

The Effect of SP-36 and KCl Fertilizer on Peanut (*Arachis hypogaea* L.) Productivity of Katana 1 Variety

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Abstract

Background: Peanut (*Arachis hypogaea* L.) productivity remains relatively low, partly due to declining soil fertility and suboptimal fertilizer management. Although phosphorus and potassium are essential for plant growth and yield, appropriate SP-36 and KCl fertilizer rates for the Katana 1 variety remain insufficiently investigated. This study evaluated the individual and interactive effects of SP-36 and KCl fertilizer rates on peanut growth and yield to identify optimal application rates. **Methodology:** A field experiment was conducted in Gogorante Village, Ngasem District, Kediri Regency, using a factorial Randomized Block Design with three replications. Treatments comprised four SP-36 rates (0, 100, 200, and 300 kg ha⁻¹) and four KCl rates (0, 50, 100, and 150 kg ha⁻¹). Days to flowering, pod number, dry pod weight, and harvest index were evaluated using analysis of variance, followed by Tukey's Honestly Significant Difference test at the 5% significance level. **Findings:** No significant interaction between SP-36 and KCl was observed across the measured parameters. SP-36 significantly influenced flowering time, pod number, and dry pod weight, whereas KCl significantly affected dry pod weight and harvest index. SP-36 at 200 kg ha⁻¹ produced the best flowering and pod number responses, while 300 kg ha⁻¹ maximized dry pod weight. KCl at 150 kg ha⁻¹ produced the highest dry pod weight and harvest index. **Contribution:** These findings provide field-based evidence supporting improved phosphorus and potassium fertilizer management for Katana 1 peanut cultivation and offer practical guidance for optimizing fertilization strategies to enhance productivity under comparable growing conditions.

Keywords: KCl fertilizer; Peanut; Productivity; SP-36 fertilizer



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INTRODUCTION

Peanuts (*Arachis hypogaea* L.) are legumes with high economic and nutritional value as a source of protein and vegetable oil. This plant forms a symbiotic relationship with nitrogen-fixing bacteria in root nodules, thereby increasing nitrogen availability and soil fertility (Sendekie, 2023). These root nodules serve as sites for biological nitrogen (N_2) fixation, supporting plant nitrogen requirements. However, root nodule formation still requires initial stimulation by external nitrogen supply (Sirait & Siahaan, 2019). Despite its high yield potential, peanut productivity at the farmer level remains relatively low. Data from the East Java Provincial Statistics Agency (BPS) shows that peanut production declined from 188,421 tons in 2014 to 153,216 tons in 2017 (BPS, 2018). This decline has been attributed to the use of less productive cultivars, reduced cultivated area, declining soil fertility, and suboptimal land management. One promising cultivar is Katana-1, a superior peanut variety with resistance to bacterial wilt and moderate resistance to leaf spot disease. It has a yield potential of up to 4.8 t ha^{-1} , with protein and fat contents of 28.9% and 46.9%, respectively. These characteristics indicate its potential for high yield and seed quality, which can be optimized through appropriate crop management and fertilization practices (Rahayu et al., 2021). Furthermore, proper fertilization is essential for improving nutrient availability and sustaining crop productivity. Fertilization supplies essential nutrients for plant growth and yield while contributing to the maintenance of soil fertility (Furqoni & Sugiyanta, 2025). In addition to providing nutrients, fertilization can also improve the physical, chemical, and biological properties of the soil, which contribute to better growing conditions for plants (Kurniasari et al., 2023). The success of fertilization is determined not only by the type of fertilizer used, but also by the accuracy of the dosage, timing, and application method (Andini et al., 2022). Therefore, the use of appropriate fertilizers, both organic and inorganic, can help increase yields while maintaining long-term soil fertility (Purwanti, 2022).

