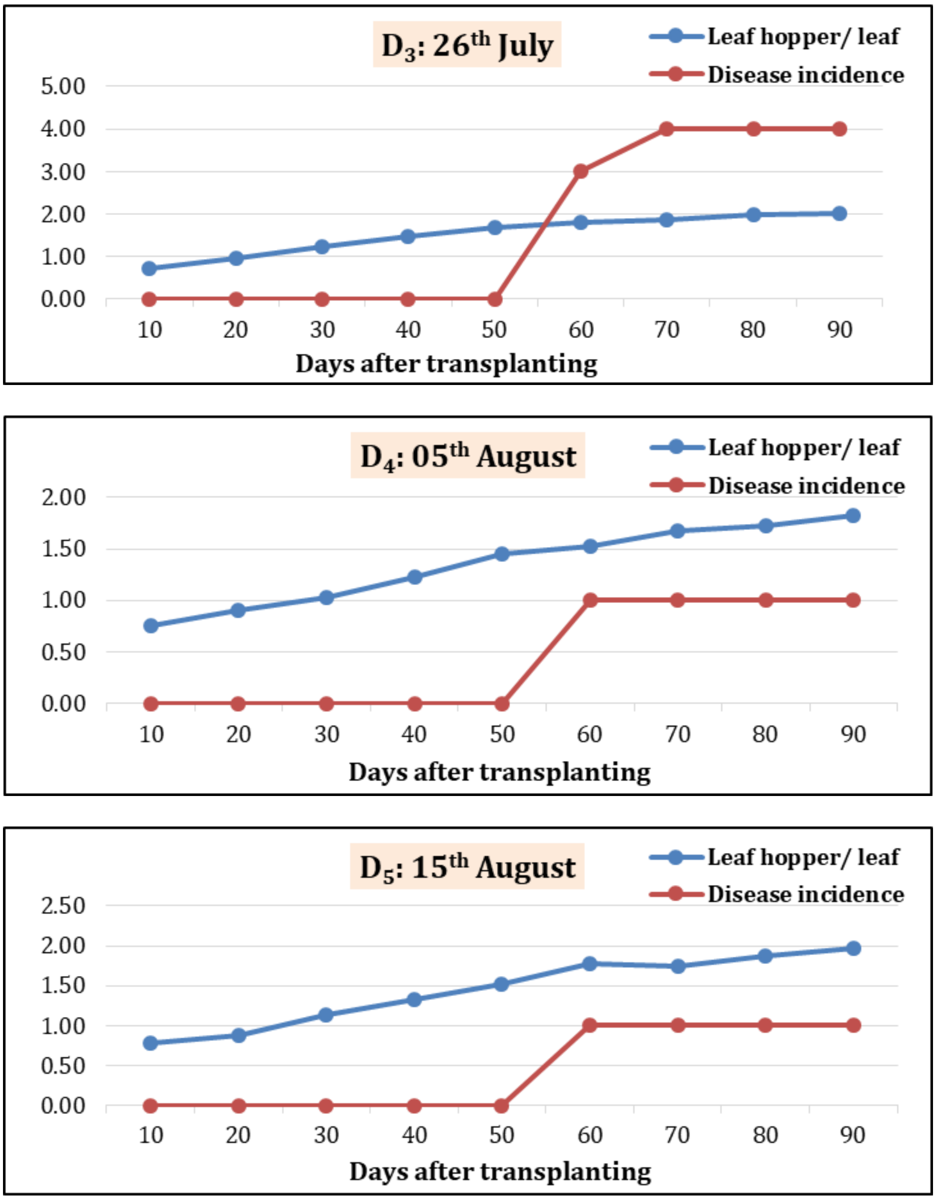


Fig 4: Correlation between leaf hopper population and brinjal little leaf disease incidence at different dates of transplanting

Effect of weather parameters on leaf hopper population

Effect of climatic factors like, rainfall number of rainy days, temperature (maximum and minimum) and relative humidity (am and pm) on leaf hopper population dynamics was studied and presented in Table 5.

Table 5: Correlation of weather parameters with leaf hopper population at different dates of transplanting

Sr. No.	Climatic factors	Correlation coefficient (r)				
		D_1 (6th July)	D_2 (16th July)	D_3 (26th July)	D_4 (5th August)	D_5 (15th August)
1.	Rainfall (mm)	0.092	-0.054	-0.275	-0.352	-0.251
2.	Rainy days	0.156	0.040	-0.189	-0.296	-0.251
3.	Temperature (Max) ^{0}C	0.699**	0.729**	0.830**	0.865**	0.771**
4.	Temperature (Min) ^{0}C	0.240	0.156	0.263	0.410	0.272
5.	Relative humidity (%) AM	0.056	-0.056	-0.127	-0.188	-0.293
6.	Relative humidity (%) PM	0.005	-0.103	-0.228	-0.302	-0.408

**Correlation is significant at 1%
* Correlation is significant at 5%

Results (Table 5) revealed that, correlation between the climatic factor, temperature (max.) with leaf hopper was significantly positive. It is indicated that, the leaf hopper population increases with increase in temperature at maximum as range.

Similar results regarding correlation between leaf hopper population and climatic factors were recorded by Kumar (2015) [7]. He observed that the high population densities of *H. phycitis* leaf hopper in eggplant fields from July to October 2014 was also followed by record of increasing incidence of brinjal little leaf symptoms which indicates potentiality of *H. phycitis* as a natural vector of brinjal little leaf phytoplasma.

Conclusion

Late transplanting (after 05th August) of brinjal crop could escape the crop from severe infestation of the insect vector leaf hoppers and thereby reduce the incidence of phytoplasmal little leaf disease. The vector leaf hopper population was found positively and significantly correlated with little leaf disease incidence. Also vector leaf hopper population was found positively and significantly correlated with the weather parameter i.e., maximum range of temperature.

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