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

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Globally, late leaf spot (LLS), a foliar fungal disease is one of the most important biotic constraint in groundnut production. LLS is a major cause of yield loss accounting for over 70% in groundnut production. This study aimed to evaluate 115 BC_1F_4 groundnut lines for resistance to LLS long with parents was done at ICRISAT in Rainy 2024 (*Kharif*). The field screening was taken in Single plant progeny rows with 2m x 1 row and disease scoring was done at 75 Days After Planting (DAP), 90 DAP and 105 DAP in that progeny rows under natural disease conditions based on visual observation. 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

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at 105 DAP exhibited moderate resistance were identified. In the present study out of 115 BC_1F_4 lines evaluated two lines showed resistance, and four lines showed moderate resistance. These lines will be advanced to the next generation and tested in multi-location trials to further assess their resistance and potential for use in breeding programs.

Keywords: Late leaf spot; biotic constraint; groundnut production and multi-location.

1. 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). Globally, late leaf spot (LLS), a foliar fungal disease is one of the most important biotic constraint in groundnut production (Wankhade et al., 2023). In India, these diseases have been documented to cause yield losses exceeding 70%, significantly impacting groundnut productivity (Subrahmanyam et al*.,* 1995, Ibrahim 2010). 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). The frequency of infection is notably influenced by temperature and relative humidity (Shew et al*.,* 1989, Waliyar et al*.,* 1995). While latent period, lesion size and spore production have been the components most commonly associated with genetic resistance (Chiyembekeza et al*.,* 1993, Walls et al*.,* 1985). 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).

2. 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).

Fig. 1. Field view of BC_1F_4 population

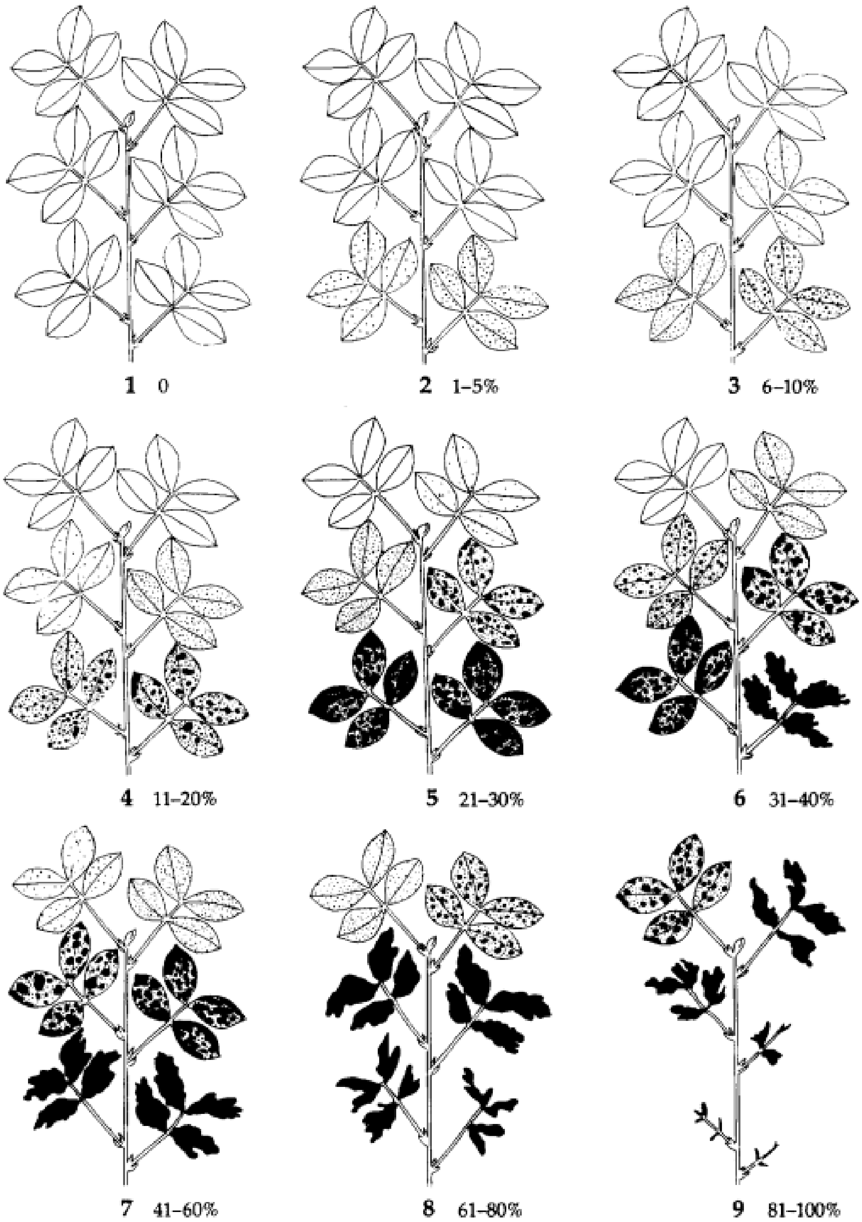

Fig. 2. Standard reference for scoring late leaf spot disease resistance (Subrahmanyam et al., 1995)

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.

3. RESULTS AND DISCUSSION

3.1 Superior Selected lines for LLS Disease in the BC_1F_4 Generation

Among the 115 BC_1F_4 Single plant progeny lines, two lines BC_1F_4-1 and BC_1F_4-2 with score 4 at 105 DAP were 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 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%

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*

3.2 Discussion

The results of this study provide valuable insights into the symptomatology, disease severity under natural conditions of the late leaf spot (LLS). The BC_1F_4 lines exhibited varying responses to LLS under natural conditions. The low disease score is an important indicator of disease dynamics, exhibited significant variability among different groundnut cultivars in field screening. These observations highlight the complexity of host-pathogen interactions in LLS and reinforces the significance of resistant cultivars in managing LLS outbreaks.

4. CONCLUSION

In the present investigation, 115 BC_1F_4 Single plant progeny lines were evaluated 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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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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