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Characteristics of Several Soybean Varieties (*Glycine max* L.) and Their Response to Grasshoppers *Oxya servile* and Pod Suckers *Riptortus linearis* Pests and Their Economic Value

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ABSTRACT

Background: Soybeans constitute a vital protein resource for Indonesia's population. Indonesian agricultural scientists have developed multiple soybean cultivars to address the nation's protein security requirements. This investigation aims to evaluate the morphological traits, arthropod resistance and commercial potential of selected Indonesian soybean genotypes.

Methods: The study was executed during 2023 in Laboratorium Tanah Maros, Maros Regency, employing a randomized complete block design incorporating 13 soybean cultivars as experimental treatments with three replications per treatment.

Result: Morphological characterization revealed cotyledon pigmentation distributed as white (47.62%), green (23.80%), yellow (19.06%) and purple (9.52%). Maximum foliar trichome dimensions occurred in Grobogan (30.93 mm), peak leaf trichome density was documented in Devon-2 (71.00 units), greatest pod trichome length was recorded in Detap-1 (46.07 mm), while highest pod trichome abundance was observed in Derap-1 (300.00) and Dega-1 (247.60). Minimal foliar injury from Oxya servile infestation was documented in Grobogan (6.89%) and lowest damage from *Plucia inclusia* attacks occurred in Grobogan (4.69%). Pod deterioration caused by *Riptortus linearis* showed minimum levels in Dena-2 (3.64%), Devon-2 (3.56%), Grobogan (3.91%) and Detap-1 (3.88%). Superior grain productivity was achieved by Dena-2 (3.78 t ha^{-1}), Derap-1 (3.13 t ha^{-1}) and Devon-2 (3.31 t ha^{-1}), whereas minimal yields were recorded in Anjasmoro (1.93 t ha^{-1}). Cultivars demonstrating optimal commercial value include Derap-1, Devon-2 and Dena-2, attributed to their elevated productivity (3.13-3.78 t ha^{-1}) combined with substantial seed dimensions.

Key words: Characteristics, Economic value, *O. servile*, Pests, *R. linearis*, Seed yield, Soybean, Varieties.

INTRODUCTION

Soybeans are an important source of protein in Indonesia, but Indonesia still imports soybeans to meet domestic needs. This is due to the low productivity of soybeans grown by farmers, namely Anjasmoro. According to Reviane *et al.* (2024), the Anjasmoro variety only produces around 1.5-2.0 tons per hectare. Furthermore, Fattah *et al.* (2018), the productivity of the Anjasmoro variety only reaches around 1.65 tons per hectare. One of the causes of Anjasmoro's low productivity is the high pest attack. According to Fattah *et al.* (2020), the level of soybean leaf damage due to *Spodoptera litura* pest attacks is quite high, around 26.68%.

The Indonesian Ministry has released several superior soybean varieties with high productivity. According to Fattah *et al.* (2023), several soybean varieties with high productivity include Grobogan (2.77 t ha^{-1}), Detap-1 (2.70 t ha^{-1}), Derap-1 (2.82 t ha^{-1}), Gepak Kuning (2.86 t ha^{-1}), Devon-1 and Dega-1 (3.82 t ha^{-1}). According to Fattah *et al.* (2023), the Dega-1 variety is somewhat more resistant to *Etiella zinckenella* pest attacks, while Derap-1 and Detap-1 are more resistant to *Riptortus linearis* and *E. zinckenella*. Furthermore, Hafid *et al.* (2021) stated that Detap-1 is somewhat more resistant to *Nezara viridula* pest attacks with a population level reaching only 0.83% with a fairly low level of attack on pods. According to Gireesha *et al.* (2025), the relationship

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between seed yield and the level of stem damage was significantly negatively correlated (-0.793).

