Impact of *Alternaria solani* (Early blight) on cultivated tomato (*Solanum lycopersicum* L.) in North-eastern region of India and identification of early blight disease resistant tomato genotypes

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Abstract: The present investigation was carried out to screen genotypes for resistance to Early blight disease of tomato (*Solanum lycopersicum* L.) of North Eastern region of India. Field trial was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the years 2012-13 and 2013-14 consecutively. The disease severity of tomato genotypes was assessed by 0-5 points scale, percent Disease Incidence (PDI). Of the total materials screened, Sel-35 (TLBRH-6 X Konbilahi) and Sel-19 (TLBRH-6 X Konbilahi) were highly resistant, 7 were resistant, 14 were moderately resistant, 16 were susceptible and 6 were highly susceptible under field condition after inoculation during both years. The genotype having high yield and resistant to early blight was 10/TOLCVRES-3. The genotypes resistant to early blight but having low yield (Sel-35, Sel-19, Sel-9 and Sel-16) may be utilized in future breeding programme for improving yield through selection for higher fruit weight and fruit diameter. Alternatively, they may be used as parents in hybridization or backcrossing programme in order to transfer the gene for resistance to early blight to already adapted high yield varieties.

Keyword: Early blight, North-eastern region, Resistant, *Solanum lycopersicum*

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) [formerly *Lycopersicon esculentum* Miller] is one of the most significant vegetable crops and cultivated in throughout the globe. In plant breeding study, the main objective of a breeder is to improve the fruit yield, a complex quantitative trait leading continuous variation, especially in major vegetable crops like tomato. Determining the appropriate selection indcia and development of efficient breeding scheme, the studies on genetic parameters and association analysis is much important (Chaerani *et al.*, 2007; Sharma *et al.*, 2008). The maladies leading to various horticultural yield losses in tomato is caused by fungi, bacteria, viruses, nematodes and also abiotic factors (Balanchar, 1992). Globally, early blight caused by the pathogen *Alternaria solani* (Ellis and Martin) Sorauer, most aggressive and destructive disease (Fry, 2008; Kumar and Srivastava, 2013) is an economically remarkable malady (Peralta *et al.*, 2005; Singh *et al.*, 2013) of cultivated tomato. The different agro-climatic zones suffer with heavy dew (Rotem and Reichert, 1964; Singh *et al.*, 2011), heavy rainfall [Northeast region of India reported the highest rainfall receiving on the earth (Jain *et al.*, 2012), high humidity (Sheri and MacNab, 1986; Singh *et al.*, 2013) and fairly high temperatures (24-29°C) (Yadav and Singh, 1998; Singh *et al.*, 2013) are more prevalent of this malady. Thus, it leads the most difficult tasks for plant breeder when high temperature and humidity conditions are prevalent. The damages caused by early blight from various parts of the countries viz., India, Canada, United States and Nigeria (Basu, 1974) reported agricultural yield losses up to 79% (Basu, 1974; Singh, 1985; Datar and Mayee, 1981, Yadav and Dabbas, 2012). In horticultural fruit crops loss may be as high as 95% under severe epiphytotic condition (Sridha and Naik, 1983). Disease-management strategies mainly depend on chemical fungicide applications, which are uneconomical and less effective due to increasing resistance of the pathogen against fungicides. Thus, identification of resistant sources from wild tomato species may be an effective method of integrated disease management strategy by reducing the environmental pollution by chemical toxicity. Early blight resistance was conferred by recessive polygenes at both seedling and adult plant stages (Thirhiammalappa and Lohithaswa, 2000). Many researchers identified the potent resistant to moderate resistant sources mainly in wild species *S.


Development and screening of early blight-resistant tomato cultivars following appropriate plants breeding tools is the only possible path for the identification and utilization of genetic resources resistant to Alternaria solani (Ellis and Martin) Sorauer [formerly L. hirsutum (Dunal) (Barksdale and Stoner, 1977; Chaerani et al., 2007; Kalloo and Banerjee, 1993; Poyasa and Tu, 1997; Foolad et al., 2000; Thirthamalappa and Lohithaswa, 2000; Singh et al., 2013)]. Many spots coalesced on the leaves, covering 25% of the surface area of the plant, 4 - Irregular, blighted leaves and sunken lesions with prominent concentric rings on the stem, petiole, and fruit, covering 40-50% of the surface area, 5 - Whole plant blighted, leaves and fruits starting to fall; foliar part free of disease. From the disease scored obtained from the above five point scale, percent disease index (PDI) (McKinney, 1923; Pandey et al., 2003) is calculated.

