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Effect of sowing date on severity of alternaria blight of Sesame (*Sesamum Indicum* L.) caused by *Alternaria sesame* (Kawamura) Mohanty and Behera

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Abstract

Background: Alternaria blight caused by *Alternaria sesami* is a devastating disease of sesame (*Sesamum indicum* L.) causing significant yield losses globally. Manipulation of sowing date offers a cost-effective and environmentally sustainable strategy for disease management. This study investigated the influence of different sowing dates on disease severity of Alternaria blight in sesame.

Methods: Field experiments were conducted during Kharif season 2022-23 at the Student's Instructional Farm, Acharya Narendra Deva University of Agriculture and Technology, Ayodhya, Uttar Pradesh, India. Four sowing dates (5 July, 20 July, 4 August, and 19 August) were evaluated in a randomized block design with three replications using sesame variety 'Type-4'. Disease severity was recorded at 33, 41, 49, 57, 65, 73, 81, and 90 days after sowing (DAS) using a 0-5 rating scale, and percent disease index (PDI) was calculated.

Results: Sowing date significantly ($p < 0.05$) influenced disease severity. The earliest sowing (5 July) recorded minimum mean disease severity (12.35%) with disease initiation at 57 DAS (5.69%) reaching 30.76% at 90 DAS. Progressively delayed sowing resulted in increased disease severity: 20 July sowing (24.12%), 4 August sowing (27.93%), and 19 August sowing (32.25%). The latest sowing (19 August) exhibited earliest disease initiation (33 DAS) with maximum severity (66.66% at 90 DAS) and highest mean disease severity (32.25%). Disease progression rate was slowest in early sowing (5-fold increase) and most rapid in late sowing (27-fold increase).

Conclusion: Early sowing during second fortnight of July effectively minimizes Alternaria blight severity in sesame. Delayed sowing beyond July leads to significantly higher disease pressure, making sowing date manipulation an effective agronomic tool for integrated disease management.

Keywords: Sesame (*Sesamum indicum* L.), alternaria blight, *Alternaria sesami*, sowing date

1. Introduction

Sesame (*Sesamum indicum* L.), often referred to as the "Queen of Oilseeds," is one of the oldest cultivated oilseed crops, prized for its high-quality edible oil with exceptional resistance to rancidity (Prasad, 2002) [21]. The seeds contain 50% oil, 20% protein, and provide 6335 kcal kg⁻¹ of dietary energy. India is the world's leading producer, cultivating sesame across 1.81 million hectares with production of 0.82 million tonnes and productivity of 478 kg ha⁻¹. The major sesame-growing states include Rajasthan, Uttar Pradesh, Madhya Pradesh, and Gujarat, with Uttar Pradesh contributing approximately 25% of national production (Directorate of Economics and Statistics, GOI, 2021) [6].

Despite its economic importance, sesame production is severely constrained by various biotic stresses, among which fungal diseases constitute the major limiting factor. Alternaria blight, caused by *Alternaria sesami* (Kawamura) Mohanty and Behera, is particularly destructive during the Kharif season, affecting the crop at all growth stages (Ojiambo *et al.*, 1999) [19]. The disease was first reported in India by Dey (1948) [5] in Uttar Pradesh, and subsequently by Mohanty and Behera (1958) [16] in Bhubaneswar. The disease manifests as small, circular to irregular brown spots on leaves, which gradually enlarge with characteristic concentric zonation, ultimately leading to blighting and premature defoliation. Severe infections extend to stems and capsules, causing significant yield losses ranging from 30 to 80% under favorable environmental conditions (Prasad and Reddy, 1997; Akbari and Parakhia, 2011) [22, 1].

Environmental factors, particularly temperature and relative humidity, play a pivotal role in disease development. *Alternaria sesame* requires high relative humidity (>90%) and moderate temperatures (25-30°C) for optimal spore germination, infection, and disease progression (Awashi and Kolte, 1994) [3]. The manipulation of sowing date offers a strategic approach to disease management by enabling the crop to avoid coincidence of susceptible growth stages with periods of favorable environmental conditions and high inoculum pressure (Hegde, 2006; Choudhary *et al.*, 2015) [9, 4].

