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Impact of Plasma Treatment on Coriander Seeds for Germination and Growth

L. N. Mishra, R. Dahal and R. Chalise
Tribhuvan University, Patan Multiple Campus, Patandhoka, Lalitpur, Nepal.
Email: lekha.mishra@pmc.tu.edu.np

Abstract

Due to its numerous health advantages, coriander is one of the most used cooking ingredients. This paper describes the coriander plant's germination and growth after plasma treatment. The seeds are treated using the gliding arc for periods ranging from one minute to ten minutes. It is discovered that as treatment time is extended, the temperature of the seed rises while its weight continues to fall. The sixth and ninth days are used to calculate the germination rate. The study shows that the treatment time of plasma on seeds increases the hydrophilicity of coriander seeds. It is found that roots and shoots of seeds treated for ten minutes and eight minutes were significantly longer than the other seeds.

Key words: Plasma, gliding arc, temperature, germination, hydrophilicity

I. Introduction

Agriculture is the activity of raising animals and plants for food. Livelihood of many people worldwide depends on agriculture. Besides, every person on earth who pursues agriculture as a profession depends on it indirectly. It is also an essential component of human life. Everyone who is involved in agriculture, whether directly or indirectly, is concerned about any effects that may arise. That suggests that it is everyone's obligation to promote and preserve agriculture throughout the world. Any negative impact on agriculture drives the world toward famine[1,2]. Every day sees an increase in this pace. Only 40% of the land on Earth is utilized for use in farming [3]. In the past, this ratio was adequate. However, given that the populace continues to rise quickly over the last few decades, this land's ability to produce food is not enough. A lack of food will cause people to die. These circumstances will be disastrous if the state of agriculture does not change, disastrous in the near future. Due to urbanization and industrialization, there is a shortage of agricultural land. Consequently, food production must expand to meet demand.

Speaking geographically, Nepal is separated into the Himalayan, Hilly, and Terai areas. Due to its fertile soil, Terai is referred to as Nepal's "granary." Although production is insufficient to meet the country's growing food needs, agriculture remains the primary activity of those who call Nepal home. For our survival, we must import food from other nations. This is because of conventional farming for a living. Instead of importing, if farming practices can be improved, food exports are permitted to those nations. In the past, there was not the technology to allow us to increase the soil's fertility and productivity. One must be totally reliant on natural production factors.

For example, in the event of a drought, food production would drastically decrease, leading to widespread hunger. Food production has thus not been steadying up to this point. Even while there may occasionally be an excess of food produced owing to favorableconditions. Due to the nature of the situation, it could not be saved. The cause of this is a lack of appropriate storage. The situation has changed as a result of technical improvement. Presently, production can also be raised, and there are locations to keep them for the future.

Seed treatment is a method intended to lessen, control, or repel disease organisms, insects, or other pests that attack the seed or seedlings using plasma jets [4,5,6], dielectric barrier discharge [7,8,9], gliding arc [10,11], microwaves [12] and so on. The procedure indicated above, which has been tried in numerous locations, can in some way boost productivity. Many of these chemical fertilizers used in crops are to blame for the health issues in humans. Here, the following papers are reviewed and their findings are reported as follows.

Filatova et al [13] investigated the effect of plasma treatment on seed quality and productivity of various cereal and legume seeds. The seeds were treated using an atmospheric pressure dielectric barrier discharge. The seeds were exposed for five, ten, fifteen, and twenty minutes. Plasma therapy has been shown to improve the germination of stable and rapid seedlings in the laboratory and in the field. On the other hand, fast-maturing unfixed seeds germinate more evenly and plasma treatment is less effective than fast-maturing stable seeds. Additionally, fungal infections were reduced by 3-15% in treated cultures compared to untreated cultures.

The effectiveness of using an atmospheric cold plasma jet to treat plant diseases was examined by Zhang et al. [14]. The black mark on leaves and plants with fungus infections was the main focus of this research. Five distinct leaves, each with a black spot, were subjected to a cold plasma jet in the atmosphere. After three weeks, it was discovered that the number of black spots had drastically decreased. Plant-fungal cells were housed on a glass slide and afterward treated with plasma. The three-minute treatment of fungus cells supports the theory that plasma jets can induce fungal cells in plants. In addition**,** it was claimed that atmospheric pressure cold plasma may be used to treat different plant tissues that had been widely afflicted by plant diseases.

