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# Management of *Alternaria* Leaf Blight in Pigeonpea through Host Plant Resistance and Micronutrient Application

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## ABSTRACT

**Background:** Pigeonpea [*Cajanus cajan* (L.) Millsp] is one of the primary grain legume crops grown in India for its high quality vegetable protein, animal feed and fodder. It is affected by various fungal and viral diseases. Among these, leaf blight caused by *Alternaria alternata* is one of the most destructive diseases and recently the disease of minor importance becomes major one in Tamil Nadu. Use of resistant cultivar is the most effective, economically viable and eco-friendly tool for combating the plant diseases. The micronutrients play a key role in many physiological and biochemical functions of the plants which influences plant pathogenic interaction. The micronutrients *viz*., Zn, Mn, Cu and Fe found to have greater impact on reducing the plant disease severity. Developing integrated disease management strategy involving disease resistant variety, micronutrient and fungicide application would be the best sustainable method for controlling the pigeonpea leaf blight.

**Methods:** Twenty four pigeonpea genotypes along with two local varieties *viz*., CO5 and CO6 were evaluated in the field for their resistance against *Alternaria alternata* leaf blight disease, consecutively for three years from 2015-16 to 2017-18 using the disease resistance scale ranging from 0 to 9. Field experiments were also conducted for three consecutive Kharif season from 2015 to 2018 to evaluate the efficacy of the foliar application of different micronutrients and combination fungicide *viz*., carbendazim 12% + mancozeb 63% on the incidence of leaf blight disease.

**Result:** A total of 24 pigeonpea genotypes were screened for their resistance against leaf blight under field condition. Among these, four genotypes *viz.,* BDN2, IPA 8F, IPA 15F and MA6 were found resistance and nine genotypes were moderately resistant and remaining 11 genotypes showed susceptible reaction to leaf blight. The results of the field experiment on micronutrient and fungicide application revealed that foliar spraying of $MnSO_4$ @0.2% on 30 days after sowing and carbendazim 12%+ mancozeb 63%@ 1g / lit on 45 days after sowing recorded the lowest leaf blight incidence of 8.1 PDI (Per cent Disease Index) with the highest disease reduction of 76.9% as against 35 PDI in the untreated control plot. The above treatments also recorded the highest grain yield of 905 kg/ ha as against 703 kg/ in the untreated control.


**Key words:** Leaf blight, Management, Micronutrient, Pigeonpea, Resistant sources.

## INTRODUCTION

Pigeonpea is the fifth prominent pulse crop in the world and the second most important pulse crop in India. It is grown under diverse agro ecological conditions as it has great potential to tolerate drought. Pigeonpea production is amenable for many biotic constraints. Among these, leaf blight caused by *Alternaria alternata* found to occur in alarming proportion recently in Tamil Nadu. Pigeonpea leaf blight caused by *A. alternata* was first reported from Varanasi, India by Pavgi and Singh (1971). Later, Kannaiyan and Nene (1977) reported its occurrences from Hyderabad as a minor disease. Now it is widely prevalent in Andhra Pradesh, Bihar and Tamil Nadu. This disease has been reported to cause yield losses up to 40-50 percent (Kushwaha *et al*., 2010). Leaf blight of pigeonpea inflicts yield losses ranged from 20-80 percent (Sharma *et al*., 2013).

In Tamil Nadu the incidence of leaf blight ranged from 3- 40 PDI and it is highly favoured by light drizzling coupled with high RH. Managing plant diseases through the use of resistant cultivar is one of the most effective, eco friendly and economical strategy. Micronutrients are capable of controlling plant pathogen infection in plants either directly by antagonising the pathogen or indirectly through enhancing plant defence mechanism by systemic acquired resistance and or stimulating antagonist population in rhizosphere (Graham and Webb,1991). Application of nutrients *viz*., Mn, Cu and B can release Ca from plant cell, which interact with salicylic acid and activate systemic acquired resistance mechanisms (Reuveni *et al*. 1997; Reuveni and Reuveni, 1998). Fungicides are commonly

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used for the effective control of foliar diseases. The efficacy carbendazim + mancozeb against *Alternaria* leaf blight was earlier reported by Venkatramanamma *et al.* (2014). Hence, the present study was carried out to identify the resistant sources and to evaluate the efficacy of various micronutrients and the combination fungicide *viz* carbendazim 12% + mancozeb 63% against the leaf blight in pigeonpea.

## MATERIALS AND METHODS

### Isolation and maintenance of pigeonpea leaf blight pathogen *A. alternata*

The leaf blight pathogen of pigeonpea (*A. alternata*) was isolated from the leaves infected with characteristic symptoms. The infected portions were cut into one cm bit and surface sterilized with 0.1 per cent mercuric chloride ($Hgcl_2$) solution for 30 sec and washed thrice in series of sterile distilled water and transferred to sterilized Petri plate containing Potato Dextrose Agar (PDA) medium amended with a pinch of streptomycin sulphate (Riker and Riker, 1933). The Petri plates were incubated at room temperature (28 ± 2°C) for 5 days and observed periodically for the growth of the fungus. Isolates were purified by single spore isolation maintained on PDA slopes for further use.