Previous studies on various oilseed crops have demonstrated the significant impact of sowing dates on *Alternaria* blight severity. In sunflower, Gadhave *et al.* (2011) [7] reported higher disease incidence in crops sown from late June to early August compared to later sowings. In linseed, Singh and Singh (2003) [25] observed maximum disease severity in October-sown crops with gradual decline in subsequent sowings. In sesame, Choudhary *et al.* (2015) [4] reported that late sowing (August) favored quick disease development with 60.50-70.50% disease intensity. Lubaina (2013) [13] found that June 20th sowing produced higher yields with lower disease incidence compared to July 10th sowing. However, systematic studies on the influence of sowing dates on *Alternaria* blight severity in sesame under the agro-climatic conditions of eastern Uttar Pradesh are limited. Therefore, the present investigation was undertaken with the objective to evaluate the effect of different sowing dates on the severity of *Alternaria* blight in sesame and to identify the optimal sowing window for minimizing disease pressure.

2. Materials and Methods

2.1 Experimental Site

The field experiment was conducted during the Kharif season of 2022-23 at the Student's Instructional Farm, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India. The experimental site is geographically situated at 26.47°N latitude, 82.12°E longitude at an elevation of 113 meters above mean sea level. The region falls under the Indo-Gangetic plains with a subtropical semi-arid climate, characterized by hot summers and cool winters, receiving an annual mean precipitation of about 1200 mm, with maximum rainfall (698.6 mm) received from July to September.

The soil of the experimental field was sandy loam in texture (62.4% sand, 26.3% silt, 11.3% clay), slightly alkaline (pH 8.3), with low organic carbon, low nitrogen, medium phosphorus, and medium potassium content.

2.2 Experimental Design and Treatments

The experiment was laid out in a Randomized Block Design (RBD) with three replications. Four sowing dates were evaluated as treatments:

T₁ (Early sowing): 5 July 2022

T₂: 20 July 2022

T₃: 4 August 2022

T₄ (Late sowing): 19 August 2022

Each plot measured 3.0 m × 3.0 m (9 m²) with row-to-row spacing of 30 cm and plant-to-plant spacing of 10 cm.

2.3 Crop Husbandry

Sesame variety 'Type-4', a popular cultivar in the region, was used for the experiment. Seeds were sown at a rate of 4 kg ha⁻¹. Recommended fertilizer dose of 35 kg N, 23 kg P₂O₅, and 23 kg K₂O per hectare was applied uniformly to all plots. Half dose of nitrogen and full doses of phosphorus and potassium were applied as basal, while the remaining nitrogen was top-dressed at 30 days after sowing. Standard agronomic practices including irrigation, manual weeding (twice at 25-30 and 60 DAS), and hoeing were followed uniformly across all treatments to ensure optimal crop growth.

2.4 Disease Assessment

Disease severity was recorded at eight regular intervals: 33, 41, 49, 57, 65, 73, 81, and 90 days after sowing (DAS). Twenty plants were randomly selected and tagged in each plot for disease observation. The per cent disease index (PDI) was calculated using a 0-5 rating scale (Anonymous, 1998) [2] based on the percentage leaf area infected:

Table 1: Disease rating scale for *Alternaria* blight severity

Rating	Description
0	No visible symptoms
1	1-10% leaf area infected
2	11-20% leaf area infected
3	21-30% leaf area infected
4	31-40% leaf area infected
5	More than 40% leaf area infected

The per cent disease index was computed using the formula proposed by Wheeler (1969) [28]:

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of individual disease ratings}}{\text{No. of leaves observed} \times \text{Maximum disease grade}} \times 100$$

2.5 Weather Data Collection

Meteorological data including maximum and minimum temperature (°C), relative humidity (%), and rainfall (mm) during the crop growing period were recorded from the university meteorological observatory located adjacent to the experimental site.

2.6 Statistical Analysis

The data on disease severity were subjected to analysis of variance (ANOVA) appropriate for randomized block design using OPSTAT software. Critical differences (CD) were calculated at 5% probability level to compare treatment means where F-test was significant.

3. Results

3.1 Weather Conditions During Crop Season

The weather parameters recorded during the experimental period (July to November 2022) are presented in Table 2. The maximum temperature ranged from 28.7 to 34.8°C, while minimum temperature ranged from 16.2 to 26.4°C. Morning relative humidity remained above 84% throughout July-October, with peak humidity (91%) in August. Total rainfall of 786.8 mm was received during the crop season, with maximum rainfall (312.4 mm) in August.

