Field Screening for Late Leaf Spot resistance in the BC_1F_4 population in Groundnut (*Arachis hypogaea L.*)

Abstract

Globally, late leaf spot (LLS), a foliar fungal disease is one of the most important biotic constraint in groundnut production (Wankhade *et al*. 2023). LLS is a major cause of yield loss accounting for over 70% in groundnut production (Ibrahim, 2010). The field of screening of 115 BC_1F_4 lines along with parents was done at ICRISAT in Rainy 2024 (*Kharif*), Two lines BC_1F_4-1 and BC_1F_4-2 with score 4 at 105 Days after planting (DAP) was identified as resistant and four lines BC_1F_4-3, BC_1F_4-4, BC_1F_4-63 and BC_1F_4-65 with score 5 and 6 at 105 DAP moderate resistance were identified. In the present study from 115 lines two lines were resistance and four lines were moderate resistance were identified. Further screening of these lines in the next generation and then after multi-location trails can be used as develop the resistance line and which can be used in future breeding programme.

Key words: Late Leaf Spot, Biotic constraint, Groundnut production and Multi-location

INTRODUCTION

Groundnut (*Arachis hypogaea L.*), is often hailed as the "king of oilseeds." Globally, cultivated in 112 countries with a total area of 30.5 million hectares (m ha) and total production of 54.2 million tonnes (m t) having productivity 1776 kg/ha and in India the total area of 5.7 (m ha) and total production of 10.1 (m t) with productivity 1776 kg/ha. (FAOSTAT, 2023). Groundnut fosters soil health through symbiotic nitrogen fixation with Rhizobia bacteria, promoting sustainable agricultural practices. Groundnut cultivation faces a formidable challenge from fungal diseases like late leaf spot (LLS), rust, Alternaria blight, stem rot, dry root rot and collar rot (Pal *et al*. 2014, Joshi *et al*. 2020.). LLS disease caused by Phaeoisariopsis personata pose the most significant threats. These widespread fungal pathogens inflict severe damage on groundnut crops. In most cases, these two pathogens occur together and hamper groundnut production (Kishore *et al*. 2005). In India, these diseases have been documented to cause yield losses exceeding 70%, significantly impacting groundnut productivity (Subrahmanyam *et al.* 1995). At ICRISAT, breeding for foliar fungal disease has resulted in development of several genotypes with high level resistance to rust and moderate resistance to LLS (Singh *et al.* 2003). An estimated global yield loss of US$600 million due to LLS was reported (Dwivedi *et al*. 2003). The detrimental effects extend beyond yield reduction, as the quality of groundnut seeds is also compromised by these fungal infections.

Late leaf spot disease LLS is caused by the fungus known a Nothopassalora personata (Berk. & M.A. Curtis) poses a significant challenge in groundnut cultivation. While chemical treatments have been recommended for the treatment of LLS, they are often costly and unsafe in certain situations and locations (Chandra *et al*. 2005; Muhammad & Bdliya, 2011;

Khan *et al*. 2014). In contrast, host plant resistance, offers a safe, efficient and environmentally friendly way of controlling LLS (Ibrahim, 2010). application of host plant resistance further improves the yield and quality of groundnuts produced by farmers (Shoba *et al*., 2012). However, the nature of the inheritance of LLS resistance is complex anpolygenic (Dwivedi *et al*. 2002), thus making the identification of resistant and susceptible lines unreliable through conventional screening techniques (Leal-Bertioli *et al.* 2009). With good polymorphic molecular markers, a breeder can easily identify LLS-resistant and susceptible groundnut plants (Mac *et al*. 2006).

Materials and methods

2.1 Experimental Site and Plant Material

In the present study, the field evaluation of the backcrossed lines and parents was carried out during the rainy season 2024 at red precison 2C field-block (17.51º North latitude and 78.27º East longitude). The soil type of the experimental block was Alfisols (Patancheru Soil Series; UdicRhodustolf) with a pH ranging from 7.0 to 7.5. The air temperature ranged between 22.6° C to 30.6° C, bright sunshine 4.1 Hrs, relative humidity varied between 60 to 90 % and rainfall 201.1mm during *kharif* 2024. The details of the material used and the techniques adopted in the present investigation for recording of observations and analysis of data are briefly presented in this chapter. The experimental material for the present study comprised of BC_1F_4 lines were derived from the donor parent (ICGV 201009) which has score 4 at 105 DAP (unpublished data) which is resistant and recipient parent (Narayani) which has score 9 at 105 DAP, which is susceptible (Subrahmanyam *et al.* 1995).

2.2 Late Leaf Spot Disease Screening

The BC_1F_4 lines, their parents and checks were raised in single plant progeny rows and evaluated for late leaf spot disease during *kharif* 2024 (Fig. 1). Screening of Late leaf spot disease was carried out by visual screening method Fig. 2 using modified 9-point scale for late leaf spot (Table 1) given by Subrahmanyam *et al*. 1995.

2.3 Disease Scoring for Late Leaf Spot

For late leaf spot disease screening, visual screening (Fig. 2) and modified 9-point scale as given by Subrahmanyam *et al*. 1995 (Table 1) was used. The visual scores (1-9) and the extent of leaf area destroyed (0-100 %) are linearly related to each other. Disease scoring was done at 75, 90 and 105 days after sowing (pod filling stage). The disease scores were mainly based on the extent of leaf area damage.

