



Correlation of Growth Components and Yield of Jack Bean (*Canavalia ensiformis*) and Velvet Bean (*Mucuna pruriens*) Treated with NPK Fertilizer

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Abstract

Background. The correlation between growth traits and yield is essential information in a plant breeding program. Jack bean and velvet bean are two legume species that have the potential to be a source of vegetable protein to replace soybeans.

Aims. This study seeks to ascertain the relationship between growth component qualities and yield in jack and velvet beans subjected to varying amounts of NPK fertilizer.

Methods. The research was conducted at Nanggela Village, Mandirancan District, Kuningan Regency, from June to November 2024. The administered treatments included of NPK fertilizer applications (150, 225, 300, 375, and 450 kg/ha) in conjunction with bean species (jack bean and velvet bean). The observed growth components included plant height, leaf count, stem diameter, root volume, root length, nodule count per plant, leaf area index, and relative growth rate. The observed yield components included the number of pods per plant, pod weight per plant, 100-seed weight, seed weight per plant, and seed weight per plot. The data were examined utilizing the Pearson Correlation Test to ascertain the strength of the association between growth components and yield, as well as yield components.

Result. The research findings indicate a correlation among both species' stem diameter, root volume, leaf area index, pod weight, seed weight, seed count, and 100-seed weight.

Conclusion. The yield components, including the number of pods per plot, the number of pods per plant, the weight of pods per plot, and the weight of pods per plant, are significantly correlated with the weight of 100 seeds and the weight of seeds per plot in the velvet bean.

Implementation. The character of stem diameter and leaf area index can be used to select high-yielding koro plants. Indirect selection in jack bean can also be done through plant height and leaf number characteristics. In velvet beans, indirect selection can be carried out through yield component traits.

Keywords: Correlation, jack bean, NPK fertilizer, velvet bean

INTRODUCTION

Legumes serve as a source of plant-derived protein that can replace animal protein (Purwandari et al., 2023). Legumes can enhance dietary diversity and bolster food security to alleviate food vulnerability (Rini, 2018). Jack bean (*Canavalia ensiformis*) and velvet bean (*Mucuna pruriens*) are leguminous species within the Fabaceae family that offer vital plant protein alternatives to soybeans. Regrettably, the average yield of these two species remains inferior to that of soybeans and mung beans.

Jack beans and velvet beans are rarer than soybeans. This is partly attributable to their inadequate yield. Therefore, attempts are necessary to improve the output of koro beans via plant breeding. The preliminary phase of a plant breeding effort involves assessing traits that correspond with yield. The objective is to enable yield selection during the vegetative period. Plant breeders generally utilize these qualities to enhance plant attributes. Moosavi et al. (2017). Mulualem, (2012) It demonstrated a substantial link between the growth components and the yield components.

This study seeks to ascertain the relationships between growth components and yield components of jack bean and velvet bean plants to find the traits that contribute to high-yield production based on correlation values.

LITERATURE REVIEW

Abdulhamed et al. (2021) state that plant breeders employ correlation analysis and route analysis to establish selection criteria, hence promoting the efficient improvement of crop yield. Correlation analysis assesses the degree of association between two variables. The correlation coefficient quantifies the degree of proximity in the relationship. Gogtay and Thatte, 2017 The correlation coefficient varies between -1 and 1. A score of -1 signifies a perfect negative correlation, while a number of 1 represents a perfect positive correlation. A value of 0 signifies the absence of correlation between the two variables. Papageorgiou, 2022.

The attributes of pod length, pod diameter, seed weight per pod, number of pods per plant, and pod weight per plant have a substantial link with the yield of long beans (Togatorop et al., 2021). The leaf length characteristic has a notable association solely with panicle length, excluding yield. No significant link exists between plant height and yield in rice crops. Panicle length and harvest index exhibit substantial connections with rice

(Moosavi et al., 2017). Crop output is influenced by the expansion of the generative phase and the maturity of the seeds (Sarijan et al., 2020). Setyono et al. (2023) report that the growth components exhibit substantial connections with seed weight in peanut plants (*Arachis hypogaea* L.). Excessive vegetative growth may result in competition between vegetative and reproductive structures.

