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Effects of Controlled Deterioration and Smoke-Water on Germination Characteristics of Chickpea (*Cicer arietinum* L.) Seeds

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Introduction: Today, the importance of smoke-water on increasing germination and crop growth has been proven in many researches. Compound called karrikin is produced from the burning of plant materials. karrikin is small organic chemical with biologically active compounds found in smoke that are produced through thermal decomposition of simple carbohydrates such as xylose, glucose or cellulose (Nelson et al., 2018). Smoke-water has a positive effect on seed germination in many plant species, and its application has become widespread in various fields of plant science. The method of preparing smoke water is relatively easy and cheap (Gupta et al., 2020). The use of smoke water has been used to reduce the effects of seed aging (Li et al., 2022). Seed deterioration, as a natural process that occurs as seeds age, can reduce seed germination (Pehlivan, 2017). Chickpea is one of the most important legumes in the world and plays a prominent role in people's nutrition (Bailly, 2004). For this purpose, it seems necessary to carry out an experiment on the effects of reducing the deterioration of chickpea seeds by using smoke water.

Materials and methods: After sterilizing chickpea seeds (Mansour variety) with sodium hypochlorite, the seeds deteriorated at 20% humidity and at 72°C for 0, 12, 24, and 36 hours. Then, the traits of seed germination checked for 7 days in a petri dish in concentrations of 0, 0.5, 1 and 2% smoke-water and at a temperature of 25±1 °C in germinator. Smoke-water were extracted from burning plant residues. This experiment was carried out as a factorial in based on completely randomized design (CRD) with three replications. In this experiment measured the characteristics included germination percentage, radicle and shoot length, seed germination index, root diameter, radicle / shoot length ratio, lateral root growth, ratio of total root length / plant height, growth ratio of radicle and shoot length, dry weight of seedlings, growth ratio Root to stem and total root growth ratio. The data analyzed with SPSS software and the means compared with the least significant difference (LSD) test.

Results and Discussion: The results showed that the percentage of germination was significantly affected by the concentration of smoke-water. The highest percentage of germination (87%) observed in the treatment of 1% smoke-water + 12 hours of deterioration (Figure 1). These results showed the positive effect of the combination of moderate concentration of smoke-water on short-term deterioration of chickpea seeds. Treatments with longer deterioration and high smoke-water concentrations led to decrease in germination percentage, which is probably caused by oxidative damage and cell destruction due to seed deterioration (Li et al., 2022). The seed vigor index, which shows a combination of the germination percentage and seedling growth, was the highest value (1248) in the treatment of 1% smoke-water + 12 hours of deterioration (Table 1). This index indicates the improvement of germination power and faster growth of chickpea seeds.

Table 1: Effect of smoke-water and seed deterioration on germination percentage and seed vigor index of chickpea seed

Treatments		Germination (%)	Seed vigor index
Deterioration (hour)	Smoke-water (%)		
0	0.0	40.5 ^{d}	409.0^{c}
	0.5	60.1 ^{c}	727.2^{b}
	1.0	70.3 ^{b}	956.0^{b}
	2.0	50.7 ^{cd}	567.8^{c}
12	0.0	65.8 ^{bc}	868.5^{b}
	0.5	76.3 ^{ab}	1065.0^{a}
	1.0	87.0 ^{a}	1248.4^{a}
	2.0	70.5 ^{b}	1052.8^{a}
24	0.0	60.5 ^{c}	744.1^{b}
	0.5	71.0 ^{b}	966.0^{a}
	1.0	78.4 ^{ab}	1189.5^{a}
	2.0	65.2 ^{bc}	960.2^{b}
36	0.0	55.3 ^{c}	744.2^{b}
	0.5	67.0 ^{b}	868.5^{a}
	1.0	72.5 ^{b}	956.2^{a}
	2.0	66.0 ^{b}	867.5^{b}

Treatments with higher concentrations of smoke-water and longer deterioration showed a significant reduction in seed germination index, which is probably due to damage caused by deterioration and smoke-water (Bailly, 2004). The growth ratio of radicle to shoot evaluated as an index of growth balance between the underground and aerial parts of the seedling. The highest growth ratio of root to shoot obtained in the treatment of 1% smoke+12 hours of deterioration (Table 1), which indicates the positive effect of these treatments on the balanced growth of root and stem. On the other hand, treatments with longer deterioration and high concentrations of smoke-water led to a decrease in this ratio, which was due to damage caused by long-term seed deterioration. The positive effect of smoke-water is limited and when deterioration was occurring for a long time, reinforcement treatments are not very effective (Ranganathan & Groot, 2023).

Conclusion: The results of this research showed that with the increase in the concentration of smoke-water in the control treatment increased germination and seedling growth of chickpea. The concentration of smoke-water of 1% had the greatest effect on decrease at short-term deterioration (12 hours). In other words, smoke-water can partially reduce the effect of seed deterioration in chickpea.

Keywords: Germination, Shoot / root ratio, Seed vigor index

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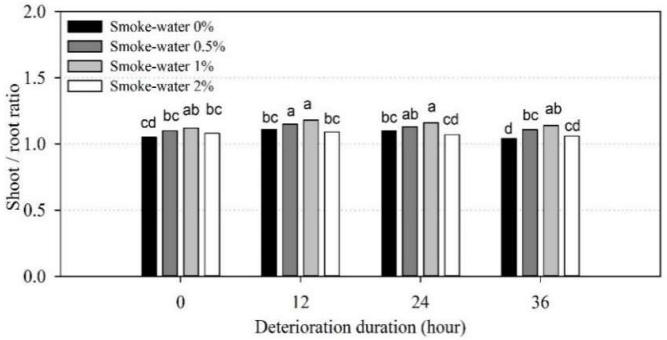

Figure 1: Mean comparison of the root / shoot ratio under different smoke-water concentrations and deterioration durations