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PDI = \frac{\text{Sum of all rating X 100}}{\text{Total no. of observations X maximum rating grade}}
\]

After finding out the PDI values, the disease reaction classes for early blight infection based on percent disease severity in tomato were given as prepared by Peteira et al. (2002).

| Disease reaction | PDI range |
|------------------|-----------|
| Highly resistant | 0-12.5    |
| Resistant        | 12.6–25.0 |
| Moderately resistant | 25.1–37.5 |
| Susceptible      | 37.6–50.0 |
| Highly susceptible | 50.1 and above |

The yield per ha data from each genotype obtained from disease free condition and that from disease infested conditions were taken separately to find out the loss in yield due to disease incidence. Later, it is calculated in percentage loss.

RESULTS AND DISCUSSION

The tomato genotypes differed in their resistance reaction against early blight (Table -3). Of the total forty five genotypes screened, Sel-35 (TLBRH-6 X Kombilahi) and Sel-19 (TLBRH-6 X Kombilahi) were highly resistant (which are the selections in segregating generations of the crosses between TLBRH-6 and S. pimpinellifolium L. [formerly L. pimpinellifolium (L.) Mill.] with PDI value range (0-12.5 %), 7 varieties were resistant with PDI value range (12.6-12.5 %), 14 were moderately resistant with PDI value range (25.6-37.5 %), 16 were susceptible with PDI value range (37.6-50 %) and 6 were highly susceptible with PDI value range (50.1 and above %) under field condition after inoculation during both years (Tables 2-4, Fig. 1). The genotype with earliness, high yield (Khaiem et al., 2014) and resistance to early blight was 10/
### Table 1. Genotypes used for study and their salient characteristics.

