International Journal of Agriculture and Environmental Analytics (IJAEA)
Vol.3, No.1, 2024: 23-34

The Use of Liquid Rubber Smoke as PGR on Coffee Seeds Germination

Hajar Setyaji* Suryanto, Mukhsin
Agrotechnology Department, Faculty of Agriculture, Universitas Jambi

ABSTRACT: The objectives of this research is to obtain the best concentration of liquid rubber smoke as a growth regulator in the germination of Arabica, Robusta and Liberica coffee seeds. Method of research: location of the research was on Seed Technology Laboratory University of Jambi, the research design was carried out using a randomized block design consisting of a factorial pattern based on 3 factors (Types of Coffee species: Arabica from Kerinci, Robusta from Merangin, and Liberica from Tanjung Jabung Barat), 3 levels of treatment for providing liquid smoke rubber 0%, 2.5%, 5%, by soaking for 5 minutes. With 3 repetitions test. Statistical data analysis by anova using SPSS. The result shows that 3 species of coffee give different response of the treatments, Arabica and Robusta seeds species has relative equal statistical response to Liberica coffee, concentration 2.5% of diluted liquid rubber smoke give the best germination and vigor seeds response performance.

Keywords: Arabica, Robusta, Liberica, Smoke liquid rubber, germination

Submitted: 26-06-2024; Revised: 30-06-2024; Accepted: 05-07-2024

* Corresponding Author: hajarsetyaji@unja.ac.id
DOI: https://doi.org/10.55927/ijaea.v3i1.10042

INTRODUCTION

Indonesia's coffee plantations hold the fourth position globally in terms of production, trailing behind Brazil, Vietnam, and Colombia. In terms of export commodities, coffee also ranks fourth in Indonesia, with a trade value of $1.19 billion in 2017. This positions coffee as one of the key plantation commodities, following oil palm, rubber, and coconut. Coffee is a key component of the Directorate General Estate Crop's strategic plan, which places emphasis on the growth of the agro-industry sector. This includes initiatives to boost output and exports as well as the growth of the rural agricultural industry. (Direktorat Jenderal Perkebunan, 2014).

The many types of coffee products commonly found on the market, can range in price from low to extremely high due to the many variables involved in processing, including the coffee growing region, post-harvest methods, roasting style, and cultivar. Within the realm of global trade, there exists a variety of coffee types, although the three most commonly cultivated across different nations are arabica, robusta, and liberica coffee. Jambi province in Indonesia country production of those 3 species of coffee. Typically, commercial coffee is planted using seedlings that are derived from seeds. However slow and uneven germination. Seeds with thick and hard parchment prevent the movement of water or oxygen into the seeds are in a dormant state.

Dormancy is a characteristic of seeds, manifested as a mass or series of masses that prevent germination under favorable conditions of moisture, temperature and gas (Kingsley Mbi etal.2022) (Luna etal. 2014). Mechanical dormancy could break by physical and chemical method (Sitanggang etal, 2022). Stripping/abrasion the seed coat and soaking the seeds in water, adding growth regulators, and chemical solutions have succeeded in snychrone and speeding up germination time (Sutopo,2012).

THEORETICAL REVIEW

Gibberellins (GAs), abscisic acid (ABA), and the ratio of GAs to ABA are examples of internal growth regulators that regulate the process of seed germination in addition to a variety of external environmental elements like light, temperature, and moisture (Plazek etal, 2018). A well-known tool for encouraging plant growth and development, plant-derived smoke has a favorable impact on a variety of plant species found in different habitats. Smith etal. (2003) reported that there may be thousands of unknown compounds in smoke, and that the positive effects of smoke on seed germination may depend on the plant species. Additionaly a recent study has reported that the active compounds that can stimulate seed germination have not existed in smoke derived from different legume materials (Ren, etal 2017). Also, smoke produced from alfalfa affects seed germination differently compared with that produced from wheat straw and prairie hay (Ren, etal, 2016), indicating that quantitative and qualitative variations exist in smoke solutions derived from different

materials. In light of this view, different plant materials have been extensively used to produce smoke-water extracts (Elsadek and Yousef, 2019)

Liquid smoke has been shown to promote the germination of wild plants from many ecosystems (Light and Van Staden, 2004) and further improve the growth and productivity of agricultural and horticultural species garden (Brown et al., 2003), despite the fact that it is important to dilute the concentration of smoke for many species (Lloyd.etal, 2000). Liquid rubber smoke is available in local market. Coffee Arabica, Robusta and Liberica bean has different physical characteristics. Those species had potentials different respond if treated with varies concentration liquid smoke rubber in germination

