Agronomic Characteristics of Three Soybean Varieties at Different Levels of Genistein

Aman Suyadi[1], Totok Agung Dwi Haryanto[2], Ismangil[3], Ponendi Hidayat[4]

[1]Department of Agrotechnology, Faculty of Agriculture and Fishery Universitas Muhammadiyah Purwokerto, Indonesia
[2]Doctoral Program in Agricultural Sciences, University of Jenderal Soedirman Purwokerto, Indonesia
[3,4]Department of Agrotechnology, Faculty of Agriculture University of Jenderal Soedirman Purwokerto, Indonesia
*Corresponding Author

Received:- 07 April 2023/ Revised:- 16 April 2023/ Accepted:- 23 April 2023/ Published: 30-04-2023

Abstract— *This research aimed to identify the agronomic characteristics of three soybean varieties at varied genistein concentrations. Three soybean varieties (V1 = Deja1, V2 = Dena1, V3 = Demas1) and four levels of genistein concentration (G0=0ppm, G1=60ppm, G2=120ppm, G3=180ppm) were the two components that made up the plot design in this research. A total of three times were used for the treatment combination. Genistein concentrations were used in the split plot's design, while the variety was applied to the main plot. The observed factors include the amount of genistein in the leaves, the number of root nodules, the amount of chlorophyll, the amount of leaf area, and the pace of plant growth.*

The study's findings demonstrate that the variety Demas1 produced the most chlorophyll. 32.04 mg/L, 0.269 mg/g dried leaves of leaf genistein, and 47.88 grains of root nodules. The Deja 1 variety yielded the widest leaf area, measuring 33.26 cm 2, and the fastest plant growth rate, measuring 0.853 g/m2/week. According to the study's findings, the best genistein concentration up to the age of 49 days after planting is 180 ppm, which can result in leaves with an area of 32.3 cm 2, chlorophyll content of 34.21 mg/L, a genistein concentration of 0.032 mg/g in leaves, 43.60 grains of root nodules, and a growth rate of 0.736 g/m2/week in plants. The best agronomic characteristics are produced by the Demas1 soybean variety, which has 180 ppm of genistein.

Keywords**—Soybean (G. max (L.) Merr.), genistein, Deja1, Dena1, Demas1.**

I. INTRODUCTION

Due to ozone layer depletion, UV radiation will be more prevalent on Earth's surface. UV-B light (280–320 nm) can be hazardous because it damages cells. Plants are vulnerable to increasing UV-B radiation because several biological components, including nucleic acids, proteins, lipids, and quinones, can directly absorb UV-B radiation. According to Kakani et al. (2003), increased UV-B exposure causes plants to photosynthesize slowly. This effect is caused by extracting photosynthetic gene expression, reduced Rubisco activity, altered thylakoid ion membrane permeability, and changes in chlorophyll and carotenoid levels. (Gaberscik *et al.*, 2002).

According to Diffey (1991), the annual UV-B radiation flux decreases with increasing distance from the equator. Crop productivity is higher in mid-latitude nations like China, Korea, and Japan since UV-B radiation exposure is lower than in Indonesia. As compared to China's soybean production of 12.943 million tons (Myers, 2014), which was more significant than Indonesia's national soybean production of 0.63 million tonnes in 2020, Korea's soybean production climbed to 154,067 MT in the 2013/2014 planting season, up 31,548 MT (26%) from the previous year. (Ministry of Agriculture, 2021)

UV light and exposure duration mainly contribute to Indonesia's low soybean productivity (Sumarno et al., 2007). UV-B radiation's photobiological effect generates free radicals and damages cells (Baumann and Allemann, 2009). Free radicals can harm proteins, amino acids, protective enzymes, and the structure and function of cells (Refdi, et al., 2014). They can also diminish the performance of substances in the body (Fisher, 2002). Biomolecules like DNA, RNA, proteins, and membranes can become damaged when exposed to UV-B radiation at high fluences or over extended periods. (Alseekn et al., 2020).

The formation of flavonoid molecules is a natural response of Leguminocae plants to UV-B exposure. In addition, flavonoids show protective effects against biotic and abiotic stressful situations, such as pathogen infections, exposure to UV-B and high-fluence white light, drought, cold, salt, and herbivore attacks (Falcone Ferreyra et al., 2012). There are 12 isoflavones in soybeans, including three aglycones called genistein, daidzein, and glycerin, all produced in reaction to UV light and herbivorous insects (Zavala et al., 2015, Piubelli et al., 2005). The primary, secondary metabolite of soybeans, genistein, is a natural isoflavonoid with several beneficial properties. (Polkowski, 2000). It takes a lot of energy to produce secondary metabolites, which inhibits pod filling and growth (Xing et al., 2014). The energy required to synthesize isoflavones can increase soybean plant growth and production by reducing the effects of UV-B radiation.

Exogenous isoflavones can boost soybean production in milk, tofu, flour, protein concentrate, soy protein isolate, and other processed soy foods that are not fermented (Coward et al., 1998). Exogenous isoflavones are given as sunscreen to lessen exposure to UV-B rays. A thin layer of isoflavones can tolerate most UV-B radiation because of one of the characteristics of UV-B light, which has deficient penetrating power. Reduced UV-B exposure can inhibit the generation of endogenous isoflavones, allowing soybean plants to grow and produce more using that energy instead of producing endogenous isoflavones.

Deja1 is a water stress-tolerant soybean variety created by a single cross between the Tanggamus variety and Anjasmoro (Balitkabi) (Anggraini, 2020). Deja1 has more trichomes than Derap1, Detam1, Detam2, and Dering1 types (Pandjaitan, 2021). Argomulya and IAC were crossed to create the shade-tolerant soybean variety known as Dena1 (Balitkabi). Dena1 has the highest antioxidant activity (80.23% DPPH inhibition), total phenolic content (4.18 mg GAE/g), and total flavonoid content (4.23 mg QE/g) (Aurelia, 2022). The excellent soybean variety Dena1 is resistant to pests and diseases (Balitkabi, 2015). In addition, Dena1 has the highest concentrations of chlorophyll a, b, and the chlorophyll a/b ratio (Noya et al., 2019) Demas1 is a variety made by crossing Mansuria and SJ that can survive in dry, acidic soils (Balitkabi). Demas-1 soybeans grow better in acidic soils because they are genetically resistant to acid. (Selvia et al, 2019).