| S. N. | Genotypes               | Source                  | Plant type    | Duration (days) | Fruit size | Fruit shape |
|-------|-------------------------|-------------------------|---------------|-----------------|------------|-------------|
| 1     | 2012/TOLCVRES-1         | AICRP (VC)              | Determinate   | 124             | Medium     | Oval        |
| 2     | 2012/TOLCVRES-2         | AICRP (VC)              | Determinate   | 122             | Medium     | Flat        |
| 3     | 2012/TOLCVRES-3         | AICRP (VC)              | Determinate   | 111             | Large      | Oblong      |
| 4     | 2012/TOLCVRES-4         | AICRP (VC)              | Determinate   | 122             | Medium     | Round       |
| 5     | 2012/TOLCVRES-5         | AICRP (VC)              | Determinate   | 119             | Medium     | Round       |
| 6     | 2012/TOLCVRES-6         | AICRP (VC)              | Determinate   | 124             | Medium     | Round       |
| 7     | 2012/TOLCVRES-7         | AICRP (VC)              | Determinate   | 120             | Large      | Round       |
| 8     | 2012/TOLCVRES-8         | AICRP (VC)              | Determinate   | 124             | Large      | Round       |
| 9     | 2012/TOLCVRES-9         | AICRP (VC)              | Determinate   | 117             | Medium     | Round       |
| 10    | 2012/SPT/TOINDVAR-1     | AICRP (VC)              | Indeterminate | 131             | Medium     | Round       |
| 11    | 2012/SPT/TOINDVAR-2     | AICRP (VC)              | Indeterminate | 133             | Large      | Oblong      |
| 12    | 2012/SPT/TOINDVAR-3     | AICRP (VC)              | Indeterminate | 131             | Medium     | Oval        |
| 13    | 2012/SPT/TOINDVAR-4     | AICRP (VC)              | Indeterminate | 130             | Medium     | Round       |
| 14    | 2012/SPT/TOINDVAR-5     | AICRP (VC)              | Indeterminate | 130             | Medium     | Round       |
| 15    | 2012/SPT/TOINDVAR-6     | AICRP (VC)              | Indeterminate | 122             | Medium     | Round       |
| 16    | 2012/SPT/TOINDVAR-7     | AICRP (VC)              | Indeterminate | 132             | Medium     | Flat round  |
| 17    | 2012/SPT/TOINDVAR-8     | AICRP (VC)              | Indeterminate | 130             | Large      | Flat round  |
| 18    | 2012/SPT/TOINDVAR-9     | AICRP (VC)              | Indeterminate | 134             | Medium     | Round       |
| 19    | 2012/SPT/TOINDVAR-10    | AICRP (VC)              | Indeterminate | 124             | Medium     | Round       |
| 20    | 2012/SPT/TODVAR-1       | AICRP (VC)              | Determinate   | 117             | Medium     | Round       |
| 21    | 2012/SPT/TODVAR-2       | AICRP (VC)              | Determinate   | 117             | Large      | Flat round  |
| 22    | 2012/SPT/TODVAR-3       | AICRP (VC)              | Determinate   | 120             | Medium     | Round       |
| 23    | 2012/SPT/TODVAR-4       | AICRP (VC)              | Determinate   | 110             | Medium     | Round       |
| 24    | 2012/SPT/TODVAR-5       | AICRP (VC)              | Determinate   | 120             | Medium     | Oval        |
| 25    | 2012/SPT/TODVAR-6       | AICRP (VC)              | Determinate   | 123             | Medium     | Round       |
| 26    | 2012/SPT/TODVAR-7       | AICRP (VC)              | Determinate   | 122             | Medium     | Pear        |
| 27    | 2012/SPT/TODVAR-8       | AICRP (VC)              | Determinate   | 123             | Medium     | Round       |
| 28    | 2012/SPT/TODVAR-9       | AICRP (VC)              | Determinate   | 121             | Medium     | Round       |
| 29    | 2012/SPT/TODVAR10       | AICRP (VC)              | Determinate   | 117             | Medium     | Round       |
| 30    | 10/TOLCVRES-1           | AICRP (VC)              | Determinate   | 122             | Medium     | Flat round  |
| 31    | 10/TOLCVRES-2           | AICRP (VC)              | Determinate   | 118             | Large      | Pear        |
| 32    | 10/TOLCVRES-3           | AICRP (VC)              | Determinate   | 117             | Medium     | Oval        |
| 33    | 10/TOLCVRES-5           | AICRP (VC)              | Determinate   | 115             | Medium     | Round       |
| 34    | 10/TOLCVRES-6           | AICRP (VC)              | Determinate   | 118             | Medium     | Round       |
| 35    | Sel-35(TLBRH-6 X Konbilahi) | AAU, Jorhat | Indeterminate | 130             | Small      | Round       |
| 36    | Sel-19 (TLBRH-6 X Konbilahi) | AAU, Jorhat | Indeterminate | 128             | Small      | Round       |
| 37    | Sel-46 (H-24 X Konbilahi) | AAU, Jorhat | Semi-indeterminate | 125 | Small      | Round       |
| 38    | Sel-16 (H-24 X Konbilahi) | AAU, Jorhat | Indeterminate | 122             | Small      | Round       |
| 39    | Sel-9 (TLBRH-5 X Konbilahi) | AAU, Jorhat | Semi-indeterminate | 126 | Small      | Round       |
| 40    | Arka vikas              | IIHR, Bangalore         | Semi-Determine| 124             | Medium     | Oval        |
| 41    | Hisar Arun              | HAU, Hisar              | Determine     | 118             | Medium     | Round       |
| 42    | H-86                    | IIVR, Varanasi          | Determine     | 117             | Medium     | Flat round  |
| 43    | Punjab Chuhara(C)       | PAU, Ludhiana           | Determine     | 116             | Large      | Oblong      |
| 44    | H-24(C)                 | IIVR, Varanasi          | Determine     | 106             | Slightly small | Round     |
| 45    | NDT-3(C)                | NDUAT, Fazilabad        | Semi-indeterminate | 128 | Medium     | Oval        |

Note: AICRP (VC)-All India Coordinated Research Project (Vegetable Crops), AAU-Assam Agricultural University, IIHR-Indian Institute of Horticultural research, HAU-Haryana Agricultural University, IIVR-Indian Institute of Vegetable Research, NDUAT- Narendra Deva University of Agriculture & Technology
Table 2. Percent disease incidence of early blight in the tomato genotypes.