Peanut growth and productivity can be improved through proper fertilization management, particularly by providing adequate phosphorus (P) and potassium (K) according to plant needs. One widely used source of phosphorus is SP-36 fertilizer, which contains 36% P_2O_5 and serves as a P supplier for plants (Astuti et al., 2022). Phosphorus is an essential macronutrient that plays a role in energy transfer, organic compound synthesis, and plant metabolism (Panunggul, 2022). Furthermore, phosphorus also plays a role in stimulating root growth in the early phase and supporting the formation of flowers, pods, and seeds, thereby increasing plant productivity (Dahlia & Setiono, 2020). Peanut plants themselves require relatively high amounts of phosphorus to support optimal growth and yield (Hayati et al., 2019). Application of SP-36 fertilizer has been shown to significantly impact growth in both the vegetative and generative phases of peanut plants (Apriliani, 2023). The combined application of SP-36 at 100 kg ha^{-1} and KCl at 100 kg ha^{-1} enhanced soybean growth and yield, as indicated by increases in leaf area, leaf number, pod number, seed weight, and harvest index compared with the unfertilized treatment. These findings suggest that the combined supply of phosphorus and potassium can contribute to improved crop productivity. However, plant responses to fertilizer rates and combinations may vary depending on crop species and cultivar (Margenda et al., 2020).

Besides phosphorus, potassium is also an essential nutrient for plant growth and yield. Potassium is a macronutrient required in relatively large quantities by peanut plants, with a high absorption rate after nitrogen (N) (Sari et al., 2024). KCl fertilizer is a commonly used source of potassium, containing approximately 60% K₂O and approximately 40% chloride, which provides K for plants (Kamratih & Ritawati, 2020). Potassium plays a role in photosynthesis, enzyme activation, translocation of photosynthetic products, and regulation of stomata opening and closing, which is related to water use efficiency (Almeida et al., 2015). In peanuts, potassium plays a role in pod formation, seed filling, and improving crop quality (Devianti et al., 2022). Furthermore, potassium also helps accelerate ripening and increase yield components such as seed weight and pod length (Berutu & Kunci, 2025).

The balanced application of SP-36 and KCl fertilizers is thought to increase nutrient absorption efficiency and support the vegetative and generative growth of peanut plants. Therefore, this study aims to determine the effect of SP-36 and KCl fertilizers on the growth and yield of peanut plants and to determine fertilization rate that provides the best response. This study is based on the assumption that the application of SP-36 and KCl fertilizers can affect the productivity of peanut plants (*Arachis hypogaea* L.).

METHOD

This research was conducted in the rice fields of Gogorante Village, Ngasem District, Kediri Regency 7°49'01,44" S, 112°03'22,65" E in December 2025 to March 2026. The experimental site was located at an elevation of 30 - 60 m above sea level (a.s.l.) and was characterized by grayish-brown Regosol soil. The air temperature ranged from 23 - 31 °C, with an average annual rainfall of 1,652 mm per year . The equipment used in this experiment included hoes, hand trowels, planting sticks, buckets, sprayers, ropes, wooden stakes, measuring tapes, digital scales, stationery, and cameras. The materials used in this study included Katana-1 peanut seeds obtained from the Indonesian Legumes and Tuber Crops Research Institute (BALITKABI) Malang, SP-36 fertilizer, KCl fertilizer, herbicides, insecticides, fungicides, wooden stakes, and labels. This research was arranged using the Randomized Block Design method with a factorial pattern because the research environment was not homogeneous. The first factor studied was the SP 36 treatment which consisted of 4 levels (S): S0 (0 Kg/ha), S1 (100 kg/ha), S2 (200 Kg/ha), S3 (300 kg/ha). The second factor was the KCl fertilizer dosage, which consisted of four levels (K): K0 (0 kg/ha), K1 (50 kg/ha), K2 (100 kg/ha), and K3 (150 kg/ha). The total treatment consisted of 48 treatment combinations with three replications. Each treatment level consisted of 12 plants, with four plant samples.

Data Collection

The observed parameters included flowering time (days after planting, DAP), number of pods (pods), dry pod weight per plant (g), and harvest index. Flowering time was determined by recording the time when the first flower opened on each

sampled plant, calculated from the planting date. The number of pods was determined after harvesting by counting all pods formed on each sampled plant. Dry pod weight per plant was determined by weighing all harvested pods after drying to a moisture content of approximately 10% using a digital balance. The harvest index was calculated as the ratio of dry seed weight to total dry biomass weight using the following formula refers to [Ambarsari & Henly \(2018\)](#):

$$\text{Harvest index} = \frac{\text{Seed Weight per plant}}{\text{Tatal Plant Biomass}}$$

Land Preparation

Land preparation involves clearing the planting area of weeds and crop residues, followed by soil cultivation. The beds are 0.8 m wide, with a spacing of 0.4 m between each bed, and a height of approximately 0.1 - 0.2 m to promote soil drainage and aeration.