This research aimed to present scientific data on the agronomic characteristics of three soybean varieties at different genistein concentrations. Experiments were done to see how each type would react to genistein concentrations. The study's findings are anticipated to be applied as a recommendation to administer genistein to three soybean types to boost production.

II. MATERIALS AND METHODS

2.1 Study Area

The research was conducted in the experimental garden of the Faculty of Agriculture and Fisheries, Muhammadiyah University, Purwokerto, Karangsari Village, Kembaran District, Banyumas Regency (coordinates 07 ^{0} 23' 56” South Latitude and 109 ^{0} 16' 53” East Longitude, altitude ± 85 md i above sea level (asl), Agrotechnology Laboratory Applied , Laboratory of Basic Agrotechnology, Faculty of Agriculture and Fisheries, and Laboratory of Pharmaceutical Biology, Faculty of Pharmacy, Universitas Muhammadiyah Purwokerto. The research started from July to October 20 21.

2.2 Procedures

The research involved a factorial experiment with polybags set up in an entirely random pattern. The genistein administration concentration (G) and the soybean varieties (V), specifically V1 = Deja1, V2 = Dena1, and V3 = Demas1, were evaluated. G0 = 0 ppm, G1 = 60 ppm, G2 = 120 ppm, and G3 = 180 ppm were the control factors. Three repeats were done, with 108 plants in each repetition Observational variables include leaf area, chlorophyll content, leaf genistein concentration, number of root nodules, and plant growth rate.

The research entailed creating the planting media, a mixture of manure and loose dirt obtained by sieving three millimeters of soil (1:1 ratio). Two soybean seeds are contained in each polybag as they are planted by hand using a shovel. Genistein was provided with concentrations by the therapy from 0 days after planting (DAP) to 50 DAP at intervals of 10 days. At zero hours, genistein was administered by watering the plant with 30 ml each. Genistein spray volume per plant, aged ten days: 180 ml, 20 days: 200 ml, 30 days: 320 ml, 40 days: 330 ml, and 50 days: 330 ml.

2.3 Data Analysis

Observational data were analyzed using the 5% level DMRT test after the F test at the 95% level of confidence if they were found to be substantially different.

III. Result and Discussion

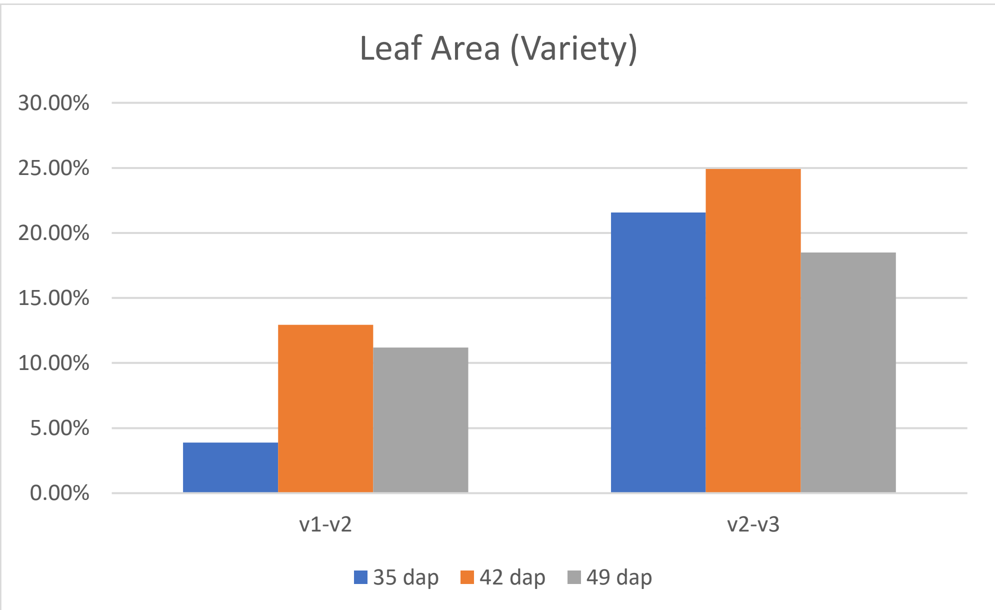
3.1 Leaf Area

TABLE 1
RESULTS OF THE VARIABLE LEAF AREA (cm^2) ANALYSIS OF 3 SOYBEAN VARIETIES WITH GENISTEIN ADDITION

Treatment	35 days after planting	42 days after planting	49 days after planting
variety			
V1	**25.81a**	**31.99a**	**33.26a**
V2	24.84a	28.32b	29.91b
V3	21.23b	25.61c	28.07c
genistein			
G0	20.91c	26.29c	28.27c
G1	24.18b	28.43b	30.26ab
G2	24.92ab	29.26b	30.92ab
G3	**25.82a**	**30.58a**	**32.3a**

Information: V = soybean variety, V1 = Deja1, V2 = Dena1, V3 = Demas1, G = genistein concentration, G0 = 0ppm, G1 = 60ppm, G2 = 120ppm, G3 = 180ppm