The systematic evaluation of morphological and physiological characteristics across diverse soybean varieties has emerged as a critical component of modern cultivar development and selection programs. Comprehensive phenotyping approaches, as advocated by Shilpashree *et al.* (2021), provide essential insights into the genetic basis of superior performance traits while enabling the identification of key selection criteria for future breeding initiatives. These detailed characterization studies not only facilitate the immediate identification of superior varieties for current production needs but also establish the foundational knowledge base necessary for accelerating genetic improvement programs through marker-assisted selection and genomic breeding technologies. According to Channakeshava *et al.* (2025), control of the bean fly pest *Melanagromyza sojae* can be done by planting resistant genotypes DSB 34, DLSB 1, NRC 197 and KDS 1096 with lower levels of stem damage (2.53%-2.93%).

Examining the characteristics of several soybean varieties and their responses to major soybean pest attacks can help identify varieties that address the problem of low soybean productivity at the farmer level. This study specifically aimed to characterize several superior soybean varieties and their responses to the major pests, grasshoppers and pod-sucking pests and to conduct a detailed economic analysis to identify varieties with high economic value.

MATERIALS AND METHODS

Field experiment

This comprehensive field experiment was conducted at the Maros Soil Laboratory, Agricultural Instrumentation Center, South Sulawesi, from April to December 2023. During the experimental period, the average temperature was 29°C, with relative humidity fluctuating between 60-82% and annual rainfall of approximately 347 mm (Maros Regency Report in Book, 2023). The study used a randomized block design with 13 soybean varieties as treatments, replicated three times. The varieties tested were: Detap-1, Demas-1, Deja-2, Dega-1, Devon-1, Grobogan, Gepak Kuning, Dena-1, Anjasmoro, Deja-1, Devon-2, Dega-1 and Derap-1. These varieties were planted in 4 m × 5 m plots with a spacing of 15 cm × 40 cm, with two seeds per planting hole. Fertilization is carried out at the age of 25 days after planting using NPK fertilizer with a dose of 240 kg per ha.

Observational variables

The study monitored the following parameters: Leaf morphology, pod pigmentation, trichome length and density on foliage and pods, population dynamics of *O. servile*, *R. linearis* and *Plucia inclusia* pests, extent of foliar damage from *O. servile* and *P. inclusa* infestations, pod injury severity from *R. linearis* attacks, seed morphological characteristics, grain yield per hectare and potential for varietal development and commercial viability.

Foliar damage assessment was calculated using the following equation (Fattah *et al.,* 2023):

$$I = \frac{\sum_{i=0}^{z} (n1 \times v1)}{Z \times N} \times 100\%$$

I: Intensity of damage.
ni: The number of leaves with a v_i scale.
N: Number of leaves observed.
Z: The higher v_i.
Scale value, v_i:
0: No damage on leaves.
1: Leaf damage >0%-20%.
3: Leaf damage >20%-40%.
5: Leaf damage >40%-60%.
7: Leaf damage >60%-80%.
9: Leaf damage >80%-100%.

Statistical analysis

Statistical evaluation was performed through analysis of variance (ANOVA) utilizing SPSS statistical software. Mean comparisons for growth parameters, yield components, leaf damage severity and additional variables were conducted using Duncan's multiple range test at 5% significance level.

RESULTS AND DISCUSSION

Physical characteristics of several superior soybean varieties

Morphological characterization shows a wide variety of soybean trichome colors, with the following distribution: brown (47.62%), brownish white (19.05%), white (14.29%), light brown (9.52%), dark brown (4.76%) and dark green (4.76%). Leaf morphology shows an oval configuration (52.38%), a slightly rounded shape (25%), a pointed shape (7.62%), an elongated oval structure (5%), a triangular shape (5%) and an angular shape (5%). Pod pigmentation is brown (38.09%), pale brown (23.81%), Gepak Kuning (19.05%), dark brown (14.29%) and yellowish brown (4.76%), as presented in Table 1. Seed size is large (57.14%) and medium (42.86%). Semahu and Purwanto (2016) showed that Grobogan has a substantial seed size (19.00 g), while Anjasmoro has a moderate seed proportion (11.00 g). Sinta and Sugito (2020) showed that Dena-1, Dega-1 and Grobogan have substantial seed sizes with a 100-seed weight of 23.86 g, 22.76 g and 20.66 g, respectively. Furthermore, findings by Sirait and Karyawati (2019) confirmed that the Dena-1 and Grobogan cultivars have substantial seed sizes, at 19.80 g and 19.79 g, respectively. Seed size, measured by 100-seed weight, is positively correlated with seed yield. Saikia *et al.* (2025) found that seed size or 100-seed weight correlated significantly with mung bean seed yield (0.603%).