| Genotypes/Sources of Origin | Percent disease index (PDI) | Score |
|----------------------------|----------------------------|-------|
|                            | 7 Days after inoculation | 22 Days after inoculation | 37 Days after inoculation | 37 Days after inoculation |
|                            | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 |
| 2012/TOLCVRES-1/           |          |          |          |          |          |          |          |          |
| 2012/TOLCVRES-2/           |          |          |          |          |          |          |          |          |
| 2012/TOLCVRES-3/           |          |          |          |          |          |          |          |          |
| 2012/TOLCVRES-4/           |          |          |          |          |          |          |          |          |
| 2012/TOLCVRES-5/           |          |          |          |          |          |          |          |          |
| 2012/TOLCVRES-6/           |          |          |          |          |          |          |          |          |
| 2012/TOLCVRES-7/           |          |          |          |          |          |          |          |          |
| 2012/TOLCVRES-8/           |          |          |          |          |          |          |          |          |
| 2012/TOLCVRES-9/           |          |          |          |          |          |          |          |          |
| 2012/SPT/TOINDVAR-1/       |          |          |          |          |          |          |          |          |
| 2012/SPT/TOINDVAR-2/       |          |          |          |          |          |          |          |          |
| 2012/SPT/TOINDVAR-3/       |          |          |          |          |          |          |          |          |
| 2012/SPT/TOINDVAR-4/       |          |          |          |          |          |          |          |          |
| 2012/SPT/TOINDVAR-5/       |          |          |          |          |          |          |          |          |
| 2012/SPT/TOINDVAR-6/       |          |          |          |          |          |          |          |          |
| 2012/SPT/TOINDVAR-7/       |          |          |          |          |          |          |          |          |
| 2012/SPT/TOINDVAR-8/       |          |          |          |          |          |          |          |          |
| 2012/SPT/TOINDVAR-9/       |          |          |          |          |          |          |          |          |

Contd.
| Year | S.E. (m) | S.E. (%) |
|------|---------|---------|
| 2012/SPT/TODVAR3/- | 21.45 | (27.57)$^{ijkl}$ |
| 2012/SPT/TODVAR4/- | 23.46 | (28.96)$^{ijkl}$ |
| 2012/SPT/TODVAR5/- | 13.45 | (21.50)$^{ij}$ |
| 2012/SPT/TODVAR6/- | 17.35 | (24.60)$^{ij}$ |
| 2012/SPT/TODVAR7/- | 21.34 | (27.48)$^{ijkl}$ |
| 2012/SPT/TODVAR8/- | 19.08 | (25.88)$^{ij}$ |
| 2012/SPT/TODVAR9/- | 28.21 | (32.06)$^{ij}$ |
| 2012/SPT/TODVAR10/- | 38.25 | (38.19)$^{ij}$ |
| 10/TOLCVRES1/- | 17.67 | (24.83)$^{ij}$ |
| 10/TOLCVRES2/- | 25.80 | (30.50)$^{ij}$ |
| 10/TOLCVRES3/- | 24.35 | (29.55)$^{ij}$ |
| 10/TOLCVRES5/- | 21.00 | (27.26)$^{ijkl}$ |
| 10/TOLCVRES6/- | 22.54 | (28.33)$^{ij}$ |
| Sel-35/- | 10.23 | (18.64)$^{ij}$ |
| Sel-19/- | 10.50 | (15.86)$^{ij}$ |
| Sel-46/- | 9.78 | (15.86)$^{ij}$ |
| Sel-16/- | 15.20 | (22.93)$^{ij}$ |
| Sel-9/- | 10.28 | (22.93)$^{ij}$ |
| Arka vikas/ | 29.73 | (33.03)$^{ij}$ |
| Hisar Arun /CCS Haryana Agri. Uni., Hisar | 21.44 | (27.57)$^{ij}$ |
| H-86/ | 28.29 | (32.12)$^{ij}$ |
| Punjab Chuhvara/ (Punjab Agri. Univ., Ludhiana) | 25.34 | (30.20)$^{ij}$ |
| H-24/ | 16.89 | (24.25)$^{ij}$ |
| NDT-3/ | 28.37 | (32.17)$^{ij}$ |
| C.D. (5%) | 3.26 | 5.37 |
| S.E. (m) | 1.14 | 1.8 |

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Table 3. Reaction of tomato genotypes against early blight on the basis percent disease index (PDI).