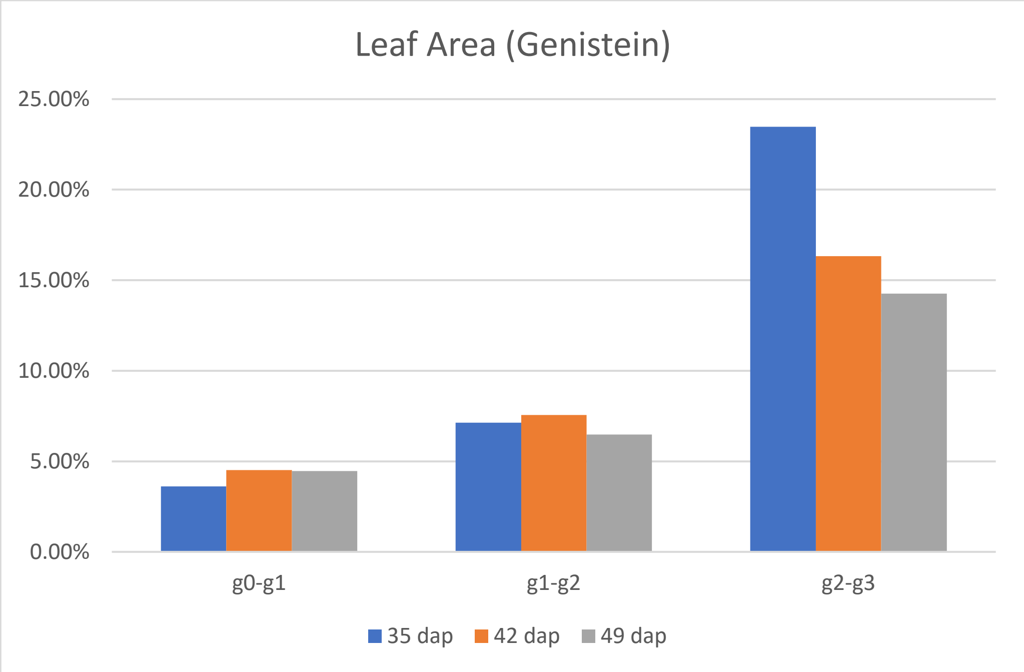
The type of soybean and the amount of genistein had a big impact on the leaf area. Table 1 demonstrates that at age 35 days after planting, treatment V1 (Deja) had the widest leaf area, measuring 25.8 cm 2, 3.9% wider than treatment V2 (Dena1), and 21.57% wider than V3 (Demas1). 42 years old. The V1 treatment (De ja 1) had the widest leaf area at 31.99 cm 2, 12.95% wider than the V2 treatment (Dena 1), and 24.91% wider than the V3 treatment (Demas1). 49 days after planting old The V1 treatment (Deja1) has the widest leaf area, measuring 33.26 cm2, 11.2% wideer than the V2 treatment (Dena1), and 18.49% wider than the V3 treatment (Demas1).



GRAPHIC 1: The percentage of leaf area increases in the various treatment

These results show that the Deja1 variety was able to produce the largest leaf area at each observational stage. It is believed that the Deja1 variety is a light-sensitive kind. Thus it must adapt to be able to absorb more sunshine. The leaves extend as a result of adaptation. The Deja1 (V1) has more wide and thin leaves, which are supposed to represent a defense mechanism against low light (Khumaida, 2002). According to Sopandie et al. (2002), shade-tolerant soybean varieties have higher chlorophyll an in their genetic characteristics to increase photon absorption. According to Evans and Porter (2001), the shadow avoidance reaction of plants under light intensity stress is carried out by maximizing light capture by altering the structure and morphology of leaves for effective photosynthesis, with thinner leaves so that the distribution of photosynthetic results to light harvesting network becomes faster. The Deja1 variety is characterized by wide, thin leaves that increase the effectiveness of photosynthetic processes by absorbing lighter and swiftly conveying it to the lower leaves. The Deja1 type can also slow down transpiration since it has more trichomes. The reduced rate of transpiration satisfies the requirement for photosynthetic water. (Pandjaitan, 2021).

According to Table 1, the leaf area tends to grow weekly. The age of the leaf area was considerably impacted by genistein concentration at 35, 42, and 49 days after planting. At the age of 35 days after planting, G3 (180 ppm) produced the widest leaf area, measuring 25.82 cm 2, 23.48% wider than G0 (0 ppm), 7.14% wider than G1 (60 ppm), and 3.61% wider than G2 (120ppm). At the age of 42 days after planting, G3 (180ppm) produced the widest leaf area, which was 30.58cm 2, 16.32% wider than G0 (0ppm), 7.56% wider than G1 (60ppm), and 4.51% wider than G2 (120ppm). The best treatment is G3 (180ppm) at the age of 49 days after planting, which produced the widest leaf area, or 33.30 2, 14.26% wider than G0 (0ppm), 6.74% wider than G1 (60ppm), and 4.46% wider than G2 (120ppm).



GRAPHIC 2. The percentage of leaf area increases in the genistein treatment

Genistein can prevent plant cell damage brought on by UV light exposure. According to Muchtadi (2012) and Cahyati et al. (2013), genistein is a secondary metabolite that protects cells from free radical damage. Without genistein protection, plants will keep growing in the presence of ultraviolet radiation, giving up their chloroplasts to protect other cells, which interferes with photosynthesis. (Barufi *et al.*, 2010). According to Ai and Banyo (2011), chlorophyll is the primary plant pigment that contributes to photosynthesis, particularly when solar energy is used to start CO2 fixation, which produces carbohydrates and energy. Proteins, lipids, nucleic acids, and other organic compounds are created from the carbohydrates generated during photosynthesis. Supplying genistein 180 ppm (G3) is likely to lessen the effects of exposure to UV-B rays by preventing and reversing chloroplast damage, allowing the photosynthesis process to function properly, and the growth and development of soybean plant leaves.

Genistein is often ingested from plants in the form of the glycoside genistin. Genistin is hydrolyzed into genistein (the bioactive aglycone) by phlorizin hydrolase, a small intestine brush-border lactase, before being absorbed or further changed by enteric bacteria (Walsh et al., 2007). (Mattison et al, 2014). Like other polyphenols, genistein has a 10% oral bioavailability. (Hu *et al*, 2007). Genistein can be passively carried into intestinal cells due to its poor absorption potential, lipophilic nature, and low molecular weight (Liu et al., 2002). This results in post-absorption metabolism. The accumulation of various flavonoids, such as flavonols, flavones, and anthocyanins, helps plants solve a variety of biotic and abiotic stresses. Phenolic chemicals, particularly flavonoids, are essential plant secondary metabolites. (Mouradoy et al 2014, Jiang et al 2016).

