# Growth Response and Nitrogen Uptake Efficiency of Three Soybean Varieties on the Use of Sonic Bloom

Istirochah Pujiwati[1*], Anis Sholihah[1]

[1]Agrotechnology Study Program, Faculty of Agriculture, University of Islam Malang, Jl. MT. Haryono 193, Malang, Indonesia

istirochahpujiwati@unisma.ac.id

**Abstract.** Seventy percent of Indonesia's demand for soybeans is still imported, partly due to low crop productivity and decreased planting area. Sonic bloom, a technology that combines exposure of plants to sound waves of a certain frequency followed by application of liquid fertilizer through the leaves, is an alternative way to increase soybean productivity. This study aims to determine the growth response and N uptake efficiency of three soybean varieties on the use of sonic bloom technology. The research was a factorial experiment with a randomized block design (RBD). The first factor was the interval of using sonic bloom, I5: 5-day interval, I10: 10-day interval, and I15: once every 15 days. The second factor was soybean varieties, VA: Anjasmoro, VD: Dega-1, and VM: Mallika (black soybean). The data obtained were analyzed using Analysis of Variance with the F = 0.05 test followed by the 5% Honest Significant Difference (HSD) test. The results showed that different soybean varieties gave different growth responses to plant length, number of leaves and leaf area at sonic bloom intervals. The Dega-1 variety, which has thicker hairs (trichomes), requires more frequent application of fertilizer through the leaves using sonic bloom technology, namely once every 5 days. For the Anjasmoro variety, application of sonic bloom once every 10 days gave the best results, while for the black soybean variety Mallika the application of sonic bloom technology every 5, 10 or 15 days gave the same response. The highest N uptake efficiency was in the Dega-1 variety at intervals of using sonic bloom once every 5 days was 23.7%, while Anjasmoro and Mallika varieties had maximum N uptake of 23.7% and 21.8% at 10-day intervals.

**Keywords:** Interval, Sonic Bloom, Soybean Variety, Nitrogen Uptake Efficiency.

## 1 Introduction

Soybean is an important agricultural commodity after rice and corn. Soybean is the basic ingredient for processed products of several nutritious foods such as tofu, tempeh, soy milk, which are rich in protein, vitamins, minerals, organic compounds, antioxidants, fiber, and several vitamins and minerals [3]. The many nutrients contained


J. Mistar et al. (eds.), *Proceedings of the 2nd International Conference on Multidisciplinary Sciences for Humanity in Society 5.0 Era (ICOMSH 2022)*, Advances in Social Science, Education and Humanities Research 811,
https://doi.org/10.2991/978-2-38476-204-0_25

in it make soybean a strategic food source and is widely consumed by Asian people, and is even considered to be able to replace other main protein sources [5].

Based on data from the Ministry of Agriculture, Indonesia's soybean production in 2021 will only be 200 thousand tonnes. Meanwhile, the demand for soybeans to produce tofu and tempeh is around 1 million tonnes per year. Data from the [4] shows the value of soybean imports is still above 2 million tons per year in the last three years, namely 2.67 tons (2019), 2.48 (2020) and 2.49 (2021). The low production of soybeans in Indonesia is partly due to the limited area of soybean cultivation and low productivity.

One of the efforts to increase soybean productivity is to use the sound frequency exposure approach in plants. Sound can increase plant growth, one of which is by stimulating the opening of stomata which can increase the effectiveness of plant absorption of external nutrients (Cai, 2014). This approach can be realized with "sonic bloom" technology. Sonic bloom is a technology to stimulate the opening of stomata wider using sound waves of a certain frequency followed by applying liquid fertilizer through the leaves. The plants are hit by sound with a frequency between 3.5 – 5.0 kHz, then sprayed with foliar fertilizer. By opening the width of the stomata, the absorption of fertilizer through the leaves is maximized [10]. This technology utilizes natural high-frequency sound waves that can stimulate the stomata to remain open so as to increase the rate and efficiency of absorption of foliar fertilizers that are beneficial to plants [14]. Sound with a certain frequency helps plants breathe better and absorb more nutrients [15]. Dan Carlson (United States) found sounds like birds singing in the morning with a frequency of 3.5 kHz to 5.0 kHz would open the stomata wider [1][2]. Meanwhile, the results of the research by [9] showed that an increase in the frequency of sound waves from 4 to 5 kHz causes an increase in stomata opening width, but if the frequency is increased to 6 to 7 kHz, there is a decrease in stomata opening width. It was also reported that the use of sonic bloom technology not only increases yields in quantity, but also improves product quality. Soybeans which generally contain 15% increase to 27% protein content. The content of vitamin C in oranges increased 121% above normal. In apple plants it was reported from laboratory test results that there was an increase in Cu (copper) content of 400%, 1.70% Zn, 300% in Cr and 126% potassium [13][6]. The results of Pujiwati and Djuhari's research (2011) showed that the response to opening of soybean leaf stomata at the age of 20 days after planting (dap) was better (stomata width ranged from 20.0 – 36.0 μm) than 30 hst (stomata width ranged from 10.0 – 17.7μm). Exposure to high-frequency sound waves is able to optimize the opening of the stomata of soybean plants, this is in accordance with [7] where the stomata of soybean plant leaves open wider when exposed to sound. [8] added that fertilizer or plant nutrition plays an important role in supporting plant growth and development. One of the absorption of nutrients in the form of liquid fertilizer through the leaves is intended so that water-soluble nutrients can be effectively absorbed by plants. These nutrients enter the leaves through the cuticle or stomata before entering the plant cells to be used in metabolism. Penetration through stomata takes place briefly after application, therefore efforts to increase the effectiveness and efficiency of nutrient uptake through leaves need to be carried out.

