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Effects of plasma treatment rates and durations on growth and yield parameters of four sesame varieties (*Sesamum indicum* L.)

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Abstract

This study assessed the effects of plasma treatment rates (50 W and 80 W) and treatment durations on plant growth and yield parameters of four sesame varieties (*Sesamum indicum* L.) viz Ba Pan, Sinyadanar-3, Sinyadanar-4, and Theintpannet, during the year 2024–2025 summer growing season at the Government compound in Magway Township, Magway Region, Myanmar. Untreated plots served as controls. Ba Pan and Sinyadanar-4 seeds were exposed to plasma for 20 to 100 seconds, whereas Sinyadanar-3 and Theintpannet seeds were treated for 20 to 120 seconds. Parameters measured included plant height (cm), capsules per plant, seeds per capsule, seed weight (g), and seed yield (baskets/acre). Statistical analysis revealed that the Sinyadanar-4 variety responded most strongly to plasma treatment. At 50 W, Sinyadanar-4 showed significant differences from the control in plant height, capsules per plant, seeds per capsule, and seed yield. Duration trials further showed that Sinyadanar-4 differed significantly from the control in plant height (at 90 s), capsules per plant (at 40 s), seeds per capsule (at 20 s), and seed yield (at 40 s). Among all varieties, Sinyadanar-4 recorded the highest seed yield (19.09 baskets/acre), followed by Ba Pan (15.46), Sinyadanar-3 (13.48), and Theintpannet (11.30). These findings recommend the use of 50 W plasma treatment with Sinyadanar-4 for optimum productivity.

Keywords: plasma treatment, rate, duration, sesame, variety, yield

Introduction

Magway Region is one of Myanmar's principal oilseed-producing areas, where peanuts, sesame, sunflower, and castor are commonly cultivated. Among these, sesame (*Sesamum indicum* L.) yields the highest proportion of oil and is consumed both domestically and exported to meet international demand. In the 2022–2023 fiscal year, the total area planted with oil crops nationwide was 8.35 million acres, of which Magway Region accounted for 1.4 million acres (*Settlement Land Records Department*). Magway Region Department of Agriculture, 2025 reported an oil self-sufficiency rate of 387.95% based on regional crop production and yield data. Seeds are subjected to various physical and biological stresses during germination, which can adversely affect seed coat permeability and water uptake both critical determinants of germination success. Several seed priming technologies have been developed to address these challenges. Among them, cold plasma technology has emerged as a promising, environmentally friendly physical seed treatment technique with potential applications in improving crop productivity, disease management, and seed quality (Biruntha *et al.*, 2025) [3]. Cold plasma has been reported to improve plant resistance, promote germination by breaking seed dormancy, boost yield, and act as a seed disinfectant (Xinru *et al.*, 2025) [17]. As a non-thermal technology, cold plasma avoids adverse environmental impacts and is considered a sustainable tool for enhancing agricultural production (Bilea *et al.*, 2024; Mohamed *et al.*, 2025) [2, 12]. The scientific basis of plasma was first articulated by the American scientist Irving Langmuir in 1922, who described ionized gases containing electrons, ions, and neutral particles as interacting elements later termed "plasma" (Chatterjee, 2022) [4]. Despite growing interest in plasma seed treatment, its variety specific effects on sesame remain insufficiently documented, particularly regarding optimal treatment rates and

exposure durations under field conditions in Myanmar. The present experiment was conducted to evaluate the responses of four sesame varieties to different plasma treatment rates and durations in terms of growth and yield parameters, and to determine whether varietal responses are consistent or variable under local environmental conditions.