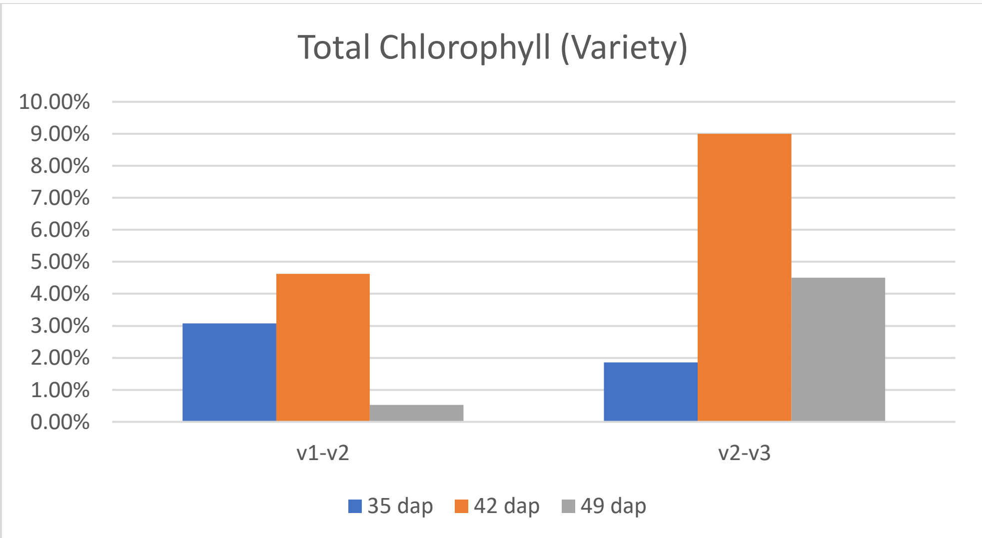
3.2 Total Chlorophyll

TABLE 2
THE RESULTS OF THE ANALYSIS OF THE VARIABLE AMOUNT OF CHLOROPHYLL (MG/L) OF THE ROOTS OF 3 SOYBEAN VARIETIES WITH THE ADDITION OF GENISTEIN

Treatment	35 days after planting	42 days after planting	49 days after planting
variety			
V1	23.38a	28.6ab	30.66b
V2	23.66a	27.45b	31.87b
V3	**24.10a**	**29.92a**	**32.04b**
genistein			
G0	21.58c	27.087c	30.66b
G1	23.39b	28.06bc	31.87b
G2	23.60a	29.11a	32.04b
G3	**26.15a**	**30.47a**	**34.21a**

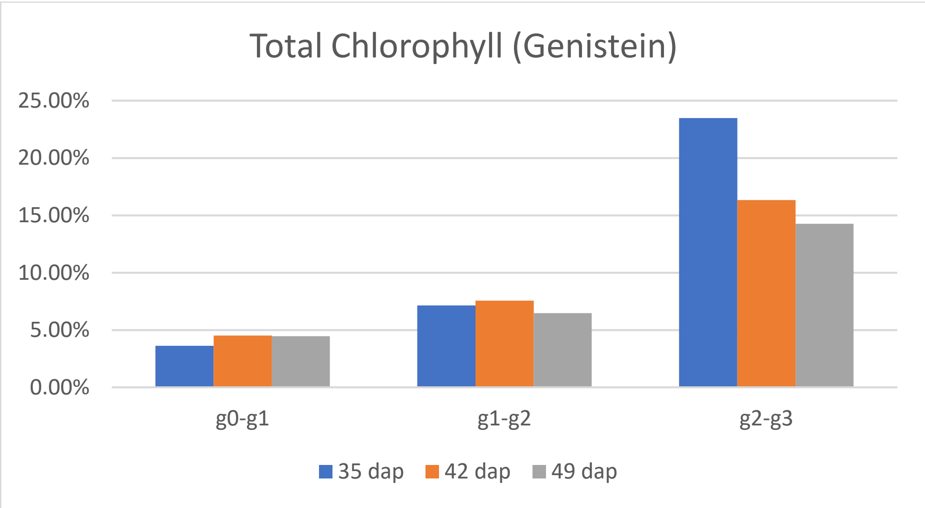
Information: V = soybean variety, V1 = Deja1, V2 = Dena1, V3 = Demas1, G = genistein concentration, G0 = 0ppm, G1 = 60ppm, G2 = 120ppm, G3 = 180ppm

Table 2 demonstrates that although the soybean varieties did not significantly change the quantity of chlorophyll at 49 days after planting, they did significantly affect the amount of chlorophyll in leaves aged 35 days after planting and 42 days after planting. Treatment V3 (Demas1), which had a leaf chlorophyll concentration of 24.10 mg/L at age 35 days after planting, had the highest level, 3.08% higher than treatment V1 (Deja1) and 1.86% higher than V2 (Dena1). Treatment V3 (Demas1), which had a leaf chlorophyll concentration of 29.92 mg/L at age 42 days after planting, had the highest level, 4.62% higher than treatment V1 (Deja1) and 9.00% higher than V2 (Dena1). Treatment V3 (Demas1), which had a leaf chlorophyll concentration of 32.04 mg/L at age 49 days after planting, was 4.50% higher than treatment V1 (Deja1) and 0.53% higher than V2 (Dena1). These findings show that the V3 (Demas1) treatment may effectively adapt to changing environmental conditions and can lessen the harmful effects of UV-B radiation, protecting against and reversing chloroplast damage. Plants become resistant and tolerant to UV-B radiation by shielding their cells. (Levit, 1980). Cotton plants' adaptive process to exposure to UV-B rays is carried out by decreasing leaf thickness and raising the stomata index, palisade layer, and wax content. (Kakani V., G., *et al* , 2002).



GRAPHIC 3: The percentage of total chlorophyll increases in the various treatment

Table 2 shows that the genistein concentration dramatically affects the amount of chlorophyll in leaves aged 35 days after planting, 42 days after planting, and 49 days after planting. At the age of 35 Days after planting, G3 (180ppm) produced the highest amount of leaf chlorophyll, namely 26.15 mg/L, 10.8% more than G0 (0ppm), 11.80% more than G1 (60ppm), and 10.81% more than G2 (120ppm). G3 (180 ppm) was the most effective treatment at 42Days after planting, producing 30.47 mg/L of leaf chlorophyll, 4.67% more than G0 (0 ppm), 8.59% more than G1 (60 ppm), and 12.49% more than G2 (120 ppm). G3 (180 ppm) was the most effective treatment at 49Days after planting, producing 34.21 mg/L of leaf chlorophyll, 6.77% more than G0 (0 ppm), 7.34% more than G1 (60 ppm), and 11.58% more than G2 (120ppm). These data suggest that genistein can protect soybean plants from the effects of exposure to UV-B radiation since it increases the amount of chlorophyll the higher the genistein concentration given which can decrease the amount of chlorophyll, it was discovered that Phaseolus vulgaris leaves grown under UV-B stress had lower levels of chlorophyll a and b (Michaela et al., 2000). Flavonoid compounds serve as UV filters by absorbing a wide spectrum of UV-B rays. Anthocyanin-containing flavonoids in corn plant DNA prevent DNA from being damaged by UV light. According to Cohen et al. (2001), flavonoids play a role in plants' defense mechanisms against UV-B exposure. Supplying exogenous flavonoids is hypothesized to be capable of providing the photosynthetic organs with a layer of protection, allowing the photosynthetic process to proceed generally while suppressing the formation of endogenous flavonoids. The next consequence is the ability of soybean plants to conserve energy and improve growth and bean pod filling through photosynthetic activity.