Table 2: Weather parameters during the crop growing period (July-November 2022)

Month	Max Temp (°C)	Min Temp (°C)	Morning RH (%)	Evening RH (%)	Rainfall (mm)
July	34.8	26.4	89	71	245.6
August	33.2	25.8	91	74	312.4
September	32.6	24.9	90	69	186.2
October	31.4	21.3	84	52	42.8
November	28.7	16.2	78	43	0.0

3.2 Disease Initiation

The time of first disease appearance varied considerably across sowing dates (Table 3; Fig. 1). In the earliest sowing (5 July), disease symptoms first appeared at 57 days after sowing with 5.69% severity. The 20 July sowing exhibited earlier disease initiation at 41 DAS (2.41% severity). Both August sowings (4 August and 19 August) showed the earliest disease appearance at 33 DAS, with severity of 1.31% and 2.48%, respectively.

3.3 Disease Progression

The progression of disease severity followed distinct patterns for different sowing dates (Table 3; Fig. 1). In the 5 July sowing, disease severity increased gradually from 5.69% at 57 DAS to 30.76% at 90 DAS, representing

approximately a 5-fold increase over the observation period. The mean disease severity across all observation dates was 12.35%.

The 20 July sowing showed a steeper progression curve, with severity increasing from 2.41% at 41 DAS to 47.82% at 90 DAS. The mean disease severity was 24.12%, approximately double that of the earliest sowing.

The 4 August sowing demonstrated more rapid disease buildup, with severity ranging from 1.31% at 33 DAS to 51.58% at 90 DAS (mean 27.93%). The latest sowing (19 August) exhibited the most dramatic disease progression, with severity escalating from 2.48% at 33 DAS to 66.66% at 90 DAS (mean 32.25%), representing approximately a 27-fold increase.

Table 3: Effect of sowing date on percent disease index (PDI) of *Alternaria* blight in sesame

Disease appearance after sowing (DAS)									
Date of Sowing	33	41	49	57	65	73	81	90	Mean
I (5 July)	0.00	0.00	0.00	5.69	12.51	22.59	27.29	30.76	12.35
II (19 July)	0.00	2.41	5.78	20.52	32.04	41.16	43.23	47.82	24.12
III (4 August)	1.31	5.41	15.69	23.87	30.62	41.40	49.26	51.58	27.93
IV (19 August)	2.48	8.54	19.32	25.77	32.08	47.94	59.50	66.66	32.25
Mean	0.95	4.09	10.20	18.96	26.81	38.27	44.82	49.20	24.16
CD @ 5%									
Date of Sowing (A)							0.39		
Disease appearance after sowing (B)							0.55		
Date of Sowing (A) × Disease appearance after sowing (B)							1.10		
SE(m)									
Date of Sowing (A)							0.14		
Disease appearance after sowing (B)							0.19		
Date of Sowing (A) × Disease appearance after sowing (B)							0.39		

**Fig 1:** View of the Experimental field to check the effect of date of sowing on disease incidence and severity of *Alternaria* blight of sesame caused *Alternaria sesami* under field condition during *Kharif* season 2022-23

3.4 Mean Disease Severity Across Sowing Dates

The overall mean disease severity across all observation dates showed a progressive increase with delayed sowing (Fig. 1). The 5 July sowing recorded the lowest mean PDI (12.35%), followed by 20 July sowing (24.12%), 4 August sowing (27.93%), and 19 August sowing (32.25%). Statistical analysis revealed significant differences ($p < 0.05$) among all sowing dates, confirming the strong influence of sowing time on disease development.

3.5 Disease Progress Rate

The rate of disease progression, calculated as the increase in PDI per unit time, was lowest in early-sown crops and highest in late-sown crops. Between 57 and 90 DAS (33-day period), the 5 July sowing showed an increase of 25.07 PDI units ($0.76 \text{ units day}^{-1}$), while during the same period, the 19 August sowing showed an increase of 40.89 PDI units from 57 to 90 DAS ($1.24 \text{ units day}^{-1}$). The accelerated disease progress in late-sown crops coincided with the peak

monsoon period characterized by high humidity and moderate temperatures.