2. Materials and Methods

2.1 Experimental Site and Weather Condition

The experiment was conducted at the Government agricultural compound in Magway Township, Magway Region, Myanmar, during the summer growing season of 2024–2025. The climate of the location is characterized as moderately to very temperate climate, with hot summers from February to May, a rainy season from June to September, and a winter season from October to January. The months of February and May was the hottest period of the year. The requirement daily means some meteorological data for cropping seasons recorded at Meteorological Observatory Centre, Magway Region. The average minimum temperature was clearly 14.8°C and the average maximum temperature was 39.8°C during the 2024–2025 year, according to mean meteorological data. Total precipitation throughout the growing season (February to the end of May) was 1.77 mm.

2.2 Experimental Design and Treatments

A simple experimental design was used with two plasma treatment rates (50 W and 80 W) and varying treatment durations. Seeds of Ba Pan and Sinyadanar-4 were treated at 50 W and 80 W for durations of 20, 30, 40, 50, 60, 70, 80, 90, and 100 seconds. Seeds of Sinyadanar-3 and Theintpannet were treated for 20, 40, 60, 80, 100, and 120 seconds at both rates. Four untreated plots served as controls. A total of 64 plots were established over a gross experimental area of 0.59 acres; each plot measured 3.75 × 60 feet and was separated by 7-foot pathways. In the third week of February, all four sesame varieties were sown.



2.3 Data Collection

Data were collected on the following parameters: plant height (cm), number of capsules per plant, number of seeds per capsule, weight of 1000 seeds (g), and seed yield (baskets/acre).

2.4 Statistical Analysis

Data were statistically analysed using Microsoft Excel 2019. Pearson's correlation coefficients between growth and yield components were calculated using Statistix 8.0 software. Differences between plasma treatments and untreated controls were assessed using the *t*-test at a 5% significance level ($P \leq 0.05$).



3. Results and Discussion

3.1 Effects of Plasma Treatment Rate on Growth and Yield Components

The effects of 50 W and 80 W plasma treatment rates on plant height, capsules per plant, seeds per capsule, seed weight of 1000

seeds, and seed yield of the four sesame varieties are presented in Table 1.

Plant Height (cm)

Plasma treatment rate significantly affected plant height in Ba Pan (50 W and 80 W), Sinyadanar-3 (50 W and 80 W), and Theintpannet (50 W) compared to the control (Table 1). Among all treatments, Sinyadanar-4 at 50 W recorded the highest mean plant height (102.5 cm); however, Sinyadanar-4 at both 50 W and 80 W did not differ statistically from the control. These findings are consistent with those of Sayahi *et al.* (2024) ^[14] and Rana *et al.* (2023) ^[13].

Capsules per Plant

Significant differences between plasma treatment rates and the control were observed for Ba Pan (50 W) and Sinyadanar-4 (50 W and 80 W). The highest number of capsules per plant was recorded in Sinyadanar-4 at 50 W across all treatments. A similar trend was reported by Ling *et al.* (2014) ^[8].

Seeds per Capsule

The maximum number of seeds per capsule was observed in Sinyadanar-4 at 50 W. However, pooled statistical analysis indicated no significant differences among Ba Pan (80 W), Sinyadanar-4 (50 W and 80 W), Sinyadanar-3 (50 W), and Theintpannet (50 W and 80 W) (Table 1). These results are consistent with the findings of Sivachandiran and Khacef (2017) ^[16].

1000-Seed Weight (g)

Pooled data indicated that the highest mean 1000-seed weight was recorded in the control plots of Sinyadanar-4; this variety showed a significant effect, whereas the other varieties did not (Table 1). This result aligns with findings by Biruntha *et al.* (2025) ^[3].

Seed Yield (baskets/acre)

Plasma treatment rate significantly influenced seed yield across treatments (Table 1). The highest yield was recorded in Sinyadanar-4 at 50 W, followed by Theintpannet (80 W), Sinyadanar-4 (80 W), and Ba Pan (50 W). These results are in agreement with Mohamed *et al.* (2025) ^[12] and Hu *et al.* (2026) ^[6].