GRAPHIC 4: The percentage of total chlorophyll increases in the genistein treatment

3.3 Leaf Genistein Concentration

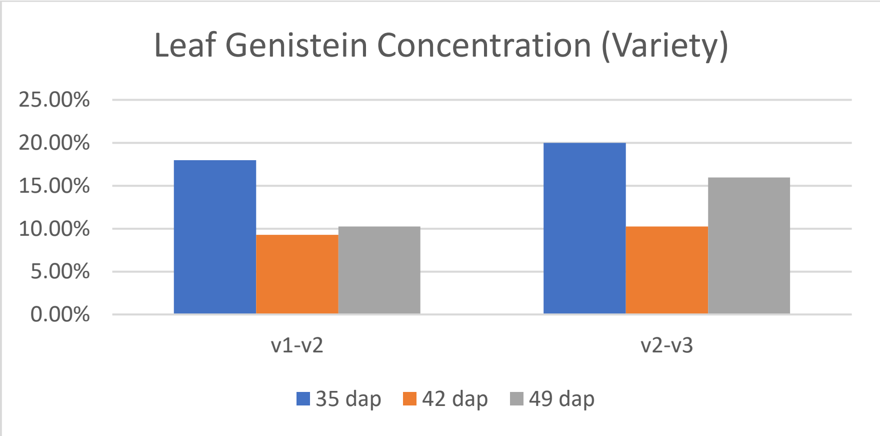
TABLE 3
THE RESULTS OF THE ANALYSIS OF THE VARIABLE GENISTEIN LEAF CONCENTRATION (MG/G DRY LEAVES) OF THREE SOYBEAN VARIETIES WITH GENISTEIN ADDITION

Treatment	35 days after planting	42 days after planting	49 days after planting
variety			
V1	0.175b	0.215b	0.244b
V2	0.178b	0.216b	0.232b
V3	**0.210a**	**0.237a**	**0.269a**
genistein			
G0	0.101d	0. 150d	0.179d
G1	0.163c	0. 192c	0.214c
G2	0.217b	0.251b	0.278b
G3	**0.271a**	**0.289a**	**0.322a**

Information: V = soybean variety, V1 = Deja1, V2 = Dena1, V3 = Demas1, G = genistein concentration, G0 = 0ppm, G1 = 60ppm, G2 = 120ppm, G3 = 180ppm

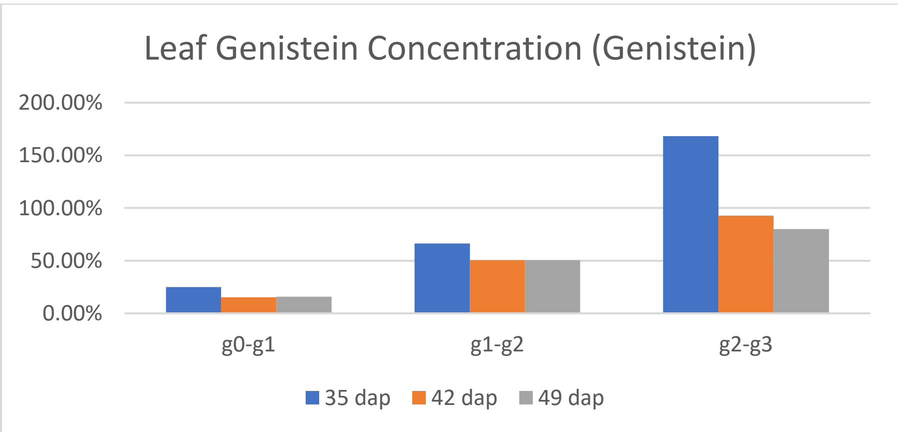
According to Table 3, soybean varieties significantly affect the number of genistein leaves aged 35, 42, and 49 days after planting. At 35 days after planting, the V3 (Demas1) treatment had the highest level of genistein leaves, 0.210 mg/g, 20%

higher than the V1 (Deja1) treatment and 17.98% more than the V2 treatment (Dena1). Treatment V3 (Demas1) had the greatest level of genistein leaves at age 42 days after planting, with 0.237 mg/g, 10.23% more than treatment V1 (Deja1) and 9.72% more than V2 (Dena1). Treatment V3 (Demas1) had the most genistein leaves at age 49 days after planting, with 0.269 mg/g, 10.25% more than treatment V1 (Deja1), and 15.95% more than V2 (Dena1). According to the data, the V3 (Demas1) treatment could prevent chlorophyll damage from UV-B light exposure. According to Moghaddam et al. (2011), leaves generate flavonoid compounds as a coating for photosynthetic pigments that prevent plant damage to lessen UV-B radiation's impact. Isoflavones are synthesized by plant cells under conditions of growth stress, such as exposure to UV-B rays. Sulistyowati et al. (2018) indicated that each genetic diversity is directly proportional to the response of plant growth and development and that variety affects the genistein content of soybean plants.



GRAPHIC 5. The percentage of leaf genistein concentration increases in the various treatment

According to Table 3, the genistein concentration greatly affects the amount of genistein in leaves aged 35 days after planting, 42 days after planting, and 49 days after planting. The most effective treatment is G3 (180ppm), which was able to produce the most leaf genistein at the age of 35 Days after planting, namely 0.271 mg/g, 168.32% more than G0 (0ppm), 66.26% more than G1 (60ppm), and 24.88% more than G2 (120ppm). The most effective method at 42Days after planting produced 0.289 mg/g of genistein in leaves, 92.67% more than G0 (0ppm), 50.52% more than G1 (60ppm), and 15.14% more than G2 (120ppm). The most successful treatment at 49Days after planting was G3 (180ppm), which was able to produce 0.322mg/g of leaf genistein, 79.89% more than G0 (0ppm), 50.47% more than G1 (60ppm), and 15.83% more than G2 (120ppm). These findings suggest that genistein can be applied to soybean plant leaves to form a residue that acts as a UV radiation absorber. 90% to 99% of UV light is absorbed by epidermal cells. The main UV absorption agents are believed to be waxes and flavonoid chemicals. UV exposure negatively impacts plants, including stunted development and morphological changes. Genistein and daidzein glycosides were primarily used to study the uptake and metabolism of isoflavones, making them both the most representative phytoestrogens for nutraceuticals. (Franke *et al.*, 2004; Heinonen *et al.*, 2003).