There were 85 soybean varieties released until 2016, both from crosses, introductions and radiation. All varieties of soybean leaves have hairs with different levels of hair density, this affects the size of the efficiency of absorption of nutrients provided through the leaves. [12] suggested that the thickness of the hairs or trichomes on soybean leaves is related to the level of tolerance to pest attacks, including the efficiency of fertilizer absorption given through the leaves. This study compared soybean varieties with leaf morphology of dense hair, sparse hair and black soybean varieties. These different leaf morphological properties are very relevant when combined with the interval of foliar application in sonic bloom technology.

## 2 Methods

### 2.1 Tools and Materials

The equipment used is a set of sonic devices that produce sound with a frequency of 4,000 Hertz, a hand sprayer, and writing instruments. Meanwhile, the materials used were: soybean seeds of the Anjasmoro, Dega-1 and Mallika varieties, Growmore compound fertilizer containing NPK 20:20:20, micro B compounds (0.02%), Cu (0.05%), Fe (0.10%), Mn (0.05%), Mo (0.0005%) Zn (0.05%), fungicide Dithane-M45 80WP, insecticide Baycarb 500EC.

### 2.2 Research Site

The research was conducted from July to October 2022 at the Technopark greenhouse, Faculty of Agriculture, Tribuana Tunggadewi University, Malang.

### 2.3 Experimental Designs

Research was a factorial experiment using a randomized block design (RBD). The first factor using of sonic bloom interval, $I_5$: 5 days interval, $I_{10}$: 10 days interval, and $I_{15}$: 15 days interval. The second factor was soybean variety, $V_A$: Anjasmoro variety, $V_D$: Dega-1 variety, and $V_M$: Mallika variety. There were 9 treatment combinations repeated three times, with each treatment consisting of 4 sample plants so that the plant population was 108. The observed plant growth variables included plant length, number of leaves and leaf area as well. Nitrogen nutrient uptake was measured using the Kjedhal method.

### 2.4 Data Analysis

The data obtained was then subjected to analysis of variance (Anova) with the F test $\alpha = 0.05$ followed by a 5% Honest Significant Difference (HSD) test and correlation regression analysis between several observed growth parameters.

## 3 Results And Discussion

The results showed that the vegetative growth of several varieties of soybean plants was affected by the use of sonic bloom intervals. In general, the Anjasmoro variety gave the best response to plant length at intervals using sonic bloom technology once every 5 days, whereas the Dega-1 variety, the 5-day and 10-day intervals produced the same good plant length and the Mallika black soybean showed the same plant length response did not differ at various intervals, as presented in Table.1 below.