3.2 Effects of Plasma Treatment Duration on Growth and Yield Components

Plant Height (cm)

Treatment duration significantly affected plant height in Sinyadanar-4 at 90 s ($P = 0.04$) and in Sinyadanar-3 at 40 s, 80 s, and 100 s ($P = 0.03$, 0.01, and 0.04, respectively) compared to the control (Table 2). These findings are consistent with Abeysingha *et al.* (2024) ^[1] and Biruntha *et al.* (2025) ^[3].

Capsules per Plant

A significant difference from the control was recorded for Sinyadanar-4 at 40 s ($P = 0.02$) (Table 3). Florescu *et al.* (2023) ^[5] reported a similar pattern.

Seeds per Capsule

A significant difference from the control was observed in Sinyadanar-4 at 20 s ($P = 0.04$) (Table 4). These findings are in agreement with Luchian *et al.* (2025) ^[9].

1000-Seed Weight (g)

No significant differences in 1000-seed weight were detected

between any treatment duration and the control (Table 5). This outcome is consistent with the findings of Ivankov *et al.* (2021)^[7] and Mildaziene *et al.* (2022)^[11].

Seed Yield (baskets/acre)

Seed yield was significantly influenced by treatment duration in Sinyadanar-4 at 40 s and Theintpannet at 20 s compared to the control (Table 6). These results agree with Xinru *et al.* (2025)^[17].

3.3 Comparative Yield Performance

Among the four varieties, Sinyadanar-4 achieved the highest overall seed yield (19.09 baskets/acre), followed by Ba Pan (15.46), Sinyadanar-3 (13.48), and Theintpannet (11.30 baskets/acre). These results demonstrate that Sinyadanar-4 was the most responsive variety to plasma treatment, both in terms of rate and duration, relative to the other three varieties.

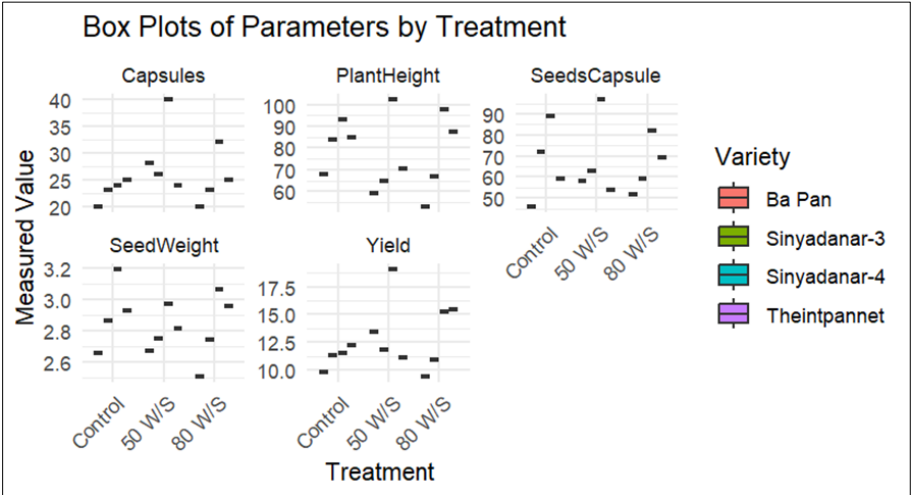


Fig 1: The plant height (cm), capsule per plant, seed per capsule, 1000 seed weight (gm) and yield (basket/acre) of Control and four sesame varieties as influenced by Plasma Treatment Rate (50 W and 80 W)