Fig.1. Field view of BC_1F_4 population

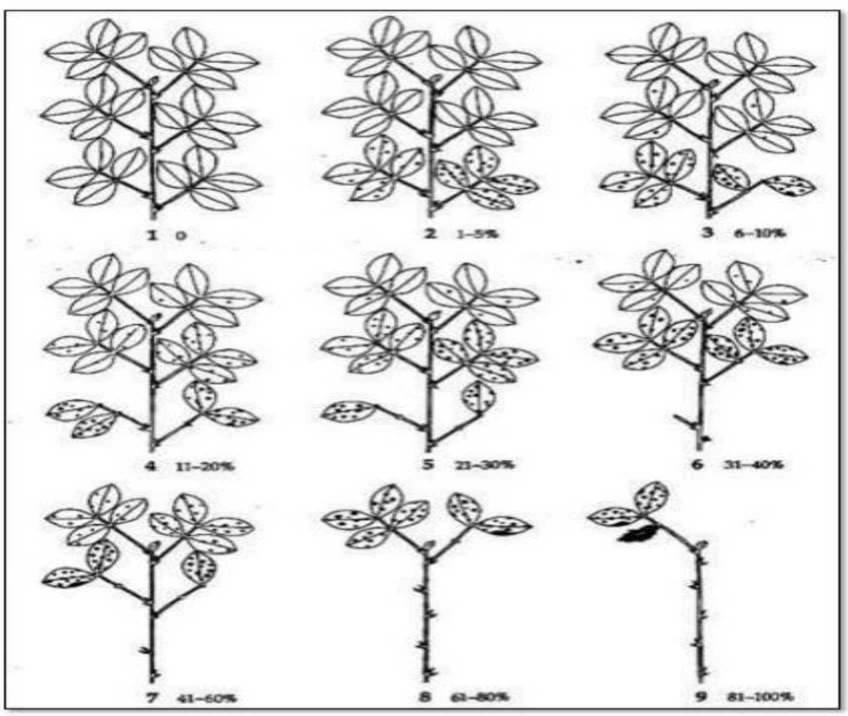

Fig. 2. Standard reference for scoring late leaf spot disease resistance (Subrahmanyam *et al*. 1995)

Table 1. **Modified 9-Point scale used for field-screening of groundnut genotypes for Late Leaf Spot resistance (**Subrahmanyam *et al*. 1995**)**

Disease score	**Phenotype description**	**Disease severity (%)**
1	No disease	0
2	Lesions present largely on lower leaves; no defoliation	1-5%
3	Lesions present largely on lower leaves, very few on middle leaves; defoliation of some leaflets evident on lower leaves	6-10%
4	Lesions present on lower and middle leaves but severe on lower leaves; defoliation of some leaflets evident on lower leaves	11-20%
5	Lesions present on lower and middle leaves, over 50 % of defoliation of lower leaves	21-30%
6	Severe lesions on lower and middle leaves; lesions present but less severe on top leaves; extensive defoliation of lower leaves; some defoliation on middle leaves	31-40%
7	Lesions on all leaves but less severe on top leaves; defoliation of all lower and middle leaves	41-60%
8	Defoliation of all lower and middle leaves; severe lesions on top leaves evident	61-80%
9	Almost all leaves defoliated, leaving bare stem; some leaflets may remain but show severe leaf spot	81-100%

3.Results and discussion

3.1. Superior Selected lines for LLS Disease in the BC_1F_4 Generation

Among the 115 BC_1F_4 two lines two lines BC_1F_4-1 and BC_1F_4-2 with score 4 at 105 DAP was identified as resistant to LLS disease and four lines BC_1F_4-3, BC_1F_4-4, BC_1F_4-63 and BC_1F_4-65 with score 5 and 6 at 105 DAP showed moderate resistance to LLS disease. Remaining 109 lines were with score 7 to 9 at 105 DAP showed highly susceptible to LLS disease. Table 2.

Table 2. Resistance lines and their scores at different days after planting(DAP)

S.No	Genotypes	75 DAP	90 DAP	105 DAP	% LAD	R/MR/S *
1	BC_1F_4-1	2	3	4	20	**R**
2	BC_1F_4-2	2	3	4	20	**R**
3	BC_1F_4-3	3	4	5	30	**MR**
4	BC_1F_4-4	3	4	5	30	**MR**
5	BC_1F_4-63	3	5	6	40	**MR**
6	BC_1F_4-65	3	5	6	40	**MR**
7	ICGV 201009	2	3	4	20	**R**
8	Narayani	4	6	8	80	**S**

DAP-Days after planting**, % LAD**- Percentage of leaf area damage

* **R**- Resistance, **MR**- Moderate resistance and **S**- susceptible

Conclusion

In the present investigation, 115 BC_1F_4 lines were evaluated in the single plant progeny rows along with parents and one check to identify superior lines for LLS disease. Results depicted that among the 115 lines, 2 lines showed consistence performance both at 75th, at 90th and at 105th days after planting normal and disease plots. Therefore, these identified lines will be forwarded for next generation and then after multi-location trails for disease resistance.

Disclaimer (ARTIFICAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies, such as large Language Models (chatGPT, COPILOT, etc) and text-to-image generations have been used during writing or editing of this manuscript.

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