Leaf shape

The Derap-1 cultivar exhibits a slightly rounded leaf shape (Fig 1a), while the Gepak Kuning cultivar exhibits an oblong

leaf shape (Fig 1b). The oblong leaf morphology characterizes several varieties, including Deja-1, Anjasmoro, Dena-1, Dega-1, Deja-1 and Demas-1 (Table 1). A slightly rounded leaf shape is found in Detap-1 (Fig 1c). In addition to the Detap-1 cultivar, this slightly circular leaf pattern also appears in the Devon-1 and Devon-2 varieties. The pointed leaf configuration is characteristic of the Grobogan variety (Fig 1d). Research by Fattah *et al.* (2024) confirmed that the slightly rounded leaf shape characterizes the Devon-2 and Devon-1 cultivars, while the pointed leaf structure is characteristic of the Grobogan variety. Leaf morphology shows a positive correlation with chlorophyll concentration, which plays an important role in photosynthetic performance and productivity potential (Sakoda *et al.,* 2016; Yu *et al.,* 2020).

The color of the pods

Pod coloration varies among cultivars, displaying yellow pigmentation (Derap-1), deep brown hues (Deja-1), brown tones (Grobogan) and pale brown shades (Anjasmoro) (Fig 2). Soybean cultivars exhibiting brown-colored pods demonstrate correlation with enhanced grain quality, as elevated protein concentrations and lignin deposits within the testa and pod structures provide enhanced mechanical durability, resulting in superior physiological integrity and pathogen resistance in seeds (Krzyzanowski *et al.,* 2023).

Length, number and shape of trichomes on soybean pod and leaves

Maximum foliar trichome dimensions were observed in Grobogan (30.93 mm), Demas-1 (27.86 mm), Derap-1 (25.73 mm) and Deja-2 (25.28 mm), whereas minimal measurements were recorded in Anjasmoro (21.60 mm). The greatest foliar trichome density occurred in Devon-2 (71.00 units), Detap-1 (57.27 units) and Dega-1 (56.67 units), while the lowest density was documented in Deja-1 (27.13 units) (Table 2) and (Fig 3).

Maximum pod trichome dimensions were recorded in Detap-1 (46.07 mm), whereas minimal lengths were observed in Demas-1 (26.52 mm), Grobogan (26.96 mm), Dena-2 (27.25 mm) and Dega-2 (27.40 mm). Peak pod trichome abundance was documented in Derap-1 (300.00 units) and Dega-1 (247.60 units), while the most limited trichome counts occurred in Detap-1 (126.20 units), Anjasmoro (132.67 units) and Gepak Kuning (132.33 units) (Table 2).

Microscopic examination revealed substantial inter-varietal differences regarding trichome density and dimensions across both foliar and pod tissues (Fig 3 and 4). The cultivars Devon-2, Dena-2 and Derap-1 demonstrated unique trichome attributes in terms of both dimensional characteristics and abundance, suggesting enhanced

Table 1: Characteristics of several superior soybean varieties.

Varieties	Protein content (%)	Fat content (%)	Leaf shape	Feather color	Pod color	Seed size
Derap-1	39.17	18.10	Round	White	Yellow	Large
Devon-2	37.9	17.2	A bit round	White	Yellow	Large
Deja-1	39.6	17.3	Oval	Brown	Dark brown	Medium
Anjasmoro	41.80	17.20	Oval	White	Light brown	Medium
Dena-1	36.67	18.81	Oval	Brown	Yellowish brown	Large
Dena-2	36.48	18.22	Triangle shape	Brown	Brown	Medium
Gepak Kuning	35.38	15.10	Oval	Brown	Light brown	Small
Grobogan	43.90	18.40	Pointed shape	Brown	Light brown	Large
Devon-1	34.8	17.3	A bit round	Brown	Light brown	Large
Dega-1	37.78	17.29	Oval	Brown	Light brown	Large
Deja-2	37.9	17.2	Oval	Brown	Light brown	Large
Demas-1	36.1	19.9	Oval	Brown	Light brown	Medium
Detap-1	40.11	16.16	A bit round	White	Yellow	Large

Source: Indonesian legume and tuber crops research institute (2016).