### Evaluation of pigeonpea genotypes for leaf blight resistance

Twenty four genotypes received from AICRP pigeonpea coordinating centres were screened for their resistance against leaf blight consecutively for three years from 2015 - 2018 at Pulses Breeding Station, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore. Two local varieties *viz.*, CO5 and CO6 were also included in the screening programme. Seeds of 24 genotypes along with above mentioned two varieties were sown in two rows of 4 meter row length during the first week of August in all the three years. Three replications were maintained for each genotypes and the crop was maintained by following standard package practices as per the recommendation of the Crop Production Guide, TNAU, Coimbatore. After 30 and 45 days of sowing the plants were sprayed with conidial suspension of *A. alternata* ($5 \times 10^5$ conidia/ml) to enhance the inoculum load of the pathogen which make screening the most effective. The observations were recorded on leaf blight incidence by following 0 to 9 scale on 60 days after sowing. The disease grade and resistance scale used for identifying resistant sources for leaf blight is furnished below (Anonymous, 2015).

### Efficacy of micronutrients and carbendazim 12%+ mancozeb 63% against leaf blight incidence

Field trials were conducted during *kharif* 2015-16, 2016-17 and 2017-18 to find out the effect of micronutrients and carbendazim 12% + mancozeb 63% on the leaf blight incidence of pigeonpea. The experiment comprised of seven treatments and each treatment was replicated thrice and arranged in RBD. The cultivar used was Co Rg7. Foliar spraying with different micronutrients (as presented in Table 3) was done on 30 Days After Sowing (DAS). Fifteen days after spraying of micronutrients (45 DAS) one fungicidal spraying was given with carbendazim 12%+ mancozeb 63% @ 1g/ lit. The observations were recorded on the incidence of leaf blight on 60DAS using 0-9 scale and per cent disease Index was worked out. The data recorded on grain yield also.

### Statistical analysis

The data were analysed statistically as per Gomez and Gomez (1984).

## RESULTS AND DISCUSSION

A total 24 pigeonpea genotypes were screened for their resistance against leaf blight consecutively for three years from 2015-2018 under field condition. Among these, four genotypes *viz.,* BDN 2, IPA 8F, IPA 15F and MA 6 were found to be resistant to leaf blight in all the three years of evaluation with the mean disease grade of 2.1, 2.4, 2.6 and 2.4 respectively. Nine genotypes *viz.*, CRG 9701, ICP 7119, ICP 2376, KPL 43, KPL 44, MAL 43, WRGE 65, WRP-1 and ICP 8863 showed moderately resistant reaction with the mean disease grade ranged from 3.2-4.2. The varieties *viz.*, CO5 and CO6 used in this study also showed moderately resistant to the disease with the mean grade of 4.2 and 3.6 respectively. Remaining 11 genotypes *viz.,* BRG 1, BRG 2, BSMR 853,BSMR 736, RVSA 07-31, RVSA 07-29, RVSA 07-10, BRG 3, BRG 4, JKM 189 and MAL 13 exhibited susceptible reaction to leaf blight (Table 1 and 2). Several workers previously evaluated the pigoenpea genotypes for leaf blight resistance and identified resistant sources. Kumar and Rani (2010) screened 96 genotypes of pigeonpea in field under artificially inoculated conditions against leaf blight and found that genotypes *viz.,* RAUP-32, RAUP-34 and Pusa-(B)-35 were resistant, 12 were moderately resistant to the leaf blight. The pigeonpea genotypes, MA-128-1, MA-128-2 and DA-2 were found to be resistant to *Alternaria* blight

Disease rating scale for *Alternaria* blight.

| Disease grade | Description | Disease grade | Disease reaction | |
|---|---|---|---|---|
| 0 | No symptom | 0 | 0 - 1 | Immune |
| 1 | Lesion small pin head covering less than 1% leaf area | 1 | 1.1 - 3 | Resistant |
| 3 | Lesion 1-2 mm diameter covering 1-10% leaf area | 3 | 3.1 - 5 | Moderately resistant |
| 5 | Enlarged lesion with 11-25% leaf coverage | 5 | 5.1 - 7 | Susceptible |
| 7 | Lesion covering 26- 50% of the leaf area | 7 | 7.1 - 9 | Highly susceptible |
| 9 | More than 50% of the area covered by large coalescing lesion and defoliation | 9 | | |