Planting

Planting is done by digging planting holes with a spacing of 40 x 15 cm. Each hole is filled with one peanut seed, then evenly covered with soil. Katana-1 is an early-maturing peanut cultivar, with an average maturity period of approximately 88 days after planting (DAP).

SP-36 and KCl Fertilizer Application

SP-36 and KCl fertilizer are applied in two stages. The first stage is applied at planting with a dose of 50% SP-36, while the remaining 50% is applied 25 days after planting, or when the plants begin to flower. KCl fertilizer is applied according to the prescribed treatment using the same ratio.

Maintenance

Plant maintenance includes watering, hilling, and pest and disease control. Watering is done as needed to maintain soil moisture. Hilling was conducted twice, at approximately 21 and 40 days after planting (DAP), to strengthen the root system and support peg penetration and pod formation. Pest and disease control is carried out mechanically and chemically if the attack exceeds the economic threshold.

Drying Process

The pods were dried for five days or until the moisture content reached approximately 10%, as indicated by hard, dense seeds, easily peeled pod shells, bright yellow seed color, and the absence of a musty odor.

Data Analysis

The research data were statistically analyzed using Analysis of Variance (ANOVA) refers to [Ambarsari & Henly \(2018\)](#) as follows:

$$Y_{ijk} = \mu + \rho k + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$$

Description:

i = 1,2,3,4 (number of SP 36 fertilizer treatments)

j = 1,2,3,4 (number of KCl fertilizer treatments)

Y_{ijk} = Observation results for the i-th SP36 fertilizer treatment unit and the j-th KCl fertilizer treatment group

μ = General mean

ρ_k = The effect of the k-th block

α_i = Effect of SP36 fertilizer treatment at the i-th level

β_j = Effect of KCl fertilizer treatment at the j-th level

(αβ) = Interaction effect of SP36 fertilizer at the i-th level and KCl fertilizer at the j-th level

e_{ij} = Random effect of the i-th treatment and the j-th group

The ANOVA analysis data will be followed up with an Honestly Significant Difference (HSD) test at the 5% level with the following equation refers to [Lestari et al., \(2023\)](#):

1.) The Tukey HSD equation for interacting treatments is as follows:

$$\text{Tukey HSD } 5\% = q_{0,05} (p; \text{error df}) \times \sqrt{\frac{\text{Mean Square Error}}{r}}$$

2.) The Tukey HSD equation for each treatment factor is as follows:

$$\text{Tukey HSD } 5\% = q_{0,05} (p; \text{error df}) \times \sqrt{\frac{\text{Mean Square Error}}{r \times \text{Treatment level}}}$$

Description :

Tukey HSD 5% = Honestly Significant Difference (HSD) at the 5% significance level

q_{0,05} = Studentized Range value at the 5% significance level

p = Number of treatments being compared

error df = Error degrees of freedom

Mean Square Error = Error mean square

r = Number of replications

RESULT AND DISCUSSION

Days to Flowering

The analysis of variance showed that the combination of SP36 and KCl fertilizer doses did not significantly affect the days to flowering. The single factor, SP36 fertilizer dose, significantly affected the flowering age parameter. The average flowering age for the SP36 and KCl fertilizer doses is presented in Table 1.

Based on Table 1, The application of KCL single fertilizer showed no significant results. Meanwhile the application of SP-36 fertilizer significantly affected the flowering time of peanut plants. This is indicated by the different letters in each treatment. The SP-36 dose of 200 kg/ha resulted in the fastest flowering time, with an average of 26.29 days after planting (DAP), which was not significantly different from the 300 kg/ha dose with an average of 26.48 days after planting, but significantly different from the 0 kg/ha and 100 kg/ha treatments. Meanwhile, the slowest flowering time was found in the treatment without SP-36, with an average of 27.40 days after planting. This is consistent with the statement [Susanti et al., \(2022\)](#) that the application of phosphorus (P) has a significant influence on plant growth and development, particularly in supporting root system development, root nodule

formation, and stimulating the flowering process. According to [Gusmiatun et al., \(2019\)](#), physical results indicate that applying phosphate fertilizer three times a day tends to accelerate flower emergence, increase pod density, and accelerate the ripening process of peanut fruit. This suggests that phosphorus plays a crucial role in supporting flower formation and pod development in peanut plants.