Ho: no different respond of three species coffee and concentration of liquid rubber smoke on germination seeds

H1: There are different respond of three species coffee and concentration of liquid rubber smoke on germination seeds

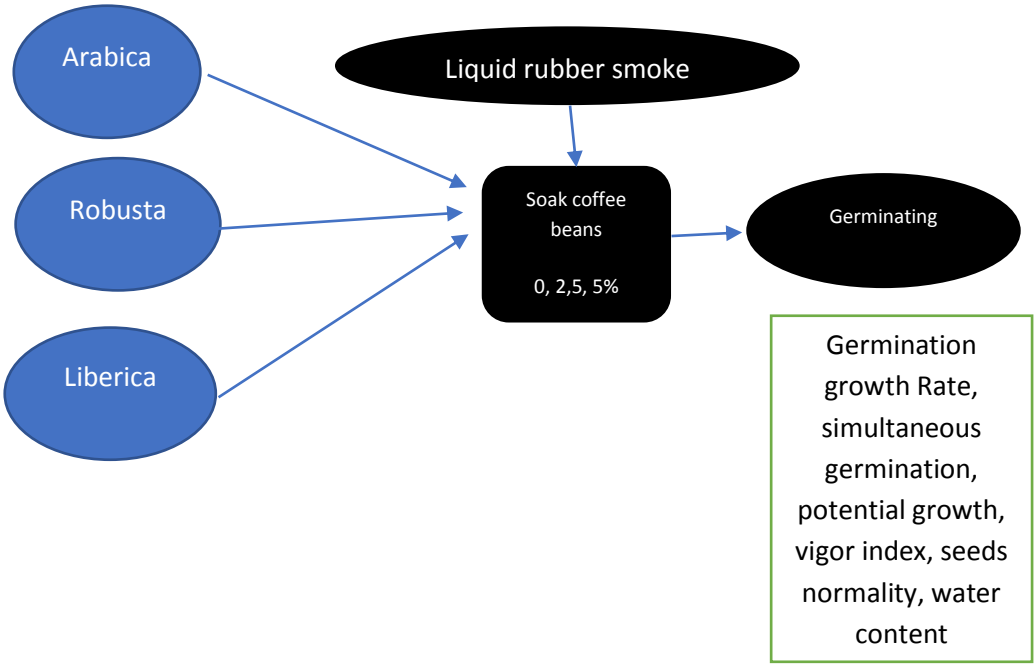

Figure 1. Conceptual Framework

METHODOLOGY

The research was conducted from May to October 2019 at the Seeds Technology Laboratory, Agroecotechnology Study Program, Faculty of Agriculture of Jambi University. The research materials are Robusta coffee fruit from Merangin Regency, Arabica coffee fruit from Kerinci Regency and Liberica coffee fruit from West Tanjung Jabung Regency. Equipment used of the research were soaking tub, coffee bean depulper, germination tub, paper, balance, petridish, sprayer. Liquid smoke rubber obtanined from South Sumatra, MRS Agar, brom thymol.

Research design was carried out using a randomized factorial block design consist 3 factors (coffee species : Arabica obtained from Kerinci, Robusta obtained from Merangin and Liberica obtained from Tanjung Jabung Barat), 3 levels of treatment liquid rubber smoke (0 %; 2.5%; 5%) with soaking for 5 minutes. 3 replicates so overall consist 27 experimental units each unit consist of 25 seeds. Germination percentages, growth Rate, simultaneous germination, potential growth, vigor index, seeds normality and water content were observed.

Germination precentages

Germination percentace $=\frac{(Number\ of\ seeds\ normal\ germination}{Number\ seeds\ that\ germinate} x\ 100\ \%$

Germination rates

Germination Rate (KCT), Germination rate is measured by counting normal sprouts. The number of normal sprouts divided by etmal (24 hours). Cumulative etmal values are calculated from the time the seeds are planted until the last observation.

Maximum Growth Potential.

Maximum Growth Potential (PTM) is the potential for seeds to grow both in normal and abnormal conditions with a minimum limit, namely with the release of radicals or roots from the seeds at wet paper media.

Vigor Index

Carried out using the Rolled Paper Test method established in plastic (UKDdp) with 25 seeds per roll.

Normality

The percentage of normal germination is all sprouts that are declared normal in the germination speed test, carried out by planting coffee seeds on merang paper, and the normal germination rate is observed.