**Table 1.** Average plant length at sonic bloom intervals with different varieties

| Treatment | Average Plant Length (cm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 28 dap | 35 dap | 42 dap | 49 dap | 56 dap | 63 dap | 70 dap |
| $I_5V_A$ | 51.3 | 54.9 | 56.8 bc | 58.7 c | 61.7 c | 65.8 bcd | 69.5 bcd |
| $I_5V_D$ | 53.4 | 57.0 | 59.7 c | 60.5 c | 62.3 c | 66.4 cd | 70.5 cd |
| $I_5V_M$ | 42.7 | 49.2 | 47.0 a | 49.4 a | 51.8 a | 56.4 a | 70.0 bcd |
| $I_{10}V_A$ | 50.3 | 53.1 | 55.1 b | 55.4 b | 56.2 b | 62.8 b | 67.6 ab |
| $I_{10}V_D$ | 53.4 | 54.5 | 57.0 bc | 58.6 c | 62.2 c | 67.2 d | 69.9 bcd |
| $I_{10}V_M$ | 46.8 | 49.4 | 48.5 a | 50.9 a | 53.1 ab | 57.8 a | 70.9 d |
| $I_{15}V_A$ | 51.8 | 52.9 | 55.8 b | 57.2 bc | 60.1 c | 63.8 bc | 67.7 abc |
| $I_{15}V_D$ | 53.4 | 54.3 | 55.3 b | 57.2 bc | 60.6 c | 64.2 bcd | 67.1 a |
| $I_{15}V_M$ | 45.2 | 47.9 | 45.7 a | 48.1 a | 50.9 a | 55.5 a | 67.8 abc |
| **HSD 5%** | NS | NS | 3.4 | 3.8 | 3.6 | 3.3 | 2.8 |

*Note : - Numbers followed by the same letter in the same column are not significantly different on the HSD 5% test; dap = days after planting*

*- $I_5$ = every 5 days interval, $I_{10}$ = every 10 days interval, $I_{15}$ = every 15 days interval*

*- $V_A$ = Anjasmoro variety, $V_D$ = Dega-1 variety, $V_M$ = Mallika variety*

The variable number of leaves showed a significant effect at the age of 28, 63 and 70 dap, where the highest number of leaves was produced in Mallika soybean varieties which were treated with sonic bloom at intervals of 5 days and 15 days although not significantly different from Anjasmoro and Dega-1 varieties given the sonic bloom treatment at intervals of 10 days (Figure 1.). This shows that the Mallika black soybean variety is more flexible in the application of sonic bloom technology, it is proven that with intervals of 5 days, 10 days and once every 15 days it produces the same number of leaves. Soybean varieties with yellow seeds are more frequently given foliar fertilizers through sonic bloom technology, in fact the number of leaves is getting smaller.

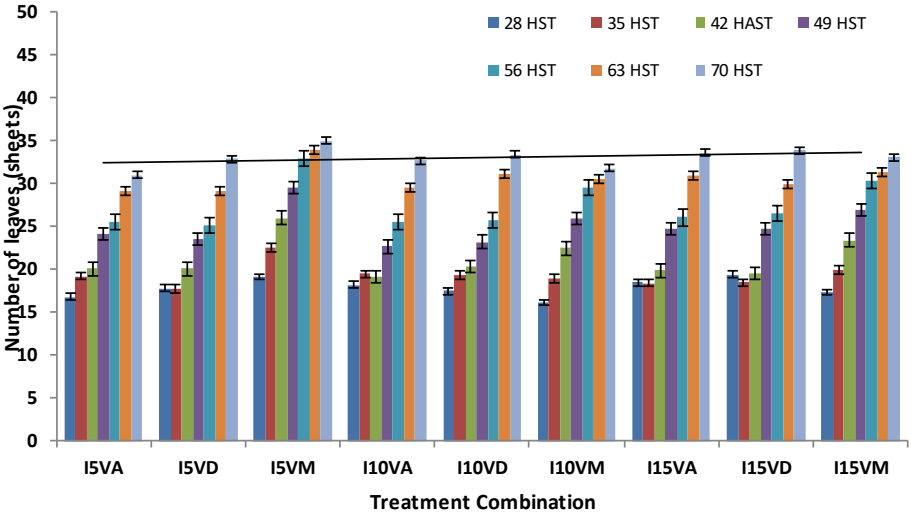


**Fig. 1.** Diagram of the number of leaves at the interval of use of sonic bloom with different varieties

The average leaf area of soybean plants showed a significant difference at the beginning of growth at the age of 28 HST, where the best leaf area was obtained from the Mallika black soybean variety which was given sound wave stimulation followed by foliar fertilizer application every 15 days.