**Table 1:** Reaction of pigeonpea genotypes/ varieties against leaf blight under field condition.

| Pigeonpea genotypes/ varieties | Leaf blight incidence (Grade)* | | | Mean grade |
|---|---|---|---|---|
| | 2015-16 | 2016-17 | 2017-18 | |
| **BDN 2** | **1.6** | **2.2** | **2.4** | **2.1** |
| BRG 1 | 5.9 | 5.7 | 6.4 | 6.0 |
| BRG 2 | 5.2 | 6.1 | 6.6 | 5.6 |
| BRG 3 | 6.3 | 6.8 | 5.0 | 6.0 |
| BRG 4 | 6.1 | 6.9 | 5.9 | 6.3 |
| BSMR 736 | 5.2 | 5..4 | 5.3 | 5.3 |
| BSMR 853 | 5.0 | 5.5 | 5.9 | 5.5 |
| CO 6 | 3.8 | 3.3 | 3.7 | 3.6 |
| CRG 9701 | 3.4 | 4.0 | 4.1 | 3.8 |
| ICP 7119 | 3.1 | 3.3 | 3.3 | 3.2 |
| ICP 2376 | 3.4 | 3.2 | 3.4 | 3.3 |
| **IPA 8F** | **2.3** | **2.6** | **2.3** | **2.4** |
| **IPA 15 F** | **2.8** | **2.5** | **2.6** | **2.6** |
| JKM 189 | 5.3 | 5.8 | 4.1 | 5.1 |
| KPL 43 | 4.1 | 4.2 | 3.2 | 3.8 |
| KPL 44 | 3.4 | 3.4 | 3.3 | 3.4 |
| MAL 13 | 4.9 | 5.5 | 5.2 | 5.2 |
| **MA 6** | **1.9** | **2.7** | **2.5** | **2.4** |
| MAL 43 | 3.5 | 3.3 | 3.4 | 3.4 |
| RVSA 07-31 | 5.3 | 5.7 | 5.2 | 5.7 |
| RVSA 07-29 | 5.0 | 6.1 | 5.5 | 5.5 |
| RVSA 07-10 | 5.5 | 5.7 | 6.1 | **5.7** |
| WRGE 65 | 3.5 | 3.4 | 3.2 | 3.4 |
| WRP-1 | 3.3 | 3.6 | 3.8 | 3.6 |
| CO 5 | 3.6 | 4.6 | 4.4 | 4.2 |
| ICP 8863 | 3.9 | 3.7 | 3.8 | 3.8 |

*Mean of three replications.

under natural field condition (Venkateswarlu, 1981). These entries were also reported to be resistant under artificially inoculated condition in green house (Kannaiyyan and Nene, 1986.). Out of 106 genotypes, seven genotypes *viz.* Path 402, Path 407, NDA14-4, NDA14-15, NDA-14-16, NDA-14-29 and NDA-14-36 were found resistant, 33 genotypes were moderately resistant, 53 genotypes were moderately susceptible and 13 genotypes were susceptible to *Alternaria* blight (Rathore *et al.,* 2018).

Field experiments were conducted consecutively for three years from 2015-16 to 2017-18 to evaluate the efficacy of micro nutrients and the combination fungicide *viz.*, carbendazim 12% + mancozeb 63% on leaf blight incidence. The foliar spraying of micronutrients *viz.*, $ZnSO_4$, $MnSO_4$, $FeSO_4$ $CuSO_4$ and Borax @ 0.2 per cent and Na $Mo_3$ @ 0.1 per cent on 30 DAS followed by spraying of carbendazim 12% + mancozeb 63% @ 1g / lit on 45 DAS was found to be promising in reducing the leaf blight incidence. Among these, foliar spraying of $MnSO_4$@0.2% on 30 DAS + carbendazim 12% + mancozeb 63% @ 1g / lit on 45 DAS recorded the lowest leaf blight incidence (8.1 PDI) and with the highest disease reduction of 76.9% (Table 3). Manganese has been reported to control the diseases *viz.*, blast and *Alternaria* leaf spot in rice (Simoglou and Dordas, 2006), soybean leaf spot and rust in cereals (Thompson and Huber, 2007). Manganese inhibits the induction of amino peptidase, an enzyme which supplies essential amino acids for fungal growth and pectin methyl esterase, a fungal enzyme that degrades host cell walls. It controls lignin and suberin (lipophilic macromolecule found in plant cell which prevents the fungal invasion) biosynthesis (Vidhyasekaran, 1997) through activation of several enzymes of the shikimic acid and phenylpropanoid pathways (Marschner, 1995). The micronutrient *viz.*, Mn has an important role in photosynthesis and phenol biosynthesis and several other functions (Dordas, 2008). The efficacy of carbendazim + mancozeb against *Alternaria* leaf blight has been proved by Venkatramanamma *et al.* (2014).

