**Prevalence and Survival of *Xanthomonas axonopodis* pv. *phaseoli*Causing Bacterial Blight in Common Bean (*Phaseolus vulgaris* L.)**

**ABSTRACT**

Bacterial blight of common bean, caused by *Xanthomonas axonopodis* pv. *phaseoli*, poses a significant threat to bean cultivation in the mid-hill regions of Himachal Pradesh. This study was conducted in 2020-2021, to assess the prevalence and severity of the disease in major bean growing localities of Solan and Sirmaur districts and to determine the survival potential of the pathogen in infected plant debris and seed under varying conditions. Survey data revealed that the disease severity was higher in the rainy season (June-sown crop), ranging from 24.2% to 58.2%, compared to the summer season (March sown crop), where it ranged from 16.2% to 29.8%. The highest disease severity (58.2%) was recorded at Karganoo in Sirmaur district. Overall, Sirmaur district exhibited greater disease intensity than Solan. Survival studies demonstrated that *X. axonopodis* pv. *phaseoli* can persist up to 12 months in infected seed, although colony-forming units (CFU) declined significantly over time. In contrast, the pathogen survived for up to 10 months in plant debris placed on the soil surface but could not be recovered beyond 6 months when buried at depths of 10 cm and 15 cm.

**Keywords:** *Xanthomonas axonopodis* pv. *phaseoli*, bacterial blight, common bean, survival, plant debris

1. **INTRODUCTION**

Common bean (*Phaseolus vulgaris* L.) is an important pulse crop cultivated globally for its edible pods and seeds. In India, especially in the mid-hill regions like Himachal Pradesh, it plays a vital role in traditional farming practices and contributes to nutritional security due to its high protein content. However, the productivity of common bean is often constrained by several biotic stresses, among which bacterial blight caused by *Xanthomonas axonopodis* pv. *phaseoli* (Xap) is one of the most devastating disease. Bacterial blight affects all aerial parts of the plant, causing water-soaked lesions, defoliation, and significant yield loss under favorable environmental conditions. Yield losses due to bacterial blight have been reported to range from 22% to 71% depending on cultivar susceptibility and environmental conditions (Gena et al., 2009). The disease is primarily seed-borne but can also survive in infected crop residues, making it difficult to eradicate once established in a field. Environmental conditions such as high relative humidity, frequent rains, and warm temperatures, typically the monsoon season in hill regions, promote effective disease development. Despite its widespread impact, region-specific data on the prevalence and seasonal dynamics of bacterial blight in Himachal Pradesh are limited. Additionally, the survival capacity of the pathogen in different sources of inoculum particularly in seed and plant debris under local environmental conditions remains poorly understood. Understanding the spatial and temporal distribution of bacterial blight and the survival behavior of Xap is essential for developing effective integrated disease management strategies.

The objectives of this study were to assess the seasonal prevalence of bacterial blight in common bean and to evaluate the survival of the causal pathogen in infected seed and plant debris.

1. **MATERIAL AND METHODS**

**2.1 Survey and Surveillance**

Periodic surveys were conducted in various bean growing regions of Solan and Sirmaur districts of Himachal Pradesh for two different cropping seasons *viz;* March sown crop and June sown crop during the year 2020. Farmer’s field surveys were conducted and the data on per cent disease severity was recorded as per the scale given by Dursun et al (2002) (Table 1).

The percent disease severity was worked out by using the formula given by McKinney (1923).

|  |  |  |  |
| --- | --- | --- | --- |
| Disease severity (%) | = | Sum of all disease ratings | × 100 |
| Total number of ratings X Maximum disease grade |

**Table 1. Disease rating scale**

|  |  |
| --- | --- |
| **Rating** | **Leaf area infected** |
| 0 | No disease |
| 1 | 0.1-10% leaf area infected |
| 2 | 10.1-25% leaf area infected |
| 3 | 25.1-50% leaf area infected |
| 4 | 50.1-75% leaf area infected |
| 5 | >75% leaf area infected |