Moisture content

It was carried out by the gravimetric method. The direct method is a method of testing the moisture content of seeds by calculating directly from the reduction in seed weight due to the loss of water from the seeds. Direct testing using an oven at 103±2°C for 17 hours or until a constant weight.

The data were analyzed of variance (ANOVA) test and comparing the mean values using Duncan's Mean Range test at the 5% levels.

RESULTS

Germination test

The results of observations on seed germination are as follows:

Table 1 Seed Germination test (%) 3 species types of coffee

Species	Liquid rubber smoke (%)	Germinations (%)
	0	27 Aa
Arabica	2.5	52 Ab

	5	69 Ac
	0	43 Aa
Robusta	2.5	63 Ab
	5	37Ac
	0	8 Ba
Liberica	2.5	40 Bb
	5	21 Bc

Different superscript letters (A,B, C,species;a, b, c, treat) in the coloumn indicate significant differences between means (Duncan's multiple range test; $p < 0.05$).

From the seed germination table, it can be seen that Arabica coffee and Robusta germination are not significantly different, while Liberica coffee has a significant difference. The use of liquid rubber smoke has a significant effect on the germination test of all species of coffee.

Germination Rate

Table 2 Germination Rate of 3 species types of coffee

Species	**Liquid rubber smoke (%)**	**Germ. Rate Growth/d**
	0	0.5 A a
Arabica	2.5	0.66 Ab
	5	0.77 Ac
	0	0.34 Aa
Robusta	2.5	0.68 Ab
	5	0.51 Aa
	0	0.04 Ba
Liberica	2.5	0.34 Ba
	5	0.32 Ba

Different superscript letters (A,B, C,species;a, b, c, treat) in the coloumn indicate significant differences between means (Duncan's multiple range test; $p < 0.05$).

From the table of seed germination Rate, it can be seen that Arabica and Robusta coffee there is no significant difference, while Liberica coffee has its own significant differences. Use rubber liquid smoke has a significant effect on the Growth Rate of all species of coffee.

Maximum Growth Potential

The results of observations on maximum growth potential obtained the following data shows on table 3:

Table 3 Maximum Potential Growth (%) 3 species types of coffee

Species	**Liquid rubber smoke (%)**	**Germinations (%)**
Arabica	0	94.7 Aa
	2.5	97.3 Ab
	5	97.3 Ab
Robusta	0	93.3 Aa
	2.5	98.7 Ab
	5	97.3 Ab
Liberica	0	85.3 Ba
	2.5	92.0 Bb
	5	88.0 Bb

Different superscript letters (A,B, C,species;a, b, c, treat) in the coloumn indicate significant differences between means (Duncan's multiple range test; $p < 0.05$).

From the table of maximum growth potential, it can be seen that the maximum potential germination of coffee Arabica , Robusta are not significantly different, while Liberica coffee has significant differences. There is an influence of liquid rubber smoke treatment on it germination on Arabica coffee seeds, Robusta coffe and Liberica coffee seeds. The use of liquid rubber smoke has a real effect on the rising maximum growth potential of all species of coffee seeds.

Vigor Index

Table 4 Vigor Index of 3 species of coffee

Species	**Liquid rubber smoke (%)**	**Vigor Index**

	0	0.26 Aa
Arabica	2.5	0.50 Ab
	5	0.69 Ab
	0	0.47 Aa
Robusta	2.5	0.71 Ab
	5	0.40 Aa
	0	0.04 Ba
Liberica	2.5	0.40 Ba
	5	0.21 Ba

Different superscript letters (A,B, C,species;a, b, c, treat) in the coloumn indicate significant differences between means (Duncan's multiple range test; $p < 0.05$).

From the seed vigor index table, it can be seen that the germination index of Arabica coffee and Robusta seeds are not significantly different, while Liberica coffee seeds has a significant different. Treatment of liquid rubber smoke 2.5 % and 5% has a significant different effect on seeds vigor index of Arabica coffee seeds with 0%, but there is no significant different at concentrations of 2.5% and 5% liquid rubber smoke. Coffee Robusta get highest vigor index at concentration 2.5 % but at 5 % no significant different with 0%. Coffee Liberica seeds vigor index show no significant different with all of treatment.