The utilization of nitrogen, phosphorus, and potassium fertilizers substantially affects shallot's growth phase and output (*Allium ascalonicum*). The research showed that the administration of nitrogen, phosphate, and potassium fertilizers enhances stem thickness, the number of productive branches, plant height, the number of leaves, leaf area index (LAI), and overall crop yield. (Efendi *et al.*, 2017). According Hendri *et al.*, (2015), nitrogen (N) nutrients are essential for plants as they contribute to chlorophyll synthesis and promote vegetative growth, encompassing the development of stems, branches, and leaves. The phosphorus (P) components in NPK fertilizer are essential for preserving energy and transferring it to the plant's metabolic processes. Moreover, phosphorus stimulates plants' generative growth, increasing the production rate. Potassium (K) is a vital element acting as a plant stomatal opener. This job significantly enhances root development and the plant's stem, rendering it more resilient. Moreover, potassium could improve the plant's capacity for absorbing other essential minerals (Nora Katrin *et al.*, 2021).

METHOD

The research was carried out at Nanggela Village, Mandirancan District, Kuningan Regency, at an altitude of approximately 260 meters above sea level, with temperatures ranging from 26°C to 31°C and an average relative humidity of 70%. The research study was conducted from June to November 2024. The implements utilized included hoes, measuring tapes, stakes, calipers, and writing equipment. Jack bean seeds, velvet bean seeds, and NPK Mutiara fertilizer were utilized. The research methodology employed is experimental, utilizing a randomized complete block design (RCBD). The treatments evaluated consisted of a combination of bean species (jack bean and velvet bean) with varying NPK fertilizer applications (150, 225, 300, 375, and 450 kg/ha). Each treatment was conducted thrice, resulting in a cumulative total of 30 research units.

The plot is 200 cm by 300 cm, with a planting spacing of 50 cm by 50 cm. Koro seeds are inserted into the planting holes at a rate of two seeds per hole. Fertilization occurs only

once, 14 days after planting (DAP), with a dosage according to the treatment. The beans are harvested at 120 to 150 DAP, characterized by a change of the pods' color to straw yellow or yellowish-brown hues.

The measured growth parameters encompass plant height, leaf count, leaf area, stem diameter, root length, root nodule quantity, and root volume. The yield components were assessed according to pod weight per plot, pod weight per plant, seeds per pod, seed weight per plot, seed weight per plant, weight of 100 seeds, pods per plant, and pods per plot.

Correlation analysis was conducted on growth and yield components with the Duncan Correlation Test at the 5% significance level. The relationship's strength is derived from Table 1.

Table 1 Parameters For Relational Connection

Coefficient Interval	Connection
0,00 – 0,199	Very Weak
0,20 – 0,399	Weak
0,40 – 0,599	Currently
0,60 – 0,799	Strong
0,80 – 1,000	Very Strong

Source: (Jabnabillah & Margina, 2022)

DISCUSSION

Correlation on Jack Bean (*Canavalia ensiformis*)

Figure 1 displays the findings of the correlation analysis for determinate jack bean plants. Plant height, leaf count, stem diameter, root volume, and leaf area index exhibit significant positive correlations with pod weight per plot ($r = 0.72$, $r = 0.74$, $r = 0.87$, $r = 0.78$, $r = 0.58$), seed weight ($r = 0.71$, $r = 0.73$, $r = 0.86$, $r = 0.78$, $r = 0.57$), and number of pods per plot ($r = 0.73$, $r = 0.75$, $r = 0.88$, $r = 0.79$, $r = 0.59$). This study's results demonstrate a substantial correlation between growth components and jack bean yields. This aligns with Bachtiar et al. (2021) on *Vigna subterranea*, which demonstrated a significant correlation between canopy width and yields. The study conducted by Burhan and Al-Hassan (2019) The rise in yield is markedly and positively connected with vegetative development. The augmented root capacity enhances nutrient absorption, whereas the increasing stem diameter accelerates the nutrient transport process during fruit growth.

The number of pods and pod weight are factors of jack bean production that exhibit a substantial correlation with the yield of 100 seed weight and seed weight per plot. This

suggests that an increase in the quantity and weight of pods correlates with a more substantial rise in the weight of 100 seeds and the weight of cowpea seeds. This aligns with the findings of Hadapad et al. (2018), which indicate that pod weight, leaf area index, and leaf count influence yield enhancement in velvet beans. Cargnelutti Filho et al. (2016) indicated that leaf quantity, as a growth component, is substantially linked with yield in jack beans (*Canavalia ensiformis*).