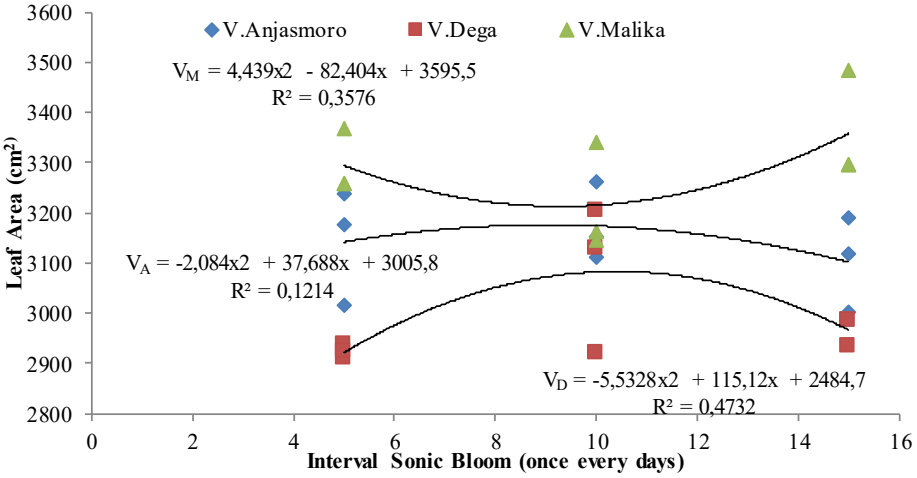


**Fig. 2.** Graph of leaf area at sonic bloom intervals for different varieties

In general, the growth of the three varieties of soybean plants showed a different response, where the Dega-1 variety which has thicker hairs (trichomes) requires more frequent application of fertilizer through the leaves in a series of using sonic bloom technology, namely at intervals of every 5 days. For the Anjasmoro variety, application of foliar fertilizer once every 10 days gave the best results, while for the black soybean variety Mallika the application of sonic bloom technology every 5, 10 or 15 days gave the same response. [12] suggested that the thickness of the hairs or trichomes on soybean leaves is related to the absorption efficiency of the fertilizer given through the leaves. The level of absorption of nutrients (nutrients) provided through the leaves for varieties with dense hairs requires frequent or short time intervals, while for leaves with less dense hairs such as the Anjasmoro variety, an interval of 10 days is sufficient, even for Mallika black soybeans the application of sonic technology bloom by administering liquid fertilizer through the leaves is done at intervals of 15 days and still gives the same vegetative growth response at intervals of 5 days or 10 days. Sound with a certain frequency helps plants breathe better and absorb more nutrients [15]. This condition is supported by N uptake data on the Dega-1 variety with the highest N uptake efficiency at the 5-day sonic bloom interval of 21.7%, while the Anjasmoro variety with N uptake of 23.7% at 10-day intervals and the Mallika's best N uptake was 21.8% at intervals of using sonic bloom every 10 days (Figure 3). According to [11] that N is the main element needed by plants for their growth. The function of N, among others, as a major component in the formation of proteins, nucleic acids, chlorophyll, and other organic compounds. Protein is a constituent of protoplasm and as a vital ingredient forming various enzymes. Nitrogen also gives leaves a green appearance as a component of chlorophyll, promotes growth, increases plant height and number of leaves, increases leaf and seed size, and increases protein composition in seeds.

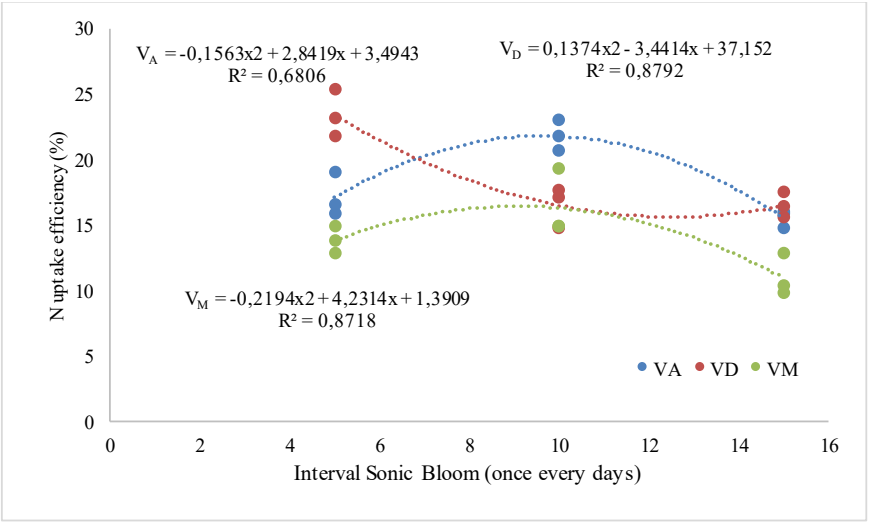


**Fig. 3.** Efficiency of nitrogen uptake at different varieties of sonic bloom intervals

## 4 Conclusions

Soybean plants that have denser hairs (trichomes) such as the Dega-1 variety require the use of sonic bloomtechnology with shorter intervals than varieties with sparse hairs such as Anjasmoro and Mallika black soybeans.