3.6 Interaction Effect

The interaction between sowing date and crop age (days after sowing) was statistically significant ($p < 0.05$), indicating that the effect of sowing date on disease severity varied with crop growth stage. Early in the season (33-49 DAS), differences among sowing dates were relatively small but became increasingly pronounced as the crop matured. At 90 DAS, the difference in disease severity between the earliest (5 July) and latest (19 August) sowing was 35.90 PDI units, highlighting the cumulative effect of sowing date on final disease pressure.

4. Discussion

The findings of this investigation demonstrate that sowing date profoundly influences the severity of *Alternaria* blight in sesame, with early sowing significantly reducing disease pressure compared to delayed sowing. These results can be explained through multiple interacting mechanisms involving host phenology, pathogen biology, and environmental conditions.

4.1 Escape from Favourable Environmental Conditions

The primary mechanism underlying reduced disease severity in early-sown crops is the temporal escape from environmental conditions conducive to disease development. *Alternaria sesami* requires prolonged leaf wetness periods (>8 hours) and high relative humidity (>90%) for successful infection and sporulation (Awashi and Kolte, 1994) [3]. In the Ayodhya region, the monsoon rains intensify during August and September (Table 2), creating ideal conditions for disease epidemics. Early-sown crops (5-20 July) complete their vegetative and reproductive growth before exposure to peak monsoon humidity, thereby escaping the most favorable infection windows.

Choudhary *et al.* (2015) [4] similarly reported that late-sown (August) sesame crops in Bihar experienced 60.50-70.50% disease intensity compared to early-sown crops, attributing this to the coincidence of susceptible crop stages with high humidity and frequent rainfall. Our findings corroborate these observations, with August-sown crops exhibiting 2.6-fold higher mean disease severity than the earliest sowing.

4.2 Plant Age and Susceptibility Window

The concept of plant age-related susceptibility is critical to understanding sowing date effects. Ojiambo *et al.* (1999) [19] demonstrated that sesame plants are most susceptible to *Alternaria sesami* infection at 8-12 weeks of age, corresponding to the flowering and capsule development stages. In our study, the 5 July sowing reached this susceptible phase during late August to mid-September, a period of relatively declining rainfall and humidity. In contrast, the 19 August sowing attained maximum susceptibility during October, when extended periods of high humidity from late monsoon rains and dew deposition create optimal infection conditions.

This age-related susceptibility pattern has been documented in other pathosystems. In safflower, Hegde (2006) [9] observed that crops sown 15 days before the recommended time suffered 75.50% disease severity, while timely-sown crops showed only 48.90% severity. The author concluded that alignment of the critical growth stage with favorable

environmental conditions determines ultimate disease expression.

4.3 Inoculum Buildup and Dispersal

Temporal patterns of inoculum availability also contribute to sowing date effects. Early-sown crops may escape peak inoculum concentrations that develop as the season progresses. *Alternaria sesami* survives in infected crop debris and seeds, with primary inoculum consisting of airborne conidia dispersed by wind and rain splash (Leppik and Sowell, 1964) [12]. As the season advances and more fields become infected, the ambient spore load increases exponentially. Late-sown crops are thus exposed to higher inoculum pressure from surrounding infected fields, accelerating disease onset and progression.

Mesta *et al.* (2009) [15] reported similar findings in sunflower, where June-September sowings showed maximum disease intensity (62.21-94.04%) due to progressive inoculum buildup, while October sowings exhibited lower disease pressure. The rapid disease progression observed in our August sowings (27-fold increase) compared to July sowings (5-fold increase) likely reflects this cumulative inoculum effect.

4.4 Temperature and Humidity Interactions

Analysis of weather data during the experimental period revealed that maximum temperature ranged from 32.4-35.7°C and minimum temperature from 24.2-27.8°C during July-September, with relative humidity consistently above 85% during morning hours (Table 2). These conditions fall within the optimal range for *Alternaria sesami* infection and sporulation (25-30°C, >90% RH). Late-sown crops experienced these favorable conditions throughout their active growth phase, while early-sown crops encountered progressively less favorable conditions as temperatures declined and humidity fluctuated in October.