The impact of plasma-activated water on fruits and vegetables was studied by Sharma et al. [15]. DBD and plasma jet devices were used to prepare plasma-activated water (PAW). Numerous physio-chemical characteristics of PAW were investigated. It was then used on fruits and vegetables. Fruits and vegetables treated with PAW lose fewer nutrients and are microbially safe. The quality of fruits and vegetables as well as sensory characteristics were shown to be least affected by PAW. Therefore, it can be said that Paw can be used in place of traditional washing agents in the fruits and vegetable business. Moreover, Paw is simple to create and has a high level of bactericidal ability; it may be employed in every other food-related industry.

Scholtz et al. [16] examined the effects of sprinkled fine grains and non-warm grains on grains. Different non-warm plasma sciences may be used to treat grain. Different approaches to offending piece capacity have led to the development of bug sprays, which has increased interest in the demand for reddish body fluid in agriculture. Both intentional and unintentional plasma disclosing have positive effects on growth. Inactivation of commencing, an increase in water joining, or a decrease in contact angle are all affected by NTP treatment. It was also established that the root and the sprint separate, the new burden increases, and the dry weight decreases, creating an NTP situation. However, grant authorization softly changes according to natural conditions Grain surrender had also been anticipated in light of the situation.

The effects of plasma water on the germination and growth of radish, fenugreek, and pea seeds were investigated by Guragain et al. [17]. Deionized water is treated using local gliding arc discharge plasma created at atmospheric pressure for a variety of durations. Water underwent plasma treatment, which altered its physical properties. As well, it has been found that PAW irrigation of seeds boosts germination rate in comparison to deionized water irrigation of seeds. Not only has the germination rate increased, but so have other germination metrics like the germination index and mean germination rate as well as growth parameters like shoot length.

In our case, we chose coriander because it is grown in almost every kitchen garden in Nepali homes. However, the majority of people grow coriander for their own consumption as well as for sale. There are many uses for coriander. While seeds are used to create spices, green leaves are utilized to add flavor to food and to make pickles. Early on, the majority of the coriander is consumed. Thus, it was unable to remove seeds from the same. As a result, dried coriander seeds are in short supply. Coriander seeds are consequently more expensive on the market. Therefore, coriander output needs to be raised in order to address this shortfall and make coriander seeds affordable and widely available. Plasma treatment is the greatest method to boost production. This project highlights the impact of non-thermal plasma treatment on seeds for their germination and growth at atmospheric pressure conditions.

II. Experimental Design and Setup (Methodology)

Figure 1 depicts the experimental setup for a gliding arc. It comprises two 13 cm long parallel copper electrodes. To hold both electrodes parallel and maintain the necessary 16 cm space between them, a cap is attached to the top. Atmospheric pressure conditions produce the gliding arc wherethe air is allowed to flow between the electrodes from the cap's top. With the aid of air blown, the spark generated at the electrode's upper end is transferred to the lower end. A one liter per minute air blower is used to release air. In order to ionize the air and create plasma, the upper ends of both electrodes are attached to the source. The plasma generated by the gliding arc system is applied for the seed treatment so-called plasma therapy on seeds. Weight loss was seen while receiving plasma treatment. Both control and treatment seeds' wettability were investigated. The seeds with various treatment times were finally sowed. Untreated seeds were planted in the following tray of plasma-activated water (PAW). The identical setup was used to treat PAW in a petri dish before placing it in the nursery tray.

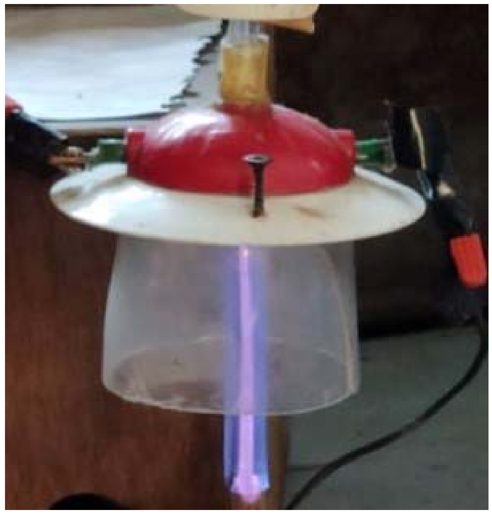

Fig. (1): Experimental setup for gliding arc.