**2.2 Survival studies**

**2.2.1 Survival in plant debris**

To study the survival of *Xanthomonas axonopodis* pv. *phaseoli* in the diseased plant debris, the infected leaves were collected from the bacterial blight infected fields and dried for a week. The infected plant debris were cut into pieces/ bits and placed in perforated nylon bags (6×4 inch). The bags were further placed in plastic containers (20×10 cm) filled with soil at different depths i.e. 0cm (soil surface), 10cm and 15cm. The containers were then kept in net house for 12 months. After an interval of every two months, the bits of the infected debris were taken out from the containers and sterilized with 1% sodium hypochlorite solution. The bits were further grinded by using a sterile mortar and pestle. The grinded plant debris (10g) was dissolved in sterile distilled water (90ml) to prepare the stock solution (10-1) for carrying out 10-fold serial dilution. One ml of aliquot from each dilution (10-2 to 10-8) was spread on the solidified nutrient agar plates under sterile conditions. The Petriplates were incubated for 72 h at 28 ± 2°C and the data was recorded for total number of bacterial colonies formed.

Colony forming units (CFU) per ml was calculated by using the formula given below:

**2.2.2 Survival in seed**

To study the survival of *Xanthomonas axonopodis* pv. *phaseoli* in the seeds, infected seeds were collected from the bacterial blight infected field and were stored for 12 months. The survivability was observed at an interval of every two months. The stored seeds were measured and placed in a conical flask containing 100ml sterile distilled water to prepare the stock solution. The flask was kept on a mechanical shaker for about 10 minutes. The prepared stock solution was then used to carry out 10- fold serial dilution. One ml aliquot from each dilution (10-2 to 10-8) was further spread on nutrient agar plates. Total bacterial colonies formed were calculated after incubating the plates for 72 h at 28 ± 2°C and CFU/ml was calculated.

**3 RESULT AND DISCUSSION**

**3.1 Survey and Surveillance**

To study the status of bacterial blight of bean, periodic surveys were conducted in different bean growing localities of Solan and Sirmaur districts of Himachal Pradesh during the year 2020. Twelve localities in district Solan and seven in district Sirmaur were selected to study the status of the disease. The disease severity was recorded as per the scale given by Dursun et al (2002) for two different growing seasons i.e. March sown crop (Summer crop) and June sown crop (Rainy season crop). The results of the study (Table 2) revealed that the disease occurred in moderate to severe form in different bean growing areas of Solan and Sirmaur districts. The further perusal of data indicated that irrespective of different bean growing localities of both the districts, the bacterial blight appeared in much higher proportions in rainy season crop (June sown crop) as compared to early crop (March sown crop). The overall severity of bacterial blight was recorded in higher proportions in Sirmaur district as compared to Solan district. Highest disease severity (58.2%) was recorded in Karganoo locality of Sirmaur district in rainy season crop. The disease severity was also significantly higher (37.4% to 46.2%) in all the bean growing localities of Sirmaur district during rainy season. The disease appeared in significant proportion (33.4% to 46.2%) in Gaura, Sadhupul, Gamberpul, Jadari, Pandah, Kotbeja and Krishangarh of Solan district during rainy season. The disease was recorded in moderate proportions in Chhachi, Diggal, Dalog and was lowest (24.2%) in Kunihar locality of Solan district during rainy season. During the summer season (March sown crop) the bacterial blight appeared in moderate proportion (16.2% to 29.8%) in different bean growing localities of Solan and Sirmaur district with minimum (16.2%) being recorded in Mansar (Solan) (Fig. 1).

**Table 2. Status and distribution of bacterial blight of bean in different localities of Solan and Sirmaur districts of Himachal Pradesh during 2020**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **District** | **Locality** | **Gram Panchayat** | **Tehsil** | **Disease severity (%)** | |
| **March sown crop** | **June sown crop** |
| **SOLAN** | Gamberpul | Haripur | Solan | 25.2 | 40.6 |
| Pandah | Oachghat | Solan | 25.6 | 37.6 |
| Mansar | Salograh | Solan | 16.2 | 26.6 |
| Gaura | Gaura | Solan | 29.8 | 46.2 |
| Dalog | Kandaghat | Kandaghat | 18.3 | 33.4 |
| Jadari | Sirinagar | Kandaghat | 28.4 | 38.2 |
| Sadhupul | Sadhupul | Kandaghat | 25.6 | 42.6 |
| Krishangarh | Kuthar | Kasauli | 26.5 | 35.2 |
| Kotbeja | Kotbeja | Kasauli | 20.2 | 33.4 |
| Chhachi | Chhachi | Nalagarh | 22.2 | 27.1 |
| Diggal | Diggal | Ramshehar | 23.6 | 28.4 |
| Kunihar | Kunihar | Arki | 18.4 | 24.2 |
| **MEAN** | | | | 23.3 | 34.4 |
| **SIRMAUR** | Karganoo | Karganoo | Rajgarh | 25.4 | 58.2 |
| Shargaon | Ranaghat | Rajgarh | 22.3 | 48.1 |
| Shogi | Naina Tikkar | Pacchad | 18.6 | 38.4 |
| Solkhad | Naina Tikkar | Pacchad | 17.6 | 39.5 |
| Mahlog | Narag | Pacchad | 28.8 | 44.2 |
| Deothal | Narag | Pacchad | 29.2 | 46.6 |
| Damkari | Narag | Pacchad | 22.4 | 37.4 |
| **MEAN** | | | | 26.76 | 44.6 |