Table 1. Average Flowering Age (DAF) of Peanut Plants in the SP36 and KCl Fertilizer Doses

Dose SP36 (kg/ha)	Days to Flowering
0 kg/ha	27.40 b
100 kg/ha	26.85 ab
200 kg/ha	26.29 a
300 kg/ha	26.48 a
HSD 5%	0.71
Dose KCL (kg/ha)	Days to Flowering
0 kg/ha	26.83 a
50 kg/ha	26.67 a
100 kg/ha	26.75 a
150 kg/ha	26.77 a
HSD 5%	ns

Description = The average value followed by the same letter in each treatment was not significantly different in the 5% Tukey HSD test. ns: not significantly different

Number of Peanut Pods

Analysis of variance showed that the combination of SP-36 and KCl fertilizer doses did not significantly affect pod number in peanut plants. However, the single-factor treatments of SP-36 and KCl fertilizer doses each significantly affected pod number. The average pod number for the SP-36 and KCl fertilizer doses is presented in Table 2.

Based on Table 2, SP-36 fertilizer application significantly affected the number of peanut pods. This is indicated by the difference in letter notation in the 5% Tukey HSD test results. The SP-36 dose of 200 kg/ha produced the highest number of pods, with an average of 34.73 pods. This was not significantly different from the 300 kg/ha dose of 34.34 pods, but significantly different from the 0 kg/ha and 100 kg/ha treatments. Meanwhile, the lowest number of pods was obtained in the treatment without SP-36 application, with an average of 31.53 pods. This indicates that sufficient phosphorus availability supports optimal pod formation. According to [Putra & Maizar \(2023\)](#), the phosphorus (P) contained in phosphate fertilizer plays an important role in supporting plant growth and development, particularly in root formation, increasing pod number, and helping accelerate pod ripening. Phosphorus (P) plays a crucial role in the formation of pods and seeds in peanut plants, accelerating seed ripening and supporting root system development ([Susilo et al., 2019](#)). Phosphorus deficiency generally occurs in the early stages of growth because young roots are limited in their ability to absorb this element, while its availability in the soil is relatively low. Furthermore, phosphorus is an essential component of various sugar-phosphate

compounds that play a role in the formation of nucleotides such as RNA and DNA (Rizki et al., 2017). This element is also involved in energy metabolism through the formation of ATP and ADP, thus influencing the ripening process and seed formation.

Table 2. Average Number of Pods (pods) of Peanut Plants in the SP36 and KCl Fertilizer Doses

Dose SP36 (kg/ha)	Number of pods
0 kg/ha	31.53 a
100 kg/ha	32.58 ab
200 kg/ha	34.73 b
300 kg/ha	34.34 b
HSD 5%	2.62
Dose KCL (kg/ha)	Number of pods
0 kg/ha	33.08 a
50 kg/ha	32.81 a
100 kg/ha	33.62 a
150 kg/ha	33.67 a
HSD 5%	ns

Description = The average values followed by the same letter for each treatment were not significantly different in the 5% Tukey HSD test.

Pod Dry Weight

The analysis of variance showed that the combination of SP36 and KCl fertilizer doses did not significantly interact with dry pod weight. The single factor, SP36 fertilizer dose, significantly affected pod dry weight per plant, while KCl fertilizer dose significantly affected pod dry weight per plant. The average pod dry weight per plant for the SP36 and KCl fertilizer doses is presented in Table 3.

Table 3. Dry Pod Weight of Peanut Plants for the SP36 and KCl Fertilizer Doses

Dose SP36 (kg/ha)	Dry Weight of Peanut Pods (g)
0 kg/ha	33.43 a
100 kg/ha	34.33 ab
200 kg/ha	36.83 bc
300 kg/ha	37.16 c
HSD 5%	2.69
Dose KCL (kg/ha)	Dry Weight of Peanut Pods (g)
0 kg/ha	34.66 ab
50 kg/ha	34.43 a
100 kg/ha	35.46 ab
150 kg/ha	37.20 b
HSD 5%	2.69

Description = The average values followed by the same letter for each treatment were not significantly different in the 5% Tukey HSD test, ns: not significantly different.