Characterization of the Sample

Several tests are carried out, some of which are listed below, to analyze the change in the sample's attributes i.e.seed temperatures. A thermal cannon was used to measure the temperature of twenty pure coriander seeds. Then, the seeds underwent a 1-minute plasma treatment. Once more, the temperature was taken and recorded. A similar procedure was carried out for seeds that were treated for 2, 4, 6, 8, and 10 minutes. Every type of temperature was plotted on the line graph that is seen Fig. (2). The graph suggests that as treatment time increases, the temperature of the seeds continues to rise.

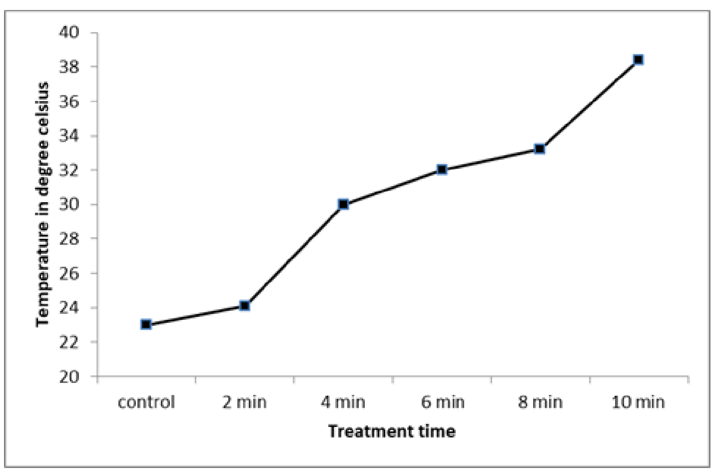

Fig. (2): A typical graph of temperature versus treatment time.

Results and Discussions

This section describes the wettability, germination rate, and growth of shoots and roots of coriander after plasma treatment. The ability of a substance to contain liquid is referred to as wettability. Hydrophilic substances are defined as having a high capacity to store liquid. Hydrophobic compounds, on the other hand, have a low capacity to store liquid. Twenty seeds were taken, each weighed, and the wettability of the seed was determined. Untreated seeds were placed in a beaker and submerged in deionized water. Twenty seeds were taken a second time, measured, and treated for one minute. After treatment, seeds were placed in a beaker of deionized water. The same procedure was used for seeds that were treated for two, three, and four minutes. Each beaker received 50 ml of water. Dipped seeds were weighed and measured every hour. The weight of the seeds was determined using delicate electrical equipment. In order to explore the impact of plasma on seeds, coriander seeds were treated with diagnostic plasma and subjected to a number of tests. After treatment, weight loss of the seed was seen with various treatment durations, followed by seed wettability. The nursery tray held seeds that had been treated. The seed germination rate was also given on the sixth and ninth days.

The weight loss of coriander seeds with respect to the treatment time is depicted in Fig. (3). When compared to prior treatment, it can be noticed that the weight of coriander seeds has decreased. Furthermore**,** a decrease in seed weight loss is shown as treatment time is extended. The diagram includes an error bar that was created by computing the standard error for each category separately. The percentage of weight loss at various treatment times is shown in Fig. (3). The bar diagramin Fig. (3) displays the wettability of seeds for various treatment times. Seeds were submerged in deionized water for eight hours, with hourly weight measurements, to determine wettability. Each time we measured weight, we wrote down the weight five times, and the average was used to visualize the data. The graph shows that the wettability of seeds increases hourly up to a certain threshold before becoming saturated. After eight hours, the seeds in this situation are soaked.