Disease severity and incidence of bacterial blight of bean has also been reported in different parts of the world by various workers (Mabagala and Saettler 1992; Gridley 1994; Allen 1995). Bacterial blight is one of the most important disease of bean crop. In India, the disease was reported to cause 71.68% yield losses in severely infected plants in Rajasthan state (Gena et al., 2009). The survey surveillance studies by Bhat et al (2017) revealed that district Srinagar has highest disease incidence and intensity of 42.72% and 23.80% whereas least incidence and intensity of 39.69% and 17.69% was observed in district Bandipora.

**Fig. 1 Bacterial blight severity in different bean growing areas of Solan and Sirmour districts of Himachal Pradesh**

**3.2 Survival studies: Effect of different storage durations on the survivability of *Xanthomonas axonopodis* pv. *phaseoli* in infected seed and plant debris**

The results of the present study presented in Table 3 revealed significant decrease in survivability of *Xanthomonas axonopodis* pv. *phaseoli* in infected seed and plant debris with the increasing storage duration.

Further perusal of data indicated the higher viability of the pathogen in infected seed as compared to infected plant debris. In infected seed, a gradual decline in viability was noticed upto 8 months of storage period. Beyond 8 months of storage period, the survivability decreased significantly. However, the pathogen could be recovered in some proportion even after 12 months of storage period in infected seed material. Irrespective of the different depth of burial of infected debris, a significant decrease in survivability of the pathogen was recorded with the increasing storage duration. The viability decreased significantly with the increasing depth of burial of the infected debris. A gradual decline in viability of the pathogen was recorded in the plant debris kept on soil surface and the pathogen could not be recovered beyond 10 months of storage. At deeper depth of burial (10cm and 15 cm), the relative viability was much lesser than the infected debris kept on the surface at different storage duration. The pathogen could not be recovered beyond 6 months of storage at increasing (10cm and 15cm) depth of burial.

**Table 3. Survivability of *Xanthomonas axonopodis* pv. *phaseoli* in seed and plant debris**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Storage duration**  **(Months)** | **Recovery of *Xanthomonas axonopodis* pv. *phaseoli* from seed**  **[cfu/ml (108)]** | **Recovery of *Xanthomonas axonopodis* pv. *phaseoli* at different depth (cm) of burial**  **[cfu/ml (108)]** | | | |
| **0** | **10** | **15** | **Mean** |
| **2** | 13.00 | 11.28 | 6.43 | 4.12 | 7.28 |
| **4** | 10.50 | 8.53 | 4.34 | 2.34 | 5.07 |
| **6** | 7.81 | 6.89 | 1.95 | 0.87 | 3.23 |
| **8** | 5.05 | 4.92 | 0.00 | 0.00 | 1.64 |
| **10** | 1.93 | 3.19 | 0.00 | 0.00 | 1.06 |
| **12** | 0.55 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Mean** | 6.47 | 5.80 | 2.12 | 1.22 |  |
| **CD (0.05)** | 1.01 | Duration- 0.41 Depth- 0.29  Duration × Depth- 0.71 | | | |

**Fig. 2. Survival of *Xanthomonas axonopodis* pv. *phaseoli* in plant debris for 12 months at different burial depths**

The results are in agreement with the studies conducted by Gent et al (2005) who also observed significant decline in the *Xanthomonas axonopodis* pv. *phaseoli* populations in buried debris as compared to the unburied debris. Okechukwu and Ekpo (2010) also observed that *Xanthomonas* can survive in infected plant debris and seed upto 8 months after the cropping season. Similar results were reported by different workers all over the world (Arnaud‑Santana et al., 1991; Marques et al., 2005; and Torres et al., 2009). Also these results are consistent with previous research (e.g., Saettler 1991; Gitaitis et al. 2003), which also established that infected plant residues and contaminated seeds serve as major sources of inoculum for initiating infections in the following growing season.