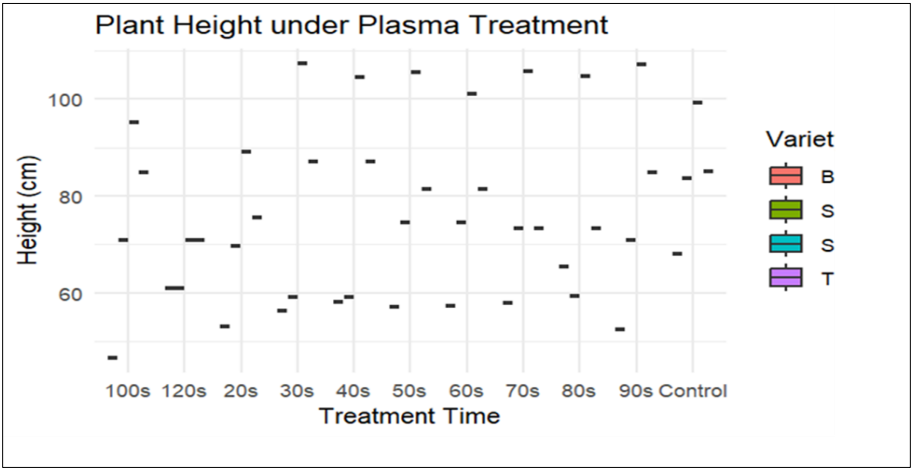


Fig 2: The plant height (cm) as influenced by Plasma Treatment Time

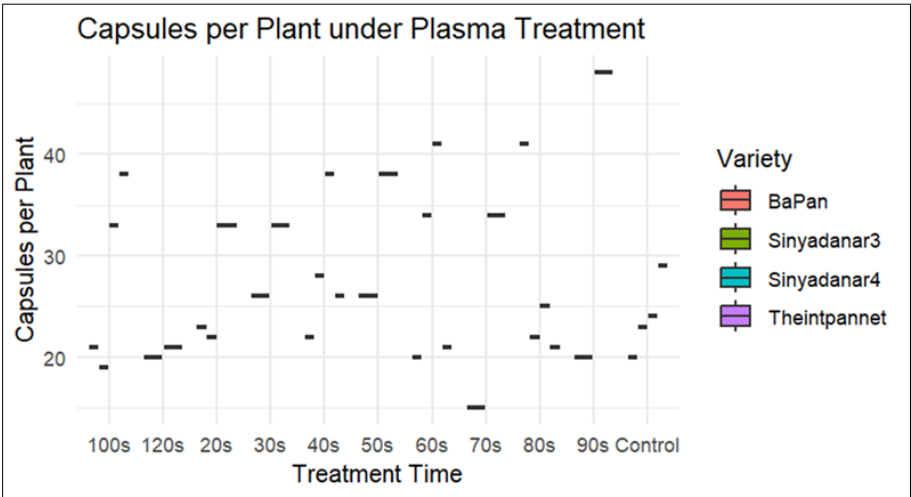


Fig 3: The capsules per plant as influenced by Plasma Treatment Time

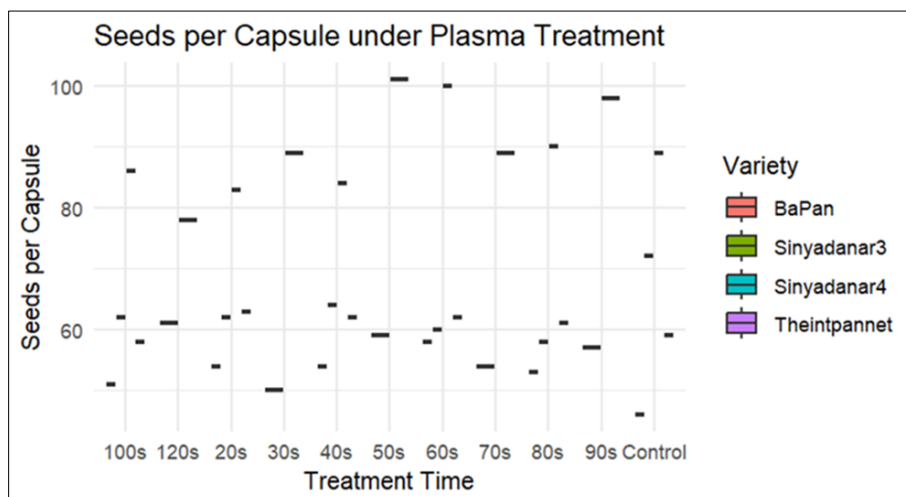


Fig 4: The seed per capsule as influenced by Plasma Treatment Time

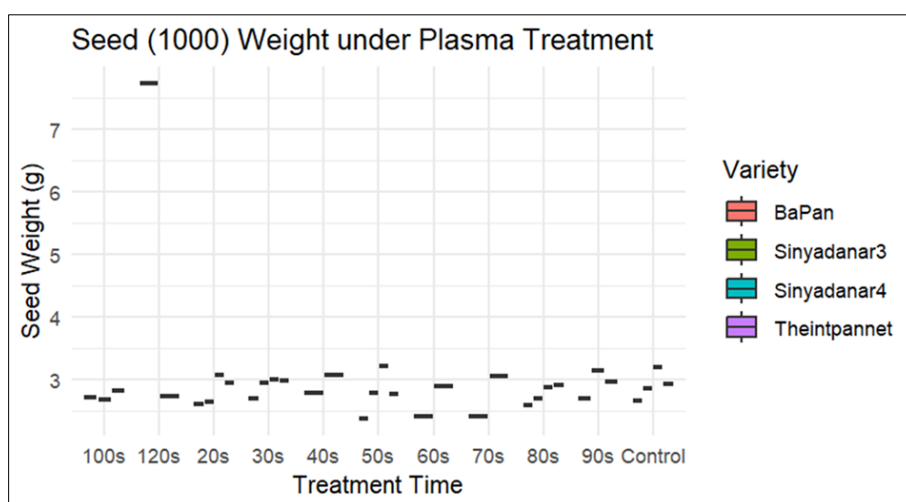


Fig 5: The seed (1000) weight as influenced by Plasma Treatment Time

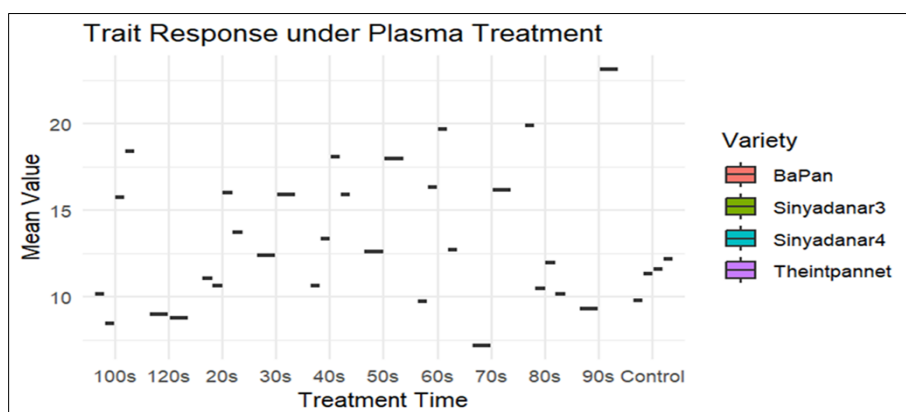


Fig 6: The Seed Yield (Basket/acre) as influenced by Plasma Treatment Time

4. Conclusion

Among the four sesame varieties evaluated, Sinyadanar-4 exhibited the strongest positive response to plasma treatment in terms of plant height, capsules per plant, seeds per capsule, and seed yield. Based on the results, a plasma treatment rate of 50 W is recommended for optimum performance of the Sinyadanar-4 variety. Regarding treatment duration, the following optimal exposure times are recommended for Sinyadanar-4: 90 s for plant height, 20 s for seeds per capsule, and 40 s for both capsules per plant and seed yield. All four varieties can be subjected to plasma seed treatment, with Sinyadanar-4 consistently showing the most

significant improvements over untreated controls.

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