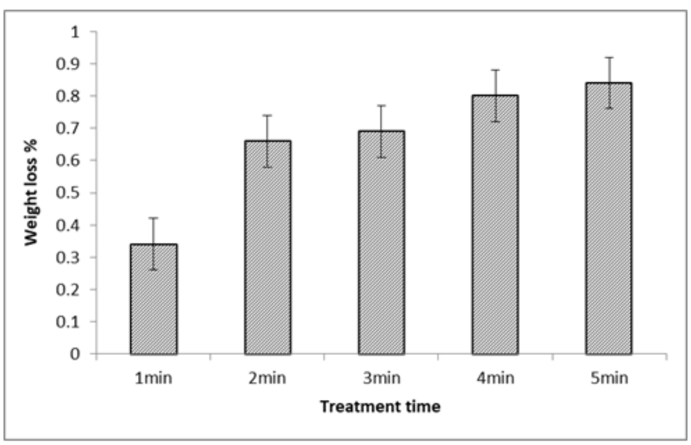

Fig. (3): Graph between weight and treatment time.

The formula, $germinated\ seeds\ \% = \frac{number\ of\ germinated\ seeds}{total\ number\ of\ seeds} \times 100\%$ can be used to determine germination rate. On the sixth and ninth days, germination rate was calculated. The germination rate of coriander seeds exposed to gliding arc discharge on the sixth and ninth days is shown in Fig. (4). It demonstrates that, on the sixth day, seeds treated for two minutes and for eight minutes have higher germination rates than other seeds. On the other hand, seeds that were treated for eight minutes had a higher germination rate on day ninth than any other category. On the ninth day, it is also seen that the seed treated for ten minutes has a lower germination rate than other seeds.Until the 22nd day, untreated seeds did not germinate. The rate of germination was the same for seeds treated for two, three, and five minutes. On the 29th day, it was also noted that seeds treated for ten minutes had a high germination rate.

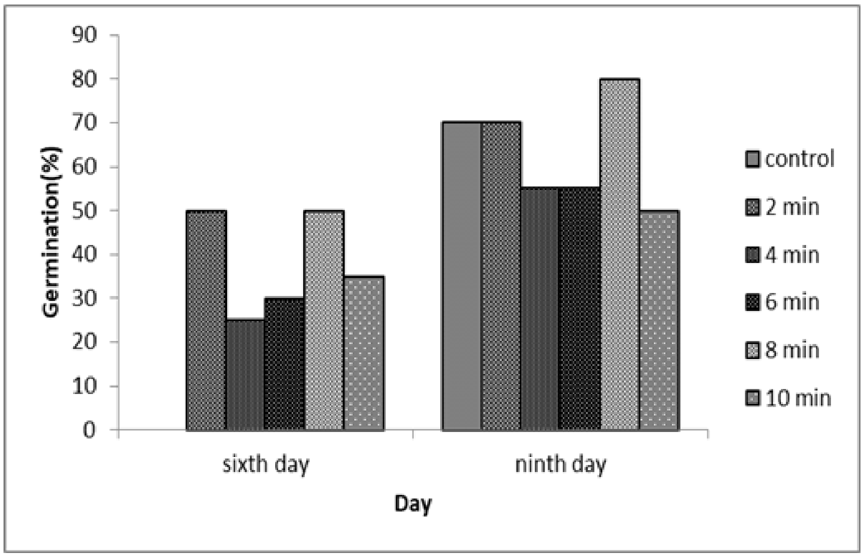

Fig. (4): A typical graph for germination on different days with the variation of treatment time.

Ten plants of coriander seeds were randomly selected from each group on the 12th day of germination, and the shoot portions were measured using a scale. To create the bar graph, the average shoot length of ten plants was used. The standard error was used to maintain the error bar. It has been found that among all seeds, those treated for eight minutes have the longest shoot length, whereas control seeds have the smallest. The bar graph in Fig. (5) displays shoot length in relation to treatment time.