GRAPHIC 6. The percentage of leaf genistein concentration in the genistein treatment

According to Ho et al. (2002), isoflavone glycosides and derivatives predominate in soybean seeds, as opposed to Kaempferol glycosides are the primary flavonoids in soybean leaves. However, Piubelli et al. (2005) confirmed that soybean leaves of various genotypes contained substantial levels of rutin (Quercitin 3-O-rhamnosyl glucoside) and genistin (genistein 7-O-glucoside). Genistein and rutin, two flavonoids, were found to be correlated with lower Anticarsia gemmates larval growth after several soybean varieties were characterized.

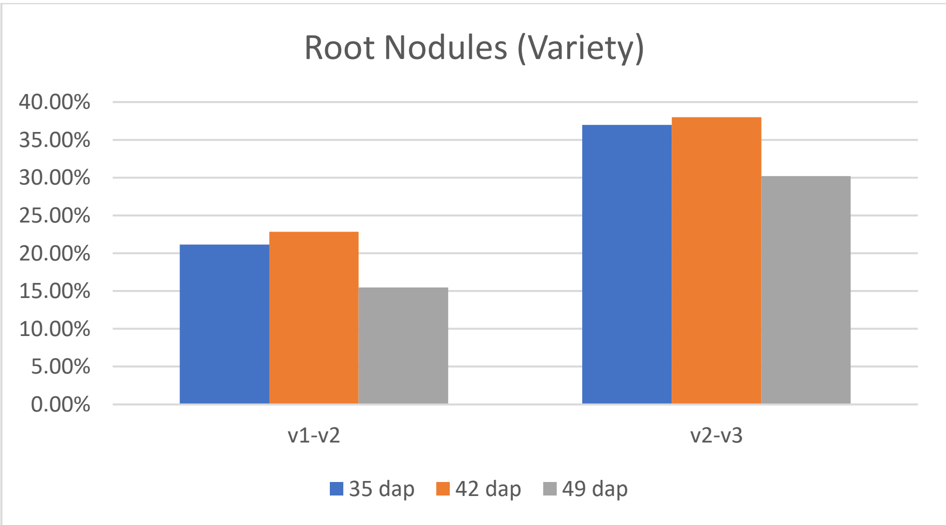
3.4 Number of Root Nodules

TABLE 4
THE RESULTS OF THE ANALYSIS OF THE VARIABLE NUMBER OF ROOT NODULES (GRAINS) OF THE THREE TYPES OF SOYBEAN VARIETIES WITH THE ADDITION OF GENISTEIN

Treatment	35 days after planting	42 days after planting	49 days after planting
variety			
V1	26,66c	29.91a	36.77c
V2	30,22b	33.60b	41.47b
V3	**36.61a**	**41.27a**	**47.88a**
genistein			
G0	29d	31.58d	40.70d
G1	30.81c	33.59c	41.44c
G2	31.63b	36.11b	42.40b
G3	**33.22a**	**38.18a**	**43.60a**

Information: V = soybean variety, V1 = Deja1, V2 = Dena1, V3 = Demas1, G = genistein concentration, G0 = 0ppm, G1 = 60ppm, G2 = 120ppm, G3 = 180ppm

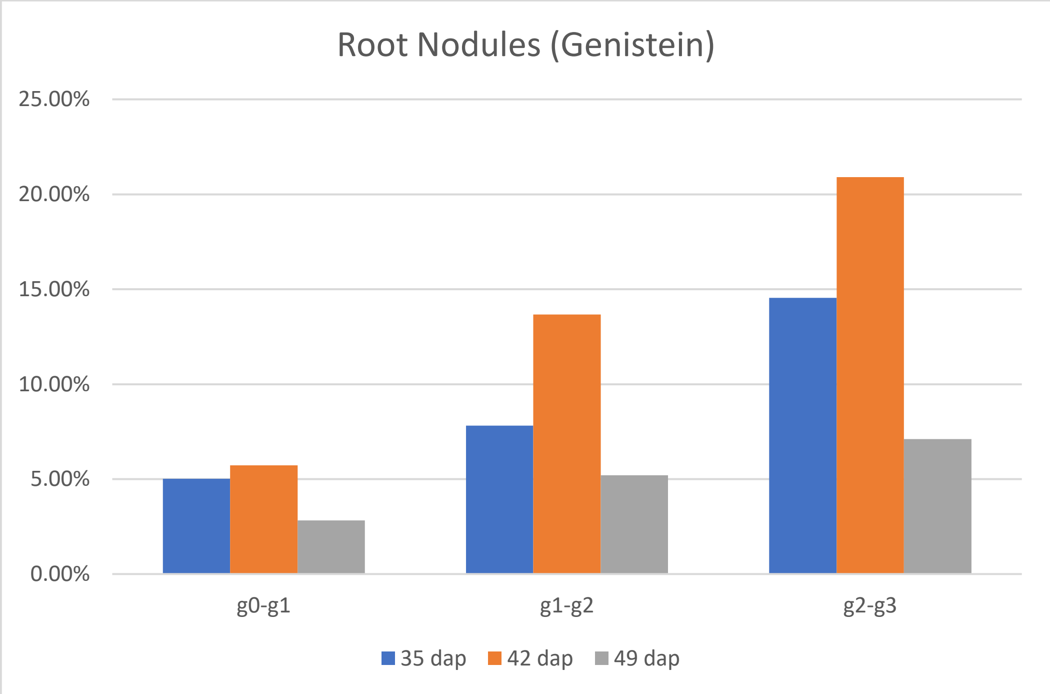
According to Table 4, V3 (Demas1) produced the most nodules at 35 days after planting, 42 days after planting, and 49 days after planting. At 35 DAP, the V3 (Demas1) treatment produced the most root nodules, 36.61 grains, 37% more than the V1 (Deja1) treatment and 21.14% more than the V2 treatment (Dena1). The V3 (Demas1) treatment produced the most root nodules at 42 DAP, with 41.27 grains, 37.98% more than the V1 (Deja1) and 22.82% more than the V2 treatment (Dena1). At 49 Days After Planting, the V3 (Demas1) treatment produced the most root nodules, or 47.88 grains, which is 30.21% more than the V1 (Deja1) treatment and 15.46% more than the V2 treatment (Dena1).