| Genotypes | PDI value range (%) | Score | Reaction |
|-----------|---------------------|-------|----------|
| Sel-35 and Sel-19 [2] | 0-12.5 | 1 | Highly resistant |
| Sel-46, Sel-16 and Sel-9 [7] | 12.6-25.0 | 2 | Resistant |
| Sel-46, Sel-16 and Sel-9 [7] | 25.1-37.5 | 3 | Moderately resistant |
| Sel-46, Sel-16 and Sel-9 [7] | 37.6-50.0 | 4 | Susceptible |
| Sel-46, Sel-16 and Sel-9 [7] | 50.1 and above | 5 | Highly susceptible |

Conclusion

The results obtained from the present work have given some important future line of work. The genotypes highly resistant to early blight were Sel-35 and Sel-19 and can be used as parents in hybridization or backcrossing programme in order to transfer the gene for resistance to already adapted varieties or susceptible varieties with desirable characters. The genotypes 2012/SPT/TOINDVAR-4, 2012/SPT/TODVAR-5, 2012/SPT/TODVAR-6, 2012/TOLCVRES-3, Sel-46, Sel-16 and Sel-9 showed resistant against Alternaria solani pathogen which may be further evaluated for stability in performance and for their durable resistance. The genotype 10/TOLCVRES-3 was found good for both high yield and resistant to early blight. Sel-35 and Sel-19 may be studied by combining classical breeding methods with molecular markers in future breeding programme.

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Table 4. Comparison of yield and its loss percentage between disease free condition and disease infested condition for the year 2012-13.