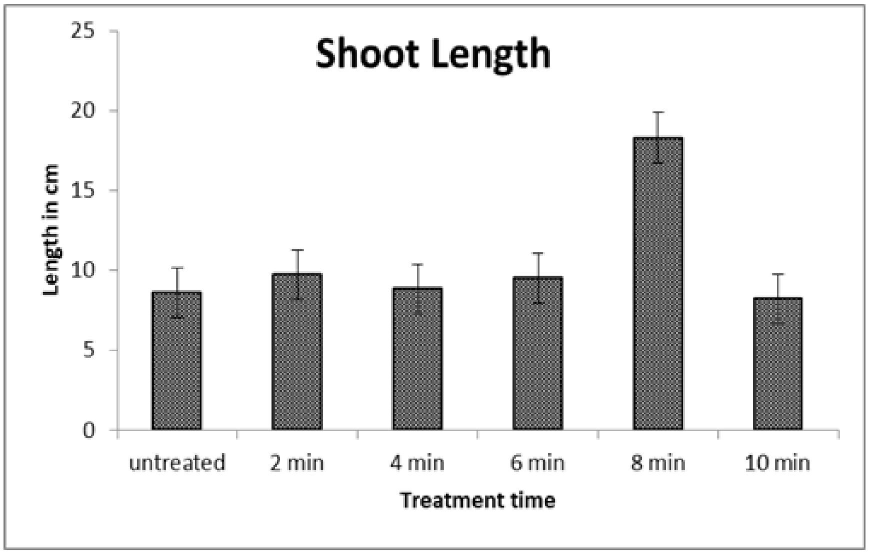

Fig. (5): A typical graph of shoot length with the variation of treatment time.

Ten plants on average were used to create the graph from the calculated data. Calculating the standard error led to the creation of the error bar. When compared to other categories, it was found that seeds treated for ten minutes had the longest roots. The shortest root length, nevertheless, is for seeds treated for two minutes. The graph below displays the inaccuracy in root length: Figure (6) shows the length of the root over time. Ten plants of coriander seeds were picked at random after the 12th day of growth, similarly to that of shoot length.

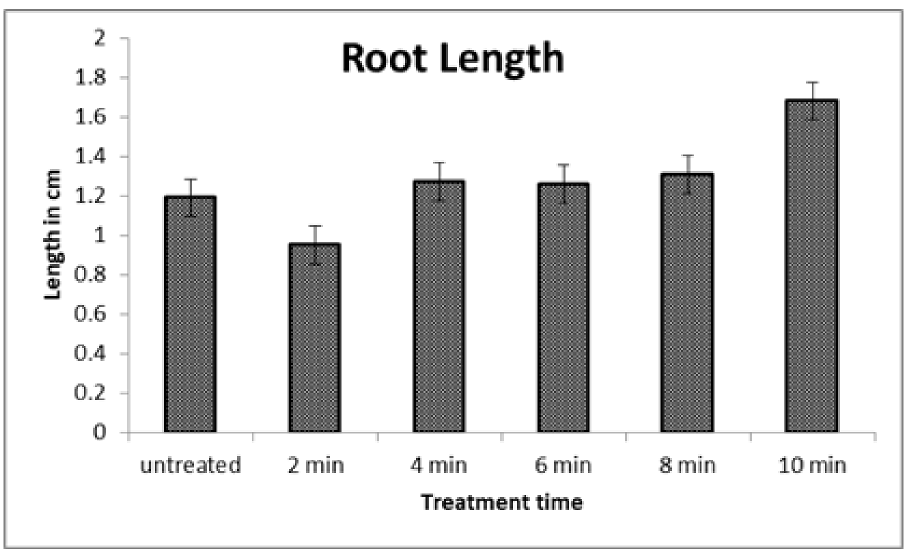

Fig. (6): A typical graph of root length with the variation of treatment time.

Conclusion

Science and technology have impacted every field in the modern world. Plasma has become a hot topic these days due to its widespread use. Nearly every field can use plasma. The creation of the gliding arc and its usage in agriculture were the main topics of this paper. Because coriander seeds are frequently used in cooking and have a number of advantages, they were chosen as samples. The plasma that was produced was characterized, demonstrating that it is composed of nitrogen and oxygen. The characterized plasma was applied to the coriander seeds. Coriander seed weight was discovered to have drastically lowered following plasma therapy. Furthermore, treatment increased the hydrophilicity of coriander seeds. A wettability test verified this. Moreover, it was found that treated seeds germinated more quickly than untreated seeds. From this, it may be inferred that the treated seeds will have a higher germination rate. Similarly, the roots of the seeds treated for ten minutes were noticeably longer than those of the other seeds. The shoot length of the seeds treated for eight minutes was longer than that of the other groups.