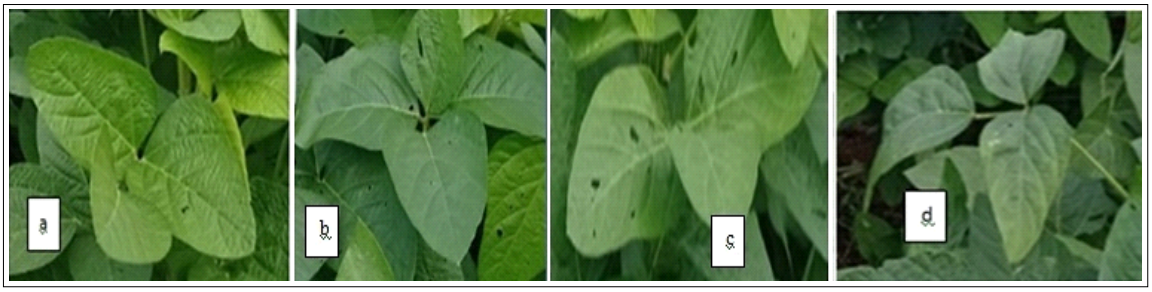


Fig 1: Leaf shape of several soybean varieties: round leaf shape (Derap-1) (a), oval leaf shape (Gepak Kuning) (b), slightly round leaf shape (Detap-1) (c) and pointed leaf shape (Grobogan) (d).

inherent defense mechanisms against arthropod colonization. Research by Murgianto *et al.* (2023) documented that Devon-2 (foliar tissue) and Derap-1 (pod surface) soybean cultivars displayed maximum trichome concentrations, which showed strong correlation with substantial decreases in whitefly oviposition and larval populations (R^2 = 0.84). Extended trichome structures can amplify the mechanical barrier effects against herbivorous insects (Adie and Krisnawati, 2017). Trichome density and dimensions substantially impede arthropod behavior

Table 2: Length and number of trichomes on leaves and pods of several soybean varieties.

Type of variety	Trichomes on leaves		Trichomes on pods	
	Length (mm)	Number (stems)	Length (mm)	Number (stems)
Detap-1	24.84ab	57.27cd	46.07c	126.20a
Derap-1	25.73abc	49.00abcd	34.29abc	300.00e
Devon-2	22.65ab	71.00d	36.36abc	227.33cde
Deja-1	22.11ab	27.13a	36.25abc	156.40abc
Dega-1	24.81ab	56.67cd	27.40a	247.60de
Dena-1	25.05ab	39.53abc	38.33bc	161.13abcd
Dena-2	23.84ab	49.53abcd	27.25a	233.07cde
Gepak kuning	24.41ab	52.13bcd	33.19abc	132.33ab
Anjasmoro	21.60a	38.40abc	33.61abc	132.67ab
Devon-1	25.03ab	28.20ab	32.83abc	148.40abc
Grobongan	30.93c	32.20ab	26.96a	222.47bcde
Deja-2	25.28abc	32.00ab	29.11ab	212.47abcde
Demas-1	27.86bc	46.67abc	26.52a	148.40abc

The numbers followed by the same letter in the same column were not significantly different according to Duncan's test at the 0.05 level.



Fig 2: Yellow pods Derap-1 variety (a), dark brown pods, Deja-1 variety (b) Brown pods, Grobogan variety (c) and light brown pods, Anjasmoro variety (d).