Based on Table 3, the results of the analysis of variance indicate that the single factor of SP-36 fertilizer application had a very significant effect on the dry weight of peanut pods. The results of the 5% Tukey HSD further test showed differences between treatments, as indicated by differences in the average values at each treatment dose. In the SP-36 fertilizer treatment, the highest dry weight of pods was obtained at a dose of 300 kg/ha, namely 37.16 g, which was significantly different from the 0 kg/ha treatment with a value of 33.43 g and the 100 kg/ha treatment with a value of 34.33 g. The 200 kg/ha treatment with a dose of 36.83 g did not show a significant difference.

The 5% Tukey HSD value of 2.69 indicates that the average difference between treatments exceeding this value is considered highly significant. According to [Bestari et al., \(2018\)](#), phosphorus (P) plays a crucial role in supporting growth and seed formation in peanut plants. Phosphorus deficiency can inhibit plant growth, resulting in stunted growth, smaller, pale green leaves, fewer pods, and low peanut yields. According to [Fatmawati et al., \(2025\)](#), SP-36 fertilizer application to peanut plants significantly affected pod number, pod weight, and seed weight per plant, but had no significant effect on plant height, leaf number, flowering age, or the number of filled and empty pods. The analysis of variance for single-factor KCl fertilizer doses showed significantly different results. The highest pod dry weight was obtained at a dose of 150 kg/ha, at 37.20 g, significantly different from the 50 kg/ha KCl dose of 34.43 g.

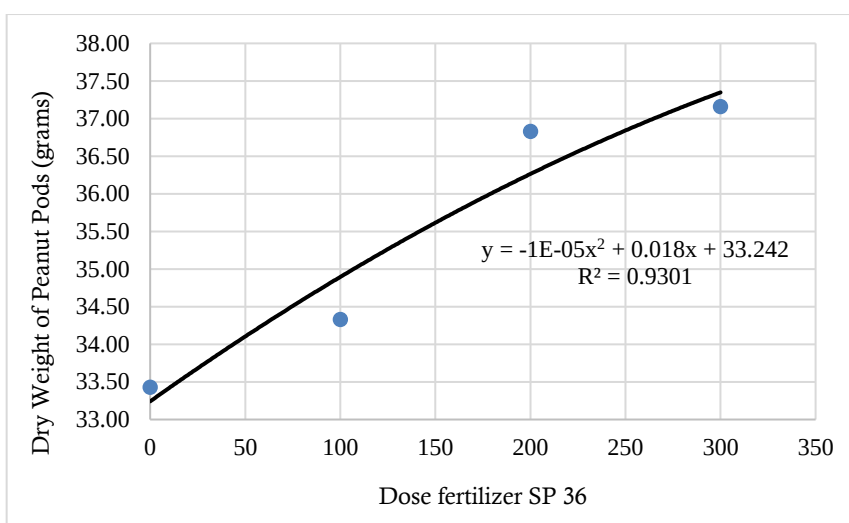


Figure 1. Polynomial Regression Graph of SP-36 Fertilizer Dosage against Peanut Pod Dry Weight

However, there was no significant difference between the 0 kg/ha treatment and the 100 kg/ha treatment, which produced a pod dry weight of 34.66 g and the 35.46 g of 100 kg/ha. This indicates that providing sufficient potassium can increase the accumulation of dry matter in plants. According to [Sitepu et al., \(2014\)](#), the application of KCl fertilizer to peanut plants is known to increase the number of pods by up to 48% and increase the percentage of seed weight by around 2%. However, the use of fertilizer dosage needs to be carefully considered because the application of fertilizer that exceeds the plant's needs is not only economically inefficient but can also disrupt the balance and availability of other nutrients in the soil. In addition, according

to Nabillah et al., (2025) it shows that the single factor of KCl dosage has a significant effect on the dry weight of pods per plant, dry weight of seeds per plant, and dry weight of seeds per plot.