GRAPHIC 7. The percentage of root nodules (grains) increases in the various treatment

The Demas1 variety showed the most significant potential to form a symbiotic relationship with Rhizobium bacteria, as evidenced by an increase in the number of root nodules. According to numerous studies, the ability of plants to morphologically alter their root architecture, form root symbioses, activate high-affinity phosphate (Pi) transporters, increase internal phosphatase activity, and release organic acids and phosphatases into the rhizosphere are all factors that contribute to their ability to adapt to acid soil. (Vance et al. 2003; Gahoonia and Nielsen 2004). The efficient use of phosphorus is connected to the importance of the soybean root system in acidic soil. Uguru et al. (2012) evaluated soybean tolerance to acid soil. They concluded that root length, root weight, and the number of root nodules were adaption characteristics of soybean in the acid soil. Using all three of these characteristics, they successfully mapped the amount of genotype tolerance of soybean to low pH. The Demas1 variety produced the most root nodules, which led to a high N fixation rate.

The number of root nodules increased when genistein was administered, and the number of root nodules grew as genistein concentration increased. Most root nodules were formed by the G3 treatment (180 ppm) 35 days after planting, 42 days after planting, and 49 days after planting. The Days after planting G3 treatment at age 35 (180 ppm) produced the most root nodules, 33.22 grains, 14.55% more than G0 (0 ppm), 7.82% more than G1 (60 ppm), and 5.02% more than G2 (120ppm). The G3 treatment (180 ppm) aged 42 Days after planting produced the most root nodules, 3 8, 18 grains, 20.9% more than G0 (0 ppm), 13.67% more than G1 (60 ppm), and 5.73% more than G2 (70 ppm) (120ppm). The G3 treatment (180 ppm) aged 49 Days after planting, produced the most root nodules, 43.60 grains, 7.1% more than the G0 (0 ppm), 5.21% more than the G1 (60 ppm), and 2.8302% more than the G2 treatment (120ppm).



GRAPHIC 8. The percentage of root nodules (grains) in the genistein treatment

An increase in root nodules suggests that genistein concentration significantly promotes Bradyrhizobium japonicum's symbiotic relationship with soybean plants, particularly as an inducer of multiple bacterial nod gene systems (Dolatabadian et al., 2012; Lang et al., 2008). Flavonoid concentrations have been found to directly impact legume nodulation and N2 fixation. It has been demonstrated that giving genistein to soybean seeds with Bradyrhizobium inoculation increases the quantity and dry weight of nodules as well as soybean N fixation at low temperatures. (Zhang and Smith, 1996).

The control treatment (G0), which produced the fewest root nodules compared to the other treatments, was thought to be less successful at N2 fixation than the root nodules of soybean plants. Active root nodules determine the ability of soybean cultivars to fix N2. The greater the ability of soybeans to fix N2 will be achieved, the more active the root nodules are. 2019 (Purwaningsih et al.). When producing primary metabolites in soybean plant cells involves too much carbon, genistein, a flavonoid molecule, is created. (Collin and Edward, 1998). Sugiyama et al. (2008) suggest that soybean plants secrete signaling molecules in the form of flavonoids from root tissue that will attract rhizobia while living in symbiosis with Rhizobium bacteria. Genistein isoflavone acts as a signal molecule for chemical communication between Bradyrhizobium japonicum and soybeans. It is found as an exudate. The number of nodules that formed due to the application of genistein may have increased due to an increase in the number of infections that were started or the percentage of infections that progressed to nodule development. Genistein stimulates the production of bacterial Nod factor by the nod genes. (Loh et al. 2002). According to Vollmann et al., the size and number of chlorophyll leaves on soybean plants have a positive correlation with the root nodules, which in turn affects the rate of photosynthesis, the amount of nitrogen fixed, the number of pods per plant, the weight of 100 seeds, the protein content, and the oil content of the seeds.

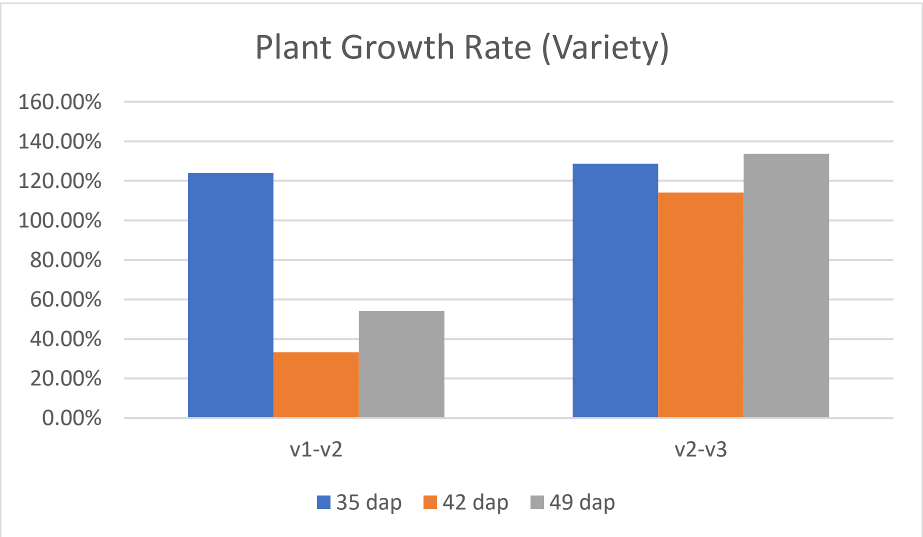
3.5 Plant Growth Rate

TABLE 5
PLANT GROWTH RATE VARIABLES (g/ m2/week) OF THREE TYPES OF SOYBEAN WITH THE ADDITION OF GENISTEIN

Treatment	35 days after planting	42 days after planting	49 days after planting
variety			
V1	0.098b	**0.359a**	**0.853a**
V2	**0.224a**	0.269a	0.553b
V3	0.1b	0.167b	0.365c
genistein			
G0	0.113	0.228	0.492
G1	0.144	0.277	0.564
G2	**0.156**	0.276	0.569
G3	0.15 0	**0.28 0**	**0.736**