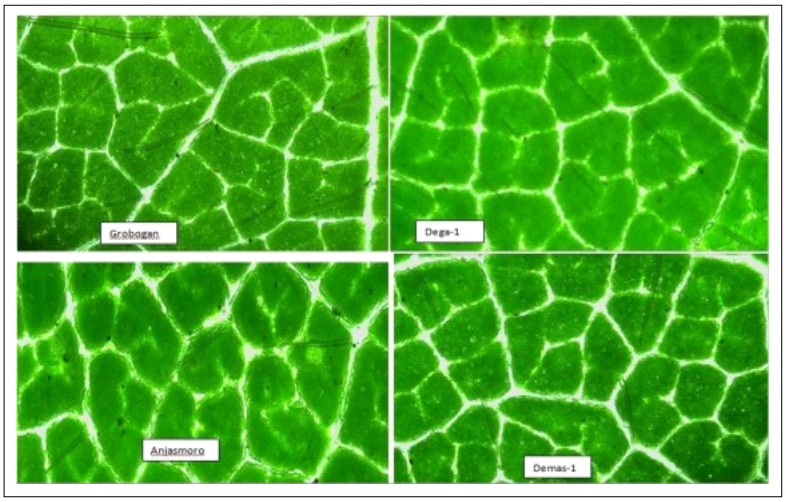


Fig 3: The shape of the leaf trichomes in the Grobogan, Dega-1, Anjasmoro and Demas-1 varieties.

through dual mechanisms involving mechanical obstruction and secretion of bioactive secondary metabolites (Abdelhamid *et al.,* 2024; Fattah *et al.,* 2024).

Elevated trichome density demonstrates positive correlation with enhanced arthropod resistance, as these structures create physical impediments to pest colonization (Adie and Krisnawati, 2017). Additionally, elongated pod trichomes reportedly restrict pest infiltration, offering distinctive mechanical protection despite reduced overall abundance. In contrast, Detap-1 and Anjasmoro cultivars, characterized by diminished trichome populations, exhibit greater vulnerability to arthropod infestation (Abdelhamid *et al.,* 2024).

Insect populations and the level of damage caused to soybean leaves and pods

One type of pest that damages soybean leaves is *O. servile* (Fig 5a) with the highest population density found in Devon-2, Dena-2, Grobogan, Devon-1, and Dega-1, while the symptoms of soybean leaf damage due to *O. servile* attacks (Fig 5b) were lowest found in Grobogan and Dega-1. The type of pest that damages soybean pods the most is *R.linearis* (Fig 5c) with the lowest population found in Derap-1, Dena-1, Dena-2, Grobogan and Devon-1. Meanwhile, the lowest level of pod damage caused by *R. linearis* was found in Devon-2, Dena-2, Derap-1 and Detap-1. Furthermore, the lowest population of *P. inclusa* was found in Devon-2, Dena-2 and Detap-1 (Table 3). The highest populations of *R. linearis*, *P. inclusa* and *O. servile* were found in Anjasmoro, Deja-2 and Demas-1. Elevated population densities showed positive correlation with intensified tissue damage severity due to pest preference for more tender plant structures or specific secondary metabolite profiles (Coolen *et al*., 2024). Tender plant tissues typically exhibit greater palatability, enhancing their attractiveness to herbivorous arthropods (Souza *et al*., 2013). Moreover, Al-Khayri *et al*. (2023) determined that softer tissues combined with reduced secondary metabolite concentrations can increase pest attraction.

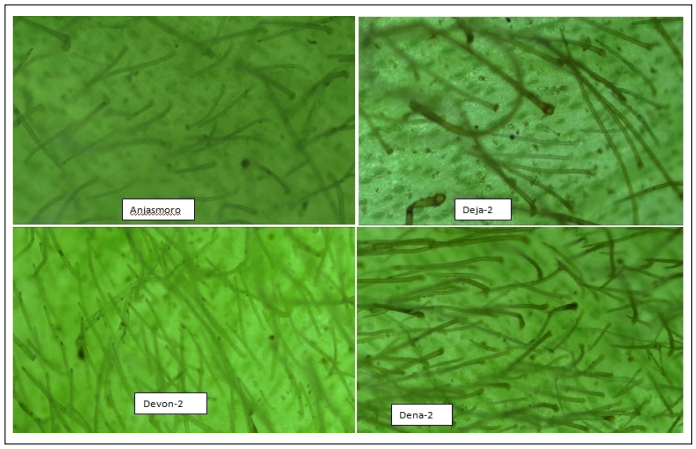


Fig 4: Trichome shape on pods of 4 varieties Anjasmoro, Deja-2, Devon-2 and Dena-2.