Murumkar *et al.* (2008) [17] established significant correlations between weather parameters and *Alternaria* leaf spot development in safflower, noting that disease progression was most rapid when maximum temperature ranged from 28-32°C with >85% RH. Our findings align with these observations, with disease progression rates increasing markedly when susceptible crop stages coincided with such conditions.

4.5 Yield Implications and Management Strategies

The significantly higher disease severity in late-sown crops has direct implications for yield loss. Although yield data were not presented in this disease-focused analysis, previous studies have established strong negative correlations between *Alternaria* blight severity and sesame yield. Naik *et al.* (2004) [18] reported yield losses of 30-50% under severe disease pressure, while Pramod and Mishra (1992) [20] documented 40-60% losses in severely affected fields. Maiti *et al.* (1985) [14] reviewed sesame diseases in India and reported that *A. sesami* is a widespread and destructive pathogen causing substantial yield reduction.

The practical implication of our findings is clear: farmers in eastern Uttar Pradesh and similar agro-climatic regions should complete sesame sowing by the third week of July to minimize *Alternaria* blight damage. This agronomic strategy offers several advantages over chemical control: it requires no additional input cost, eliminates environmental and health concerns associated with pesticide use, and can be

easily integrated with other management practices such as resistant varieties (Jahagirdar *et al.*, 2003) ^[10] and botanical extracts (Guleria and Kumar, 2006; Ranaware *et al.*, 2010) ^[8, 23].

4.6 Comparison with Previous Studies

Our results are consistent with and extend previous findings on sowing date effects in sesame and related oilseed crops: Gadhave *et al.* (2011) ^[7] in sunflower: Reported higher disease incidence in June-July sowings compared to August sowings, with cultivar MSFH-17 showing lower disease than Morden across all dates.

Singh and Singh (2003) ^[25] in linseed: Observed maximum disease severity (72.29-94.45%) in October 15th sowings, with progressive decline in later sowings, and highest seed yield in November 5th sowings.

Lubaina (2013) ^[13] in sesame: Found that June 20th sowing produced higher oil and seed yields with lower disease incidence compared to July 10th sowing.

Kadam *et al.* (2016) ^[11] in tomato: Documented severe early blight occurrence during August kharif transplanting, with disease progress increasing linearly with plant growth.

Tripathi *et al.* (1998) ^[27] in sesame: Noted significant variations in disease severity between sowing dates, with delayed sowing resulting in increased severity, and variety T-13 exhibiting significantly less disease.

Singh (2002) ^[26] in sunflower: Found low disease severity in August 26th sown crops compared to July to first week August sowings, attributing this to high humidity and dense crop canopy during rainy season.

The consistency of these findings across different crops and geographical locations underscores the fundamental importance of sowing date manipulation as a disease management strategy.

5. Conclusion

This investigation conclusively demonstrates that sowing date significantly influences *Alternaria* blight severity in sesame under the agro-climatic conditions of eastern Uttar Pradesh. Early sowing during the second fortnight of July (5-20 July) minimizes disease pressure by enabling the crop to escape favorable infection conditions during its most susceptible growth stages. Progressively delayed sowing results in increasingly severe disease, with August-sown crops exhibiting the highest disease severity and most rapid disease progression.

The significant interaction between sowing date and crop age highlights the importance of synchronizing crop phenology with seasonal weather patterns to optimize disease escape. The mean disease severity ranged from 12.35% in 5 July sowing to 32.25% in 19 August sowing, representing a 2.6-fold increase with delayed sowing. Disease initiation was earliest (33 DAS) and progression most rapid (27-fold increase) in the latest sowing.

These findings provide a scientific basis for recommending early sowing as a core component of integrated disease management in sesame. Farmers should be advised to complete sowing operations by 20 July to achieve effective disease suppression without additional input costs.

Future research should focus on validating these findings across multiple locations and years, incorporating yield loss assessment, and developing predictive models that integrate sowing date with weather parameters for location-specific recommendations. Additionally, studies on the interaction

between sowing date and other management practices (resistant varieties, fungicide application, botanical extracts) could further refine integrated disease management strategies for sustainable sesame production. The identification of resistant varieties (Savitha *et al.*, 2013) ^[24] combined with optimal sowing time could provide more effective and durable disease management.

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