The results of the polynomial regression analysis in Figure 1 show that SP-36 fertilizer application and the average Peanut Pod Dry Weigh form a quadratic relationship. The results of the polynomial regression analysis in Figure 1 show a quadratic relationship between SP-36 fertilizer application and the average dry weight of peanut pods. In the treatment without SP-36 fertilizer (0 kg/ha), the average dry pod weight produced was 33.43 g. Increasing the fertilizer dosage to 200 kg/ha raised the dry pod weight to 36.83 g, reaching a peak of 37.16 g at a dosage of 300 kg/ha. This is in accordance with Elviani et al., (2022) statement that phosphate fertilizer with various doses has a very significant effect on the number of full pods per clump, dry pod weight per net plot, and dry seed weight per net plot in peanuts. The regression equation obtained was ($y = -0.000014x^2 + 0.017965x + 33.240972$), with an (R^2) value of 0.9294. This value indicates that the regression model explained 92.94% of the variation in dry pod weight per plant, while the remaining variation may have been influenced by other factors outside the research model. Furthermore, dry pod weight continued to increase up to the highest SP-36 application rate tested (300 kg ha⁻¹), suggesting that the optimum SP-36 fertilizer rate had not yet been reached within the treatment range evaluated in this study.

Harvest Index

The analysis of variance indicated that the interaction between SP-36 and KCl fertilizer doses had no significant effect on the harvest index of peanut plants. The SP-36 fertilizer dose also had no significant effect on the harvest index, whereas the KCl fertilizer dose significantly affected this parameter. The mean harvest index of peanut plants under different SP-36 and KCl fertilizer treatments is presented in Table 4.

Table 4. Harvest Index of Peanut Plants in the SP36 and KCl Fertilizer Doses Treatments

Dose SP36 (kg/ha)	Harvest Index
0 kg/ha	0.449 a
100 kg/ha	0.456 a
200 kg/ha	0.467 a
300 kg/ha	0.463 a
HSD 5%	ns
Dose KCL (kg/ha)	Harvest Index
0 kg/ha	0.444 a
50 kg/ha	0.454 ab
100 kg/ha	0.463 ab
150 kg/ha	0.474 b
HSD 5%	0.03

Description = The average values followed by the same letter for each treatment were not significantly different in the 5% BNJ test, , ns: not significantly different

The results of the analysis of variance showed that the combination of SP-36 and KCl fertilizer doses did not significantly interact with the peanut harvest index parameter (Table 4). This indicates that plant response to variations in phosphate fertilizer doses is not influenced by potassium fertilizer doses, and vice versa (Juliawati et al., 2024). The single factor of SP-36 fertilizer dose also had no significant effect on the harvest index, as indicated by the results of the 5% BNJ test, where all treatments had the same notation (ns). The average harvest index value for the SP-36 treatment was 0.449, 100 kg/ha 0.456, 200 kg/ha 0.467, and 300 kg/ha 0.463. Meanwhile, the single factor of KCl fertilizer dose had a significantly different effect on the peanut harvest index.

Based on the 5% Tukey HSD test, the 150 kg/ha KCl treatment produced the highest average value of 0.474 and was significantly different from the 0 kg/ha treatment which produced a value of 0.444. The 50 kg/ha KCl dose treatment of 0.454 and 100 kg/ha of 0.463 showed results that were not significantly different from the other treatments. The 5% Tukey HSD value in the KCl treatment was 0.03. This is in accordance with the potassium fertilizer dose of 150 kg KCl ha⁻¹ is considered sufficient to increase the yield of long beans optimally (Sumemi & Guritno, 2023). This is also in accordance with the statement that the application of potassium fertilizer has been proven to significantly increase peanut plant production. This is due to the role of potassium in increasing the process of protein and carbohydrate formation, which are the main components of peanut pods and seeds (Samosir & Pakpahan, 2019).

CONCLUSION

Based on the results, there was no interaction between SP-36 and KCl fertilizer applications on days to flowering, number of pods, dry pod weight, and harvest index of Katana 1 peanut plants. SP-36 at 200 kg ha⁻¹ was the most effective dose for accelerating flowering by 4.05% and increasing pod number by 10.15%, while KCl at 150 kg ha⁻¹ increased dry pod weight by 7.33% and harvest index by 6.76% compared with the respective controls. Therefore, SP-36 at 200 kg ha⁻¹ and KCl at 150 kg ha⁻¹ can be considered effective fertilizer rates for supporting Katana 1 peanut production. Further research is recommended using different SP-36 and KCl rates or combining them with other fertilizers to obtain more effective fertilization strategies for increasing the growth and yield of Katana 1 peanut.

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