Information: V = soybean variety, V1 = Deja1, V2 = Dena1, V3 = Demas1, G = genistein concentration, G0 = 0ppm, G1 = 60ppm, G2 = 120ppm, G3 = 180ppm

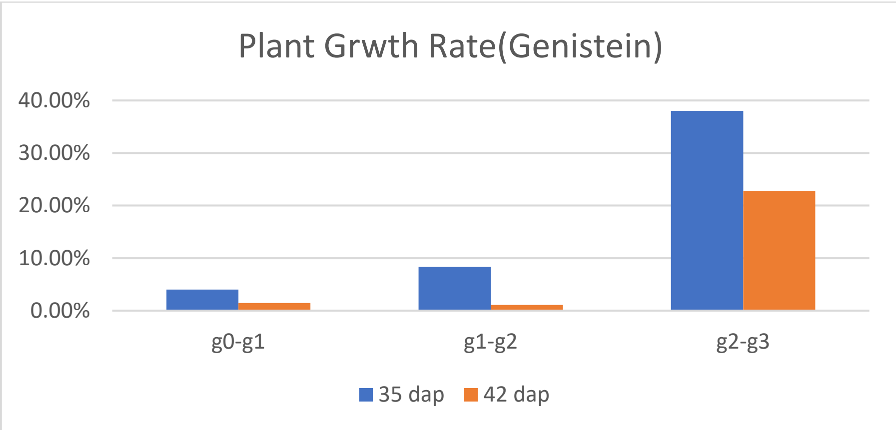
According to Table 5, the treatment of soybean varieties considerably impacted the growth rate of plants between the ages of 14 and 56 days after planting. The maximum Plant Growth Rate (LPT) was produced by Treatment V2 (Dena1), 0.22g/m2/week, 128.57% faster than Treatment V1 (Deja1) and 124% faster than Treatment V3 (Demas1). This indicates that Treatment V2 (Dena1) grew optimally in the vegetative to the generative growth transition period, which is assumed to be related to the concentration of genistein and the amount of chlorophyll. The genistein concentration of 0.17 8 mg/g dry leaves, capable of producing photosynthates for the best vegetative growth of soybean plants, exhibited the ability of the leaves to protect chlorophyll by absorbing UV-B rays. Early generative growth phase measurements of plant growth rate (LPT) revealed that treatment V1 (Dena1) produced the highest LPT, 0.359g/m2 / week, 33.36% quicker than treatment V1 (Deja1), and 114% greater than V3 (Demas1). Plant Growth Rate (LPT) results from the final generative growth phase showed that treatment V1 (Dena1) produced the highest LPT, 0.853g/m2 / week, 54.250% faster than treatment V2 (Deja1), and 133.699% faster than treatment V3 (Demas1). This suggests that treatment V1 (Dena1) had the best growth in the early and late generative growth phases, which is thought to be related to the leaf area of treatment V1 (Dena1) in that phase which reached 31.99 cm^2 and 33.26 cm^2. Soybeans have an indeterminate growth type, meaning plants keep growing even after entering the generative phase. The distribution of photosynthate by the soybean plant promotes the growth of its vegetative tissue and the filling of its pods. The accumulation of dry matter is a reflection of plants' ability to use sunlight energy for photosynthesis and their interactions with the surrounding environment. (Sumarsono, 2008).



GRAPHIC 9. The percentage of plant growth rate increases in the various treatment

The amount of genistein present substantially impacts the rate of plant growth. The LPT of soybean plants in the vegetative growth to generative growth transition phase revealed that the G2 treatment (120 ppm) produced the highest LPT, 0.156g/m2 / week, 38.05% faster than the G0 treatment (0 ppm), 8.33% faster than the G1 treatment (60 ppm), and 4.0% faster than the treatment G3 (180 ppm). This demonstrates that the administration of 120 ppm genistein can be effectively controlled to protect chlorophyll from harm caused by exposure to UV-B rays during the transitional period of vegetative to generative growth. According to Table 3, the G2 treatment (120 ppm) was able to leave a genistein residue in the leaves of 0.217 mg/g dry leaves. This residue protected the chlorophyll from UV-B exposure so that it reached 23.60 mg/L and was sufficient for processing agriculture to produce wide leaves of 24.92 cm 2 and the highest soybean LPT. Early generative growth of soybean plants revealed that treatment G3 (180 ppm) produced the highest LPT, namely 0.280g/m2/week, which was 22.81% greater than treatment G0 (0 ppm), 1.08% higher than G1 (80 ppm), and 1.45% higher than G2 (120ppm). The final generative development phase of the soybean plant growth rate demonstrated the G3 treatment (180 ppm). These findings suggest that plants need significant energy to add and fill pods during the early and late generative growth phases.

Consequently, a high genistein concentration is required to protect the leaf chlorophyll, prevent damage, and ensure optimal photosynthesis. At the early and late generative growth periods, the G3 treatment (180 ppm) generated 30,47 mg/L and 34,21 ml/L of chlorophyll, as well as 30,58 cm 2 and 32.2 cm 2 of leaf areas, respectively. This data generated the best LPT of soybean plants during the filling and pod-formation phases. According to Hamid et al. (2020), photosynthesis can improve photosynthesize. The distribution of photosynthate among the various sections of the soybean plant favours the leaves more than the other plant components. This demonstrates that the source (leaf) is still active and impacts the sink's capacity.



GRAPHIC 10: The percentage of plant growth rate in the genistein treatment

IV. CONCLUSION

The study aimed to investigate the agronomic characteristics of three soybean varieties with varying concentrations of genistein. The findings suggest that the variety Demas1 produced the most chlorophyll and root nodules, while Deja1 had the widest leaf area and fastest plant growth rate. The optimal genistein concentration was found to be 180 ppm, which resulted in leaves with a large area, high chlorophyll content, significant root nodules, and fast plant growth rate. The Demas1 variety produced the best agronomic characteristics with 180 ppm of genistein. The study highlights the importance of understanding the impact of genistein on soybean agronomics and the potential trade-offs between genistein content and desirable agronomic traits. Further research is needed to explore the relationship between genistein and soybean agronomics to improve soybean production and genistein content.

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