References

[1]. Jordan, C. F. (2022). Can Organic Agriculture Feed the World? In *Evolution from a Thermodynamic Perspective* (pp. 315-318). Springer, Cham.

[2]. Patzek, T. W. (2008). Thermodynamics of agricultural sustainability: The case of US maize agriculture. *Critical Reviews in Plant Sciences*, *27*(4), 272-293.

[3]. Owen, J. (2005). Catacomb Find Boosts Early Christian-Jewish Ties, Study Says. *National Geographic News*, *20*.

[4]. Lotfy, K. (2017). Effects of cold atmospheric plasma jet treatment on the seed germination and enhancement growth of watermelon. *Open Journal of Applied Sciences*, *7*(12), 705.

[5]. Puligundla, P., Kim, J. W., &Mok, C. (2017). Effect of corona discharge plasma jet treatment on decontamination and sprouting of rapeseed (Brassica napus L.) seeds. *Food Control*, *71*, 376-382.

[6]. Attri, P., Ishikawa, K., Okumura, T., Koga, K., &Shiratani, M. (2020). Plasma agriculture from laboratory to farm: A review. *Processes*, *8*(8), 1002.

[7]. Meng, Y., Qu, G., Wang, T., Sun, Q., Liang, D., & Hu, S. (2017). Enhancement of germination and seedling growth of wheat seed using dielectric barrier discharge plasma with various gas sources. *Plasma Chemistry and Plasma Processing*, *37*(4), 1105-1119.

[8]. Li, Y., Wang, T., Meng, Y., Qu, G., Sun, Q., Liang, D., & Hu, S. (2017). Air atmospheric dielectric barrier discharge plasma-induced germination and growth enhancement of wheat seed. *Plasma Chemistry and Plasma Processing*, *37*(6), 1621-1634.

[9]. Gao, X., Zhang, A., Héroux, P., Sand, W., Sun, Z., Zhan, J., ... & Liu, Y. (2019). Effect of dielectric barrier discharge cold plasma on pea seed growth. *Journal of agricultural and food chemistry*, *67*(39), 10813-10822.

[10]. Terebun, P., Kwiatkowski, M., Hensel, K., Kopacki, M., &Pawłat, J. (2021). Influence of plasma-activated water generated in a gliding arc discharge reactor on germination of beetroot and carrot seeds. *Applied Sciences*, *11*(13), 6164.

[11]. Yang, J., Li, T., Zhong, C., Guan, X., & Hu, C. (2016). Nitrogen fixation in water using air phase gliding arc plasma. *Journal of The Electrochemical Society*, *163*(10), E288.

[12]. Ragha, L., Mishra, S., Ramachandran, V., & Bhatia, M. S. (2011). Effects of low-power microwave fields on seed germination and growth rate. *Journal of Electromagnetic Analysis and Applications*, *2011*.

[13]. Filatova, I., Azharonok, V., Kadyrov, M., Beljavsky, V., Gvozdov, A., Shik, A., &Antonuk, A. (2011). The effect of plasma treatment of seeds of some grain and legumes on their sowing quality and productivity. *Rom. J. Phys*, *56*, 139-143.

[14]. Jiang, J., Lu, Y., Li, J., Li, L., He, X., Shao, H., & Dong, Y. (2014). Effect of seed treatment by cold plasma on the resistance of tomato to Ralstoniasolanacearum (bacterial wilt). *Plos one*, *9* (5), e97753.

[15]. Mitra, A., Li, Y. F., Klämpfl, T. G., Shimizu, T., Jeon, J., Morfill, G. E., & Zimmermann, J. L. (2014). Inactivation of surface-borne microorganisms and increased germination of seed specimen by cold atmospheric plasma. *Food and Bioprocess Technology*, *7*(3), 645-653.

[16]. Scholtz, V., Šerá, B., Khun, J., Šerý, M., &Julák, J. (2019). Effects of nonthermal plasma on wheat grains and products. *Journal of Food Quality*, *2019*.

[17] Ling, L., Jiangang, L., Minchong, S., Chunlei, Z., & Yuanhua, D. (2015). Cold plasma treatment enhances oilseed rape seed germination under drought stress. *Scientific reports*, *5*(1), 1-10.