Seeds Normality

Table 5 Seed Normality (%) 3 species types of coffee

Species	**Liquid rubber smoke (%)**	**Germinations (%)**
	0	80.9 Aa
Arabica	2.5	82.8 Aab
	5	82.1 Aab
	0	76.8 Aa
Robusta	2.5	88.9 Ab
	5	83.4 Aab

	0	77.1 Ba
Liberica	2.5	79.6 Ba
	5	72.8 Ba

Different superscript letters (A,B, C,species;a, b, c, treat) in the coloumn indicate significant differences between means (Duncan's multiple range test; $p < 0.05$).

From the seed normality table, it can be seen that the seeds are normality of Arabica coffee and Robusta coffee seeds at is not significantly different, while Liberica coffee has a significant different.

The use of liquid rubber smoke has a significant effect on the normality of the seeds. Coffee arabica and Coffee Liberica seeds at concentrations 0 no , 2.5, and 5% not significant different but those of species significant difference with Robusta seeds liquid smoke treatment at concentration 2.5%, but not significantly different from 0 and 5% concentrations of liquid rubber smoke.

Moisture Content

Table 5 Moisture Content (%) 3 species types of coffee

Species	**Liquid rubber smoke (%)**	**Germinations (%)**
	0	28.5 Aa
Arabica	2.5	29.0 Aa
	5	30.0 Aa
	0	29.0 Aa
Robusta	2.5	28.0 Aa
	5	28.3 Aa
	0	28.3 Aa
Liberica	2.5	29.0 Aa
	5	27.3 Aa

Different superscript letters (A,B, C,species;a, b, c, treat) in the coloumn indicate significant differences between means (Duncan's multiple range test; $p < 0.05$).

In the table of moisture content it can be stated that the water content level is not influenced by species of coffee and level of liquid smoke treated in the

coffee. Moisture content of coffee seed after soaking with liquid rubber smoke are higher than before. Higher moisture content at initial sowing result significantly higher germination (Nasiro, etal, 2017).

DISCUSSION

Germination and emergence are the two most important stages in the plant life cycle and determine the efficient use of nutrients and water resources available to the plant. Germination consists of three phases, namely: the physical phase which is related to the imbibition of water by the seeds followed by physiological activities and morphogenesis which stimulates the emergence of roots (Fu et.al 2024). During the germination process, from the beginning of absorption to complete emergence, many events occur. This complex process leads to the development of the embryo and the weakening of the endosperm to allow emergence as a seed (Waters et al. 2015). Cells get ready for the emergence of macromolecules and the reactivation of already-existing organelles during the imbibition phase. This is followed by cell division and growth. The cotyledon, a feature of epigeal seedling growth, is the first part of the seed to emerge from the soil. It takes the cotyledon three to four weeks to fully consume the endosperm and become residue-free. Bojórquez-Quintal, etal (2011),

Germination, Growth Rate, potential growth, vigor index of Arabica and robusta coffee were not significant different, but Liberica species has significant different, however, liquid rubber smoke had varying effects on seed germination of three coffee species. Liquid rubber smoke as plant growth regulator showed effectively at 2.5% concentration treatment. Gupta et.al (2024) reported that fraction Smoke-Water effectively as plant growth regulator for lettuce seed at low concentration.

The germination potential maximum of Arabica and Robusta coffee seeds is not significantly different but Liberica coffee sprouts were significantly different with the lowest germination rate. Power The sprouts of the three types of coffee are influenced by the use of rubber liquid smoke, the use of liquid smoke with a concentration of 2.5% provides the best germination response for robusta coffee and coffee liberica, while the use of liquid rubber smoke at a concentration of 5% provides a power response High sprouts in Liberica coffee. The difference in germination response is thought to be caused by different species of coffee.

The germination rate of Arabica and Robusta coffee is relatively no different significant, while the growth Rate of Liberica coffee seeds is significantly different, Liberica coffee has low germination rate compared to Robusta coffee and Arabica coffee. The germination response of coffee seeds at a PGR concentration of 5% gave different result. At Robusta coffee, the use of a concentration of 5% liquid rubber smoke germination rate response highest, while in Robusta and Liberica coffee the response was different, the highest concentration of liquid smoke was 2.5%, at a concentration of 5% it actually gave a response decreased germination rate.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The result shows that 3 species of coffee give different response of the treatments, Arabica and Robusta seeds species has relative equal statistical response to Liberica coffee, concentration 2.5% of diluted liquid rubber smoke give the best germination and vigor seeds response performance.