Table 3: Number of pest populations and levels of pest and disease damage to soybeans.

Type of variety	Pest population (individuals per 15 m^2)			The intensity of damage to soybeans (%)			Yield ($t\ ha^{-1}$)
	Oxya serville	*R. linearis*	*P. inclusa*	*O. servile*	*R. linearis*	*P. inclusa* (leaf)	
Detap-1	3.33a	3.61bc	2.67ab	8.95de	3.88ab	5.95b	5.86c
Deja-2	6.33bc	5.61ef	6.61cd	16.08h	12.34g	12.55de	3.13cd
Derap-1	3.67a	2.66a	3.31ab	8.63cde	3.87ab	5.63b	3.311d
Grobongan	2.67a	2.66ab	3.31ab	6.89a	3.91ab	4.69a	2.40b
Deja-1	5.33b	5.33de	6.31cd	11.97f	6.24d	6.99c	8.08d
Devon-2	2.66a	3.33abc	2.33a	8.05bcd	3.56a	6.00b	3.78e
Dena-1	3.00a	2.60ab	3.31ab	8.57cde	5.70cd	5.69b	2.36b
Dena-2	2.67a	2.30a	2.67ab	7.78abc	3.64a	4.12a	2.33b
Gepak Kuning	5.33b	6.30ef	5.60c	13.51g	11.13f	12.07de	1.93a
Devon-1	2.33a	2.33a	3.67b	9.51e	4.19ab	6.00b	3.00b
Dega-1	2.66a	3.31abc	3.32ab	7.35ab	4.82bc	4.37a	2.96b
Anjasmoro	6.00bc	6.67f	7.33d	21.03i	12.18g	12.84e	7.92d
Demas-1	7.00c	4.30cd	5.61c	22.42i	10.07e	11.78d	6.19cd

The numbers followed by the same letter in the same column were not significantly different according to Duncan's test at the 0.05 level.

Cultivar resistance mechanisms are intimately linked to plant morphological attributes including trichome abundance, cuticular thickness and concentrations of defensive compounds such as flavonoids or glucosinolates (Xing *et al.,* 2017). Additionally, these researchers demonstrated that foliar trichome density serves as a mechanical deterrent against pest infiltration and attachment, while simultaneously reducing herbivorous insect feeding behavior. Arthropod resistance results from combined trichome characteristics and genetic expression pathways controlling terpene, flavonoid and phenyl propanoid synthesis, along with pathogen defense mechanisms (Dixon and Gschwend, 2024).

The assessment of pod deterioration caused by *R. linearis* (Fig 5c) infestation revealed substantial varietal differences in susceptibility patterns across the tested soybean cultivars. Among the superior performing varieties, minimal damage levels were consistently observed in Devon-1 (3.15%), Dena-2 (3.17%), Detap-1 (3.45%), Derap-1 (3.47%) and Grobogan (3.67%), indicating these cultivars possess inherent resistance mechanisms that effectively limit hemipteran colonization.

In stark contrast, several cultivars exhibited significantly elevated vulnerability to *R. linearis* attacks, with Deja-2 (12.16%) and Anjasmoro (12.78%) showing particularly severe damage levels (Fig 5d), while Gepak Kuning also demonstrated high susceptibility. The nearly four-fold difference in damage intensity between resistant and susceptible varieties underscores the critical importance of varietal selection in integrated pest management programs. Supporting evidence from previous research reinforces these observations, as Fattah *et al.* (2021) documented similar patterns of differential *R. linearis* colonization across soybean varieties, though with generally higher damage levels than observed in the current study. Their findings showed reduced infestation rates in Grobogan (8.50%), Argomulyo (9.40%) and Detam-1 (9.0%), suggesting that environmental conditions and management practices may influence the absolute magnitude of pest damage while maintaining relative resistance rankings among cultivars. The morphological basis for these resistance differences has been elucidated by Sarjan and Sab'i (2014), who established strong correlations between pericarp thickness and *R. linearis* infestation intensity, indicating that physical pod characteristics serve as primary defense mechanisms against hemipteran penetration.