The efficiency of nitrogen uptake in soybean varieties with dense hairs can be increased by shortening the interval using sonic bloom technology. The efficiency of N uptake on the Dega-1 variety with a sonic bloom interval of 5 days is the same as the Anjasmoro variety with an interval of 10 days, which is 23.7%.

## Acknowledgement

Our thanks go to the Directorate of Research, Technology and Community Service (DRTCS), Directorate General of Higher Education, Research and Technology, Ministry of Education, Culture, Research and Technology of the Republic of Indonesia for funding this research through the Higher Education Excellence Applied Research scheme (HEEAR) with contract number 272/G164/U.LPPM/K/B.07/VI/2022.

## References


1. Anonymous. (2008). Pembukaan dan Penutupan Stomata. http://www.en.wikipedia.org/wiki.stomata
2. Anonymous. (2011). Cara Kerja dan Kegunaan Teknologi *Sonic Bloom*. http://sanaureka.wordpress.com
3. Anonymous. (2015). Kandungan Vitamin dan Gizi, Serta Manfaat Kedelai Bagi Kesehatan. http://www.carakhasiatmanfaat.com/artikel/kandungan-vitamin-dan-gizi-serta-manfaat-kedelai-bagi-kesehatan.html
4. Badan Pusat Statistik. (2022). Impor Kedelai menurut Negara Asal Utama tahun 2017-2021. https://www.bps.go.id/statictable/2019/02/14/2015/impor-kedelai-menurut-negara-asal-utama-2017-2021.html
5. Garg, S., Lule, V.K., Malik, R.K., and Tomar, S.K. (2016). Soy Bioactive Components in Functional Perspective: A Review. *International Journal of Food Properties,* 19:2250-2574
6. Hassanien, R.H.E., HOU Tian-zhen, LI Yu-feng dan LI Bao-ming. (2014). Advances in Effect of Sound Waves on Plants. *Journal of Integrative Agriculture. 13*(2) : 335-348
7. Noor, Rohmah I. 2012. Pengaruh Pemaparan Suara Anjing Tanah (Orong-Orong) Termanipulasi pada Peak Frequency (2,9 ± 0,1) $10^3$Hz terhadap Pertumbuhan dan Produktivitas Tanaman Kacang Kedelai (*Glycine max* (L.) Merr). Skripsi, Fakultas MIPA Universitas Negeri Yogjakarta.
8. Oosterhuis, D. (2009). Foliar Fertilization : Mechanisms and Magnitude of Nutrient Uptake. Paper for the Fluid Fertilizer Foundation Meeting in Scottsdale. Arizona
9. Pujiwati, I. dan Djuhari. (2011). Penentuan Model Pembukaan Stomata Daun Kedelai (*Glycine max* (L.) Merril) akibat Paparan Gelombang Suara Frekuensi Tinggi. *AGRITEK*. 20 : 636-642
10. Pujiwati, I. and Djuhari. (2014). The Pattern of Stomatal Opening through the Exposure of High-Frequency Sound Wave with the Different Duration and Age of Soybeans (*Glycine max* (L.) Merril). *Agricultural Science. 2* (1) : 69-77
11. Sumiyanah dan I. Sungkawa. 2018. Pengaruh Pemangkasan Pucuk dan Pupuk Nitrogen terhadap Pertumbuhan dan Hasil Tanaman Kedelai (*Glicyne max.* L., Merril) Varietas Anjasmoro. Jurnal AGROSWAGATI. 6 (1) : 693-709.
12. Sunarti, C. dan Maryani. (2019). Karakter Anatomis Daun Kedelai (*Glycine max* (L.) Merril) 'Grobogan' Hasil Perlakuan Kekeringan dan Mulsa Jerami. Prosiding Seminar Nasional. ISSN 2443-1109. Vol 2 (1): 881-896
13. Tompkins, P. (2001). SONIC BLOOM. http://www.moonsign2001.htm
14. Widyawati, Y.,N, Kadarisman dan A.Purwanto. (2011). Pengaruh Suara "Garengpung" (*Dundubia manifera*) Termanipulasi pada *Peak* Frekuensi (6,07±0,04) 103 Hz terhadap Pertumbuhan dan Produktivitas Tanaman Kacang Dieng (*Vicia faba Linn*). *Prosiding Seminar Nasional Penelitian, Pendidikan dan Penerapan MIPA.* Fakultas MIPA Universitas Negeri Yogyakarta. 14 Mei 2011
15. Zhu, J.R., Jiang, S.R. dan Shen, L.Q. (2011). Effect of music acoustic frequency on indoleacetic acid in plants. *Agricultural Science and Technology*. 12 : 1749-1752.