Recommendations

Soaking treatment in 2.5% liquid rubber smoke can be recommended to increase the vigor and viability of coffee seeds**.**

FURTHER STUDY

The range of research liquid rubber smoke treatments is still too wide, the concentration and duration of immersion in liquid rubber smoke should be further optimized

ACKNOWLEDGMENT

The authors would like to thanks to LPPM Jambi University for fully support and funding of this research.

REFERENCES

Bojórquez-Quintal JEA, Sánchez-Cach LA, Gamboa-Tec NF etal (2011) Effect of plant growth regulators on in vitro germinationof coffee zygotic embryos. Afr J Biotech 10(82):19056–19065

Brown, N.A.C., Van Staden, J., Daws, M.I. & Johnson, T. 2003 Patterns in the seed germination response to smoke in plants from the Cape Floristic Region. South Africa S. Afr. J. Bot. 70 559 581

Direktorat Jenderal Perkebunan, 2014, Statistik Perkebunan Indonesia: Kopi 2013-2015, Kementerian Pertanian, Jakarta

Elsadek MA, Yousef EAA.(2019). Smoke-Water Enhances Germination and Seedling Growth of Four Horticultural Crops. Plants (Basel). Apr 18;8(4):104. doi: 10.3390/plants8040104. PMID: 31003496; PMCID: PMC6524032.

Gupta, S., Hrdlička, J., Ngoroyemoto, N., Nemahunguni, N. K., Gucký, T., Novák, O., … Van Staden, J. (2019). Preparation and Standardisation of Smoke-Water for Seed Germination and Plant Growth Stimulation. Journal of Plant Growth Regulation. doi:10.1007/s00344-019-09985-y

Kingsley Mbi T, Godswill Ntsefong N and Eugene Lenzemo T (2022) Seed Dormancy: Induction, Maintenance and Seed Technology Approaches to Break Dormancy. Seed Biology Updates. IntechOpen. Available at: http://dx.doi.org/10.5772/intechopen.106153.

Light ME, Van Staden J (2004) The potential of smoke in seed technology. South African Journal of Botany 70: 97–101

Lloyd, M.V., Dixon, K.W. & Sivasithamparam, K. 2000 Comparative effects of different smoke treatments on germination of Australian native plants Austral Ecol. 25 610 615

Luna, Tara; Wilkinson, Kim M.; Dumroese, R. Kasten. 2014. Seed germination and sowing options [Chapter 9]. In: Wilkinson, Kim M.; Landis, Thomas D.; Haase, Diane L.; Daley, Brian F.; Dumroese, R. Kasten, eds. Tropical Nursery Manual: A guide to starting and operating a nursery for native and traditional plants. Agriculture Handbook 732. Washington, DC: U.S. Department of Agriculture, Forest Service. p. 163-183.

Nasiro, K.; T. Shimber & A. Mohammed (2017). Germination and seedling growth rateof coffee (Coffea arabica L.) seeds asinfluenced by initial seed moisturecontent, storage time and storagecondition. Food Science and QualityManagement, 70, 17–24

Płażek A, Dubert F, Kopeć P, Dziurka M, Kalandyk A, Pastuszak J, Wolko B.(2018) Seed Hydropriming and Smoke Water Significantly Improve Low-Temperature Germination of Lupinus angustifolius L. Int J Mol Sci. Mar 26;19(4):992. doi: 10.3390/ijms19040992. PMID: 29587459; PMCID: PMC5979301.

Ren L., Bai Y., Reaney M. (2017) Evidence of different compounds in smoke derived from legumes and grasses acting on seed germination and seedling emergence. Seed Sci. Res. ;27:154–164. doi: 10.1017/S0960258517000113.

Sitanggang, Antonio & Irmansyah, Teuku & Irsal,. (2022). Effect of Dormancy Treatment on Germination of Arabica Coffee (Coffea arabica L.). Jurnal Online Agroekoteknologi. 9. 40-46. 10.32734/joa.v9i3.8608.

Smith C., Perfetti T., Garg R., Hansch C. (2003) IARC carcinogens reported in cigarette mainstream smoke and their calculated log P values. *Food Chem. Toxicol.* ;41:807–817. doi: 10.1016/S0278-6915(03)00021-8

Sutopo, L. 2012. Teknologi benih. Raja Grafindo Persada: Jakarta.

Waters, D. M., Arendt, E. K., & Moroni, A. V. (2015). Overview on the mechanisms of coffee germination and fermentation and their significance for coffee and coffee beverage quality. Critical Reviews in Food Science and Nutrition, 57(2), 259–274. doi:10.1080/10408398.2014.902804.