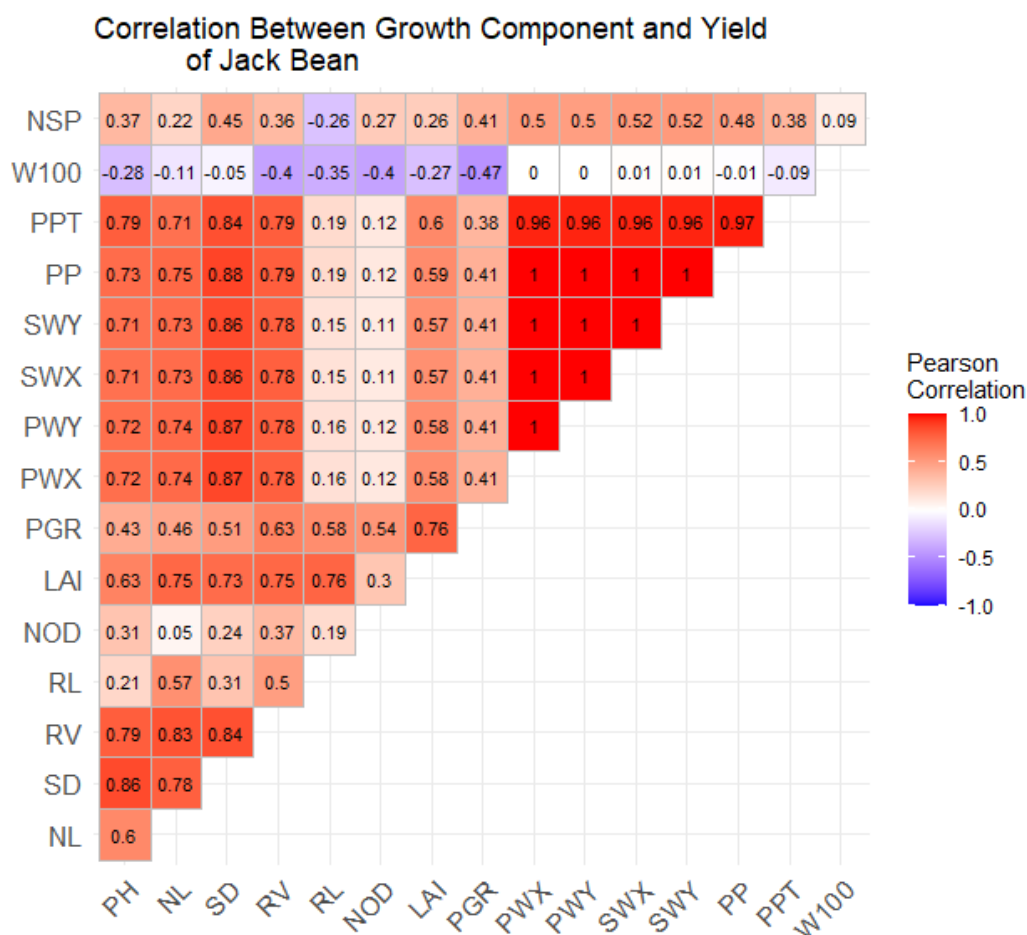


Figure 1. Correlation Between Growth and Yield of Jack Bean

PH = plant height, NL = number of leaves, SD = stem diameter, RV = root volume, RL = root length, NOD = number of nodules, LAI = leaf area index, LPT = plant growth rate, PWX = pod weight per plot, PWY = pod weight per plant, SWX = seed weight per plot, SWY = seed weight per plant, PP = number of pod per plot, PPT = number of pod per plant, W100 = weight of 100 seeds, NSP = number of seed per pod.

Correlation on Velvet Bean (*Mucuna pruriens*)

The correlation study results between growth components and velvet bean yields are illustrated in Figure 2. Unlike the findings from the investigation of jack beans, there was no substantial association between growth components and yield in velvet beans. There is no significant link between the number of leaves, stem diameter, root volume, root length, and leaf area index with yield metrics, including the number of pods per plot, number of pods per plant, pod weight per plot, pod weight per plant, 100-seed weight, and seed weight per plot. Plant height and the quantity of root nodules demonstrate a substantial negative connection with the weight of 100 seeds ($r = -0.58$ and $r = -0.58$, respectively). Furthermore, a significant positive association existed between the quantity of pods per plot, the weight of pods per plot, and the weight of seeds per plot ($r = 1$). This outcome signifies that a rise in the number of pods on the plant is associated with increased seed weight per plot. This aligns with Chinapolaiah et al. (2019). The yield components substantially influence yield, and a strong link exists between yield components and yield.