The temporal dynamics of pest-plant interactions add another layer of complexity to *R. linearis* management strategies. Research by Defensor *et al.* (2020) demonstrated that soybean developmental stages significantly influence hemipteran population dynamics, with critical vulnerability periods occurring during anthesis, reproductive development and physiological maturity phases. This phenological synchronization between pest activity and plant development suggests that resistant varieties may possess temporal advantages in addition to their morphological defense mechanisms, potentially offering enhanced protection during the most susceptible growth stages when pod formation and seed development are most critical for final yield determination. In addition to physical factors, varieties also influence pest resistance. According to Sathish *et al.* (2024), biochemical content, such as flavonoids and phenols, is negatively correlated with the level of seed damage caused by Callosobruchus chenensis attacks (r = -0.752 and r = 0.729) and high phenol content makes plants resistant to pod borer attacks.

Maximum grain productivity was recorded in the Dena-2 cultivar (3.78 t ha^{-1}), whereas minimal yields occurred in Anjasmoro (1.93 t ha^{-1}) and Deja-2 (2.02 t ha^{-1}), while Grobogan demonstrated intermediate productivity levels of approximately 2.96 t ha^{-1} (Table 3). The Dena-2 cultivar exhibits multiple beneficial characteristics, including superior grain productivity, tolerance to hemipteran pod pests and resistance to lepidopteran defoliator *S. litura*.

Economic value of each variety

The commercial potential of individual soybean cultivars demonstrates significant variation based on grain dimensions. Multiple cultivars possess substantial seed size combined with elevated productivity, encompassing Derap-1, Devon-2, Detap-1, Dega-1 and Grobogan. Cultivars characterized by larger grain dimensions command superior market value compared to those with smaller seed characteristics. Large-seeded cultivars receive preference from tempeh manufacturers over their smaller counterparts. Research by Ginting *et al.* (2009)

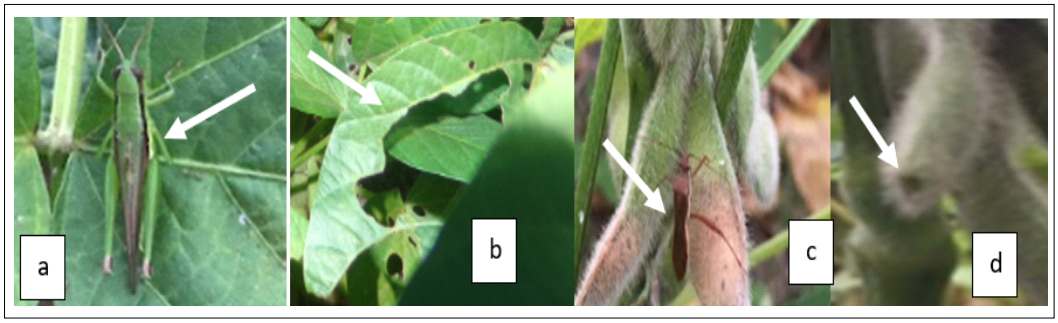


Fig 5: Grasshopper pest *O. serville* (a) and symptoms of grasshopper attack (b) and pod sucking pest *R. linearis* (c) and symptoms of attack (d).

established that grain dimensions determine tempeh product quality through positive correlation with final product mass and volume. Large-seeded soybean cultivars demonstrate predominant utilization in soymilk production relative to small-seeded varieties (Ginting *et al.,* 2009).

CONCLUSION

- Cultivar attributes represent critical determinants influencing grain productivity achieved by individual genotypes across diverse agricultural environments.
- Cultivars exhibiting elevated foliar trichome density and dimensions demonstrate enhanced resistance to *S. litura*, *O. servila* and *P. inclusia* infestations. Correspondingly, genotypes possessing abundant and elongated pod trichomes show reduced susceptibility to *R. linearis* colonization.
- Maximum grain yields were documented in Dena-2, Derap-1 and Devon-2, whereas minimal productivity was observed in Anjasmoro and Deja-2.
- The cultivars demonstrating superior commercial potential were Derap-1, Devon-2 and Dena-2, attributed to their substantial grain dimensions combined with elevated productivity levels.

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Conflict of interest

The authors declare no competing interests.

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