| S. N. | Genotypes            | Resistant reaction from PDI reading | Yield per ha (q) (disease free condition) | Yield per ha (q) (disease infested condition) | Loss in yield per ha (q) (due to disease incidence) | % loss in yield (due to disease incidence) |
|------|----------------------|-------------------------------------|------------------------------------------|------------------------------------------------|-------------------------------------------------|------------------------------------------|
| 1    | 2012/TOLCVRES-1      | HS                                  | 246.53                                   | 172.21                                          | 74.32                                           | 30.15                                    |
| 2    | 2012/TOLCVRES-2      | S                                   | 192.4                                    | 154.21                                          | 38.19                                           | 19.85                                    |
| 3    | 2012/TOLCVRES-3      | S                                   | 240.00                                   | 220.21                                          | 45.59                                           | 17.15                                    |
| 4    | 2012/TOLCVRES-4      | MR                                  | 237.9                                    | 203.43                                          | 34.47                                           | 14.49                                    |
| 5    | 2012/TOLCVRES-5      | HS                                  | 221.83                                   | 151.34                                          | 70.49                                           | 31.78                                    |
| 6    | 2012/TOLCVRES-6      | MR                                  | 222.47                                   | 190.21                                          | 32.26                                           | 14.50                                    |
| 7    | 2012/TOLCVRES-7      | S                                   | 181.6                                    | 146.42                                          | 35.18                                           | 19.37                                    |
| 8    | 2012/TOLCVRES-8      | HS                                  | 230.2                                    | 160.24                                          | 69.96                                           | 30.39                                    |
| 9    | 2012/TOLCVRES-9      | MR                                  | 250.87                                   | 220.12                                          | 30.75                                           | 12.26                                    |
| 10   | 2012/SPT/TOINDVAR-1  | MR                                  | 205.48                                   | 176.48                                          | 29.00                                           | 14.11                                    |
| 11   | 2012/SPT/TOINDVAR-2  | S                                   | 173.43                                   | 136.42                                          | 37.01                                           | 21.34                                    |
| 12   | 2012/SPT/TOINDVAR-3  | HS                                  | 196.96                                   | 131.00                                          | 65.96                                           | 33.49                                    |
| 13   | 2012/SPT/TOINDVAR-4  | R                                   | 126.1                                    | 118.80                                          | 7.30                                            | 5.79                                     |
| 14   | 2012/SPT/TOINDVAR-5  | S                                   | 116.55                                   | 94.42                                           | 22.13                                           | 18.99                                    |
| 15   | 2012/SPT/TOINDVAR-6  | S                                   | 159.55                                   | 132.21                                          | 27.34                                           | 17.14                                    |
| 16   | 2012/SPT/TOINDVAR-7  | S                                   | 145.93                                   | 116.98                                          | 28.95                                           | 19.84                                    |
| 17   | 2012/SPT/TOINDVAR-8  | MR                                  | 190.69                                   | 166.59                                          | 24.10                                           | 12.64                                    |
| 18   | 2012/SPT/TOINDVAR-9  | HS                                  | 192.78                                   | 110.37                                          | 82.41                                           | 42.75                                    |
| 19   | 2012/SPT/TOINDVAR-10 | MR                                  | 211.9                                    | 186.21                                          | 25.69                                           | 12.12                                    |
| 20   | 2012/SPT/TODVAR-1    | MR                                  | 224.22                                   | 198.42                                          | 25.80                                           | 11.51                                    |
| 21   | 2012/SPT/TODVAR-2    | MR                                  | 240.13                                   | 214.24                                          | 25.89                                           | 10.78                                    |
| 22   | 2012/SPT/TODVAR-3    | S                                   | 264.67                                   | 212.11                                          | 52.56                                           | 19.86                                    |
| 23   | 2012/SPT/TODVAR-4    | S                                   | 168.15                                   | 135.00                                          | 33.15                                           | 19.71                                    |
| 24   | 2012/SPT/TODVAR-5    | R                                   | 188.52                                   | 170.21                                          | 18.31                                           | 9.71                                     |
| 25   | 2012/SPT/TODVAR-6    | R                                   | 244.2                                    | 230.12                                          | 14.08                                           | 5.77                                     |
| 26   | 2012/SPT/TODVAR-7    | MR                                  | 211.2                                    | 184.21                                          | 26.99                                           | 12.78                                    |
| 27   | 2012/SPT/TODVAR-8    | MR                                  | 195.68                                   | 172.42                                          | 23.26                                           | 11.89                                    |
| 28   | 2012/SPT/TODVAR-9    | S                                   | 235.62                                   | 189.00                                          | 46.62                                           | 19.79                                    |
| 29   | 2012/SPT/TODVAR10    | HS                                  | 194.7                                    | 121.72                                          | 72.98                                           | 37.48                                    |
| 30   | 10/TOLCVRES-1        | MR                                  | 201.29                                   | 178.34                                          | 22.95                                           | 11.40                                    |
| 31   | 10/TOLCVRES-2        | S                                   | 208.67                                   | 168.21                                          | 40.46                                           | 19.39                                    |
| 32   | 10/TOLCVRES-3        | R                                   | 268.82                                   | 250.12                                          | 18.70                                           | 6.96                                     |
| 33   | 10/TOLCVRES-5        | S                                   | 196.78                                   | 158.21                                          | 38.57                                           | 19.60                                    |
| 34   | 10/TOLCVRES-6        | MR                                  | 142.74                                   | 123.35                                          | 19.39                                           | 13.58                                    |
| 35   | Sel-35               | HR                                  | 80                                       | 77.56                                           | 2.44                                            | 3.05                                     |
| 36   | Sel-19               | HR                                  | 77.67                                    | 76.00                                           | 1.67                                            | 2.15                                     |
| 37   | Sel-46               | R                                   | 95.67                                    | 86.24                                           | 9.43                                            | 9.86                                     |
| 38   | Sel-16               | R                                   | 90.67                                    | 83.46                                           | 7.21                                            | 7.95                                     |
| 39   | Sel-9                | R                                   | 81.33                                    | 74.56                                           | 6.77                                            | 8.32                                     |
| 40   | Arka Vikas           | S                                   | 194.48                                   | 156.22                                          | 38.26                                           | 19.67                                    |
| 41   | Hisar Arun           | MR                                  | 205.56                                   | 182.24                                          | 23.32                                           | 11.34                                    |
| 42   | H-86                 | S                                   | 146.27                                   | 118.21                                          | 28.06                                           | 19.18                                    |
| 43   | Punjab Chhuhara      | MR                                  | 221.76                                   | 198.24                                          | 23.52                                           | 10.61                                    |
| 44   | H-24                 | S                                   | 303                                      | 252.21                                          | 50.79                                           | 16.76                                    |
| 45   | NDT-3                | S                                   | 258.19                                   | 212.12                                          | 46.07                                           | 17.84                                    |
Fig. 1. Comparison of percent disease index (PDI) on the genotypes artificially inoculated by A. solani for both the years 2012-13 and 2013-14.

Fig. 2. Yield comparison under early blight free and early blight infested condition during 2012-13.
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