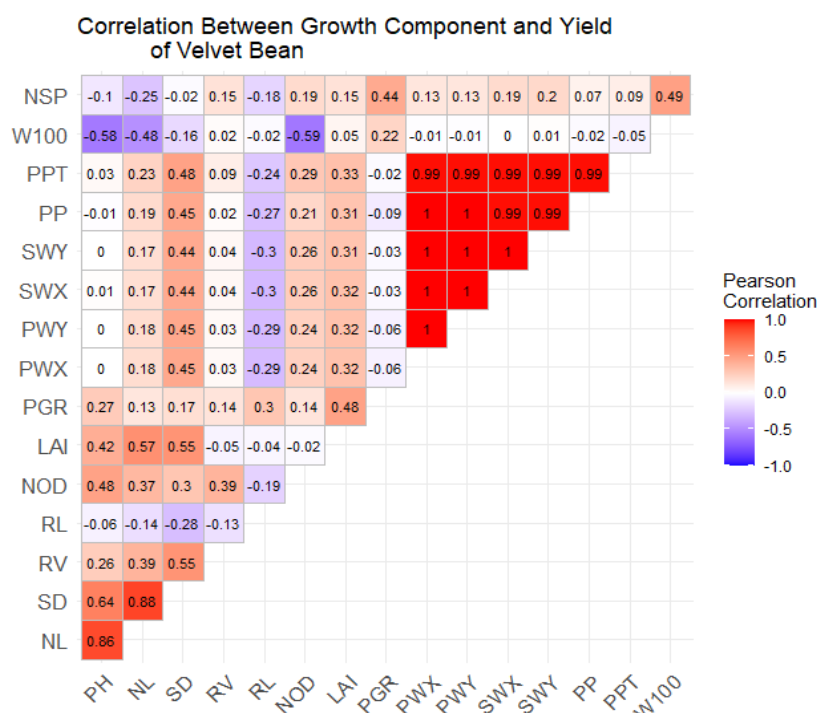


Figure 2. Correlation Between Growth and Yield of Velvet Bean

PH = plant height, NL = number of leaves, SD = stem diameter, RV = root volume, RL = root length, NOD = number of nodules, LAI = leaf area index, PGR = plant growth rate, PWX = pod weight per plot, PWY = pod weight per plant, SWX = seed weight per plot, SWY = seed weight per plant, PP = number of pod per plot, PPT = number of pod per plant, W100 = weight of 100 seeds, NSP = number of seed per pod.

The number of pods is not correlated with the weight of 100 seeds ($r = 0.49$). This is contrary to the research. (Khan *et al.*, 2018) Which states that in indeterminate plants, the number of pods positively correlates with the weight of 100 seeds.

Correlation in Two Species of Koro Beans

The results of the correlation analysis on two species of koro beans are presented in Figure 3. Stem diameter, root volume, and leaf area index correlate significantly positively with the pod weight per plot component ($r = 0.88$, $r = 0.86$, and $r = 0.7$, respectively). This indicates that the wider the leaves of the cowpea, the higher the yield of pod weight, seed weight, and the number of pods. This is in line with Setyono *et al.*, (2023) The wider the canopy, the higher the weight of fresh pods and the number of pods produced.