**3.3 CONCLUSION**

Bacterial blight of common bean, caused by Xanthomonas axonopodis pv. phaseoli, was found to be more severe during the rainy season in Himachal Pradesh, particularly in Sirmaur district. The pathogen showed prolonged survival in infected seed (up to 12 months) and on surface crop debris (up to 10 months), but survival declined sharply with burial depth and duration. These findings highlight the importance of using clean seed, removing or deeply burying infected debris, and adjusting sowing times to reduce disease impact. Integrated management practices are essential to minimize losses and ensure sustainable bean production in hill regions. These findings have important implications for disease forecasting and sanitation practices in common bean cultivation, highlighting the need for timely pathogen detection and effective field hygiene to reduce the inoculum load and limit the disease spread.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

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

**REFERENCES**

Allen DJ. An annotated list of diseases, pathogens and associated fungi of common bean (Phaseolus vulgaris L.) in Eastern and Southern Africa. Wallingford (UK): CAB International; 1995. 62 pp.

Arnaud‑Santana E, Pena‑Matos E, Coyne DP, Vidaver AK. Longevity of Xanthomonas campestris pv. phaseoli in naturally infested dry bean (Phaseolus vulgaris) debris. Plant Dis. 1991;75:952–953.

Bhat TA, Wani SH, Ahanger RA, Dar SA, Bhat NA. Status of bacterial blight of common beans (Phaseolus vulgaris L.) in Kashmir. J Pharmacogn Phytochem. 2017;6:376–379.

Dursun A, Donmez MF, Sahin F. Identification of resistance to common bacterial blight disease on bean genotypes grown in Turkey. Eur J Plant Pathol. 2002;108:811–813.

Gena GM, Shah R, Jodon KS, Mali BL. Host range of Xanthomonas axonopodis pv. vignicola, the incitant of bacterial blight in cowpea. Indian Phytopathol. 2009;64:539–540.

Gent DH, Lang JM, Bartolo ME, Schwartz HF. Inoculum sources and survival of Xanthomonas axonopodis pv. allii in Colorado. Plant Dis. 2005;89:507–514.

Gridley HE. Bean production constraints in Africa with special reference to breeding for resistance to common bean mosaic virus in Uganda. In: Allen DJ, Buruchara R, editors. Proc Pan African Working Group Meeting on Bacterial and Virus Diseases of Common Bean, Cali, Colombia; 1994 Jul 9–13. p. 33–43.

Mabagala RB, Saettler AW. An improved semi-selective media for the recovery of Xanthomonas campestris pv. phaseoli. Plant Dis. 1992;76:443–446.

Marques AS, Guimaraes PM, Santos JP, Vieira TM. Survival and viability of Xanthomonas axonopodis pv. phaseoli associated with bean seeds stored under controlled conditions. Fitopatol Bras. 2005;30:527–531.

McKinney HH. Influence of soil temperature and moisture on infection of wheat seedlings by Helminthosporium sativum. J Agric Res. 1923;26:195–217.

Okechukwu R, Ekpo E. Survival of Xanthomonas campestris pv. vignicola in infested soil, cowpea seed and cowpea debris. Trop Agric Res Ext. 2010;11:45–48.

Torres JP, Maringoni AC, Silva TAF. Survival of Xanthomonas axonopodis pv. phaseoli var. fuscans in common bean leaflets on soil. J Plant Pathol. 2009;91:195–198.

Saettler AW. Common bacterial blight. In: Hall R, editor. Compendium of bean diseases. St. Paul (MN): APS Press; 1991. p. 29–31.

Gitaitis R, Walcott R. The epidemiology and management of seedborne bacterial diseases. Annu Rev Phytopathol. 2003;41:371–97.