Foliar spraying of $ZnSO_4$ @ 0.2% + carbendazim 12% + mancozeb 63%@ 1g / lit ranked next in reducing the leaf spot incidence by recording 9.8 PDI with 72.0 per cent disease reduction. In the control plot leaf spot incidence of 35 PDI was registered. Zinc nutrition plays a pivotal function in plant immune responses (Shirasu *et al*., 1999) and decreased the plant disease symptoms (Grewal *et al*., 1996; Li *et al*., 2016; Machado *et al*., 2018). Plant nutrients inhibit the disease development by changing the plant physiology or by affecting pathogen or both of them. Plant pathogen dynamics in response to nutrient availability are thought to be more complicated as nutrient deficiency/sufficiency in plant system modulate host physiological system and plant reacts differentially (susceptible or tolerance) against different pathogens. However, some nutrient elements have a direct and greater impact on plant diseases than others (Graham and Webb, 1991).

Foliar spraying of $MnSO_4$ @0.2% on 30 DAS + carbendazim 12% + mancozeb 63% @ 1g / lit on 45 DAS registered the highest grain yield of 905 kg/ha as against 703 kg/ha in the control (Table 3). Application of $MnSo_4$ at 2.5 kg $ha^{-1}$ increased the yield in soybean (Tomar *et al*., 1991). The micro nutrients *viz.*, Mn, Zn, B and Mb are important for

**Table 2:** Grouping of pigeonpea genotypes based on their reaction against *Alternaria* leaf blight under field condition.

| Pigeonpea genotypes | Disease grade | Disease reaction |
|---|---|---|
| BDN 2, IPA 8F, IPA 15F, MA 6 | 1.1 - 3 | Resistant |
| CRG 9701, ICP 7119, ICP 2376, KPL 43, KPL 44, MAL 43, WRGE 65, WRP-1, ICP 8863 | 3.1 - 5 | Moderately resistant |
| BRG 1, BRG 2, BSMR 853,BSMR 736, RVSA 07-31, RVSA 07-29, RVSA 07-10, BRG 3, BRG 4, JKM 189, MAL 13 | 5.1 - 7 | Susceptible |

**Table 3:** Efficacy of foliar spraying of micronutrients and fungicide against leaf blight in pigeonpea under field condition.

| Tmt no. | Treatments | Leaf blight | | Grain yield |
|---|---|---|---|---|
| | | Incidence (PDI)* | Disease reduction% | Kg/ha* |
| $T_1$ | $FeSO_4$ foliar spray @0.2% on 30 DAS + carbendazim 12%+ mancozeb 63% on 45 DAS | 13.3 (21.3) | 62.0 | 880 |
| $T_2$ | $ZnSO_4$ foliar spray @0.2% on 30 DAS + carbendazim 12 %+ mancozeb 63% on 45 DAS | 9.8 (18.2) | 72.0 | 885 |
| $T_3$ | $MnSO_4$ foliar spray @0.2% on 30 DAS + carbendazim 12 %+ mancozeb 63% on 45 DAS | 8.1 (16.5) | 76.9 | 905 |
| $T_4$ | $CuSO_4$ foliar spray @0.2% on 30 DAS + carbendazim 12 %+ mancozeb 63% on 45 DAS | 12.3 (20.5) | 64.9 | 857 |
| $T_5$ | Borax foliar spray @0.2% on 30 DAS + carbendazim 12 %+ mancozeb 63% on 45 DAS | 13.4 (21.4) | 61.7 | 823 |
| $T_6$ | Na $Mo_3$ @0.1% foliar spray on 30 DAS + carbendazim 12% + mancozeb 63% on 45 DAS | 14.7 (22.5) | 58.0 | 807 |
| $T_7$ | Control | 35.0 (36.3) | | 703 |
| CD(P=0.05) | | 1.3 | | 19.7 |

Pooled data of three field trials, DAS- Days after sowing; PDI- Per cent disease index.
Values in parenthesis represents Arc sine transformed values. *Mean of three replications.

increasing the productivity of soybean (Devarajan and Palaniappan, 1995). It was followed by $ZnSO_4$ @ 0.2% on 30 DAS + carbendazim 12% + mancozeb 63% on 45 DAS which recorded the grain yield of 885 kg/ha. This was in concordance with findings of Yashona *et al.* (2018) who found that foliar application Zn enhances the growth and yield attributes of pigeonpea.

## CONCLUSION

In the present study the pigeonpea genotypes *viz.*, BDN 2, IPA 8F, IPA 15F and MA 6 were identified as resistant sources for pigeonpea leaf blight caused by *A. alternata* which will be further used for breeding programme. The micronutrient *viz.,* manganese and the fungicide carbendazim 12%+ mancozeb 63%, effective against leaf blight should be one of the component for sustainable integrated disease management strategy.

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### Conflict of interest

All authors declare that they have no conflicts of interest.

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