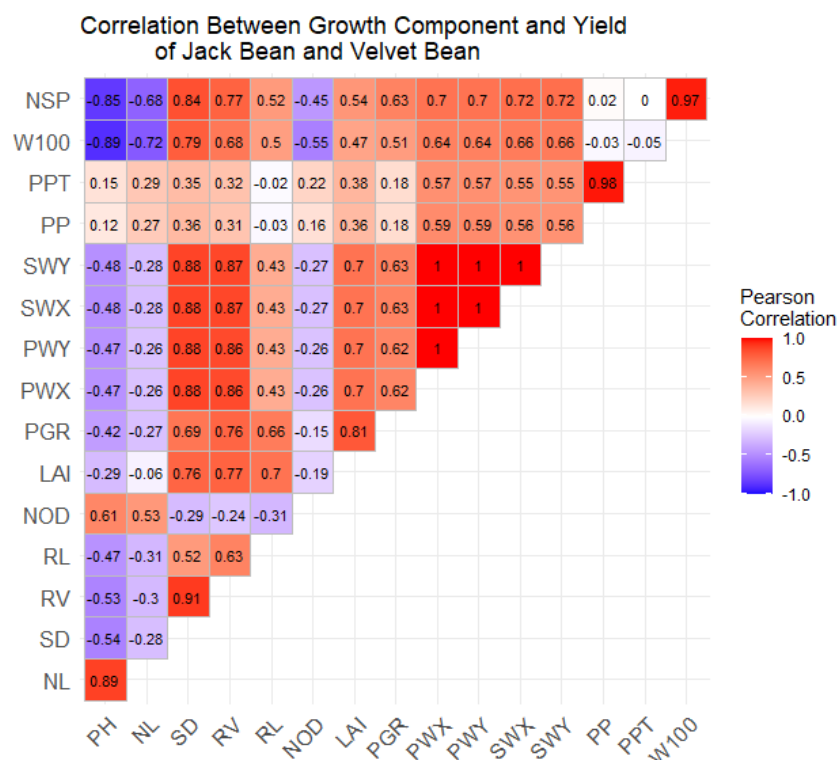


Figure 3. Correlation Between Growth and Yield in Two Species Beans

PH = plant height, NL = number of leaves, SD = stem diameter, RV = root volume, RL = root length, NOD = number of nodules, LAI = leaf area index, LPT = plant growth rate, PWX = pod weight per plot, PWY = pod weight per plant, SWX = seed weight per plot, SWY = seed weight per plant, PP = number of pod per plot, PPT = number of pod per plant, W100 = weight of 100 seeds, NSP = number of seed per pod.

Increasing root volume will increase the plant's ability to absorb nutrients, increasing plant growth and the number of pods, weight, and seeds. Stem's diameter is significantly correlation with all yield components and yield. A greater stem diameter is believed to

enhance nutrient transfer capability. This aligns with the studies. Wang *et al.* (2006) A greater stem diameter correlates with an enhanced capacity for nutrition transfer to the leaves and pods of beans, resulting in increased pod weight, seed weight, and pod quantity.

Plant height and leaf count exhibit a substantial negative connection with the quantity of seeds per pod ($r = -0.85$, $r = -0.68$). This indicates that an increase in plant height and leaf count does not necessarily lead to a rise in the number of seeds per pod, and vice versa. The number of pods per plot and per plant has a non-significant positive correlation with growth components, indicating that these pod amounts are not influenced by growth components. The results correspond with the research conducted by Bachtiar *et al.* (2021), which established that no vegetative components significantly correlate with yield components in Bogor nut plants (*Vigna subterranea*).

Yield components in two species of beans are significantly correlated with yield. This indicates that the higher the pod weight and the number of pods, the more significant the increase in seed weight. Chinapolaiah *et al.*, (2019) Stated that yield components can affect yield and that there is a significant correlation.

CONCLUSION

The research findings indicate a correlation among both species' stem diameter, root volume, leaf area index, pod weight, seed weight, seed count, and 100-seed weight. In jack bean plants, the traits of plant height, leaf count, stem diameter, root volume, and leaf area index exhibit significant correlations with yield components, including pod weight per plot, pod weight per plant, seed weight per plot, seed weight per plant, number of pods per plot, and number of pods per plant. A notable correlation exists among the yield components, including the number of pods per plot, the number of pods per plant, the weight of pods per plot, and the weight of pods per plant, in relation to the weight of 100 seeds and the weight of seeds per plot in the velvet bean.

IMPLICATION

The character of stem diameter and leaf area index can be used to select high-yielding koro plants. Indirect selection in jack bean can also be done through plant height and leaf number characteristics. In velvet bean, indirect selection can be carried out through yield component traits.

ACKNOWLEDGEMENT

Gratitude is expressed to the Research Institute of Swadaya Gunung Jati University, which has funded this research through the University Research Grant for Fundamental Research scheme for 2024.

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