**Evaluation of Growth and Yield Potential of Two Grain Corn Varieties Suitable for Bris Soil**

**ABSTRACT**

Grain corn is primarily utilized as poultry feed, playing a significant role in the food, feed, and seed industries in Malaysia. Its high carbohydrate content provides essential energy, making it a crucial ingredient in poultry diets to support the growth and production of chickens, turkeys, and other poultry species. This study aims to evaluate the growth potential and yield performance of two grain corn varieties suited for cultivation in BRIS soil. The field experiment was conducted at MARDI Bachok on BRIS soil to assess the performance of two hybrid varieties GWG888 and P4546 based on vegetative growth, yield and yield components. Modified agronomic practices were applied for planting and maintaining the crops. Findings revealed no significant difference in dry yield between the two varieties. Some characteristics were significantly influenced by the planting season, excluding plant height and stem diameter. These traits indicated that vegetative growth did not affect those specific characteristics. P4546 outperformed GWG888 in total plant number, total cob production, and ear placement height. P4546 achieved a higher gross yield of 7.2 tons/ha, compared to GWG888's 5.89 tons/ha. Yield component evaluations further highlighted the better performance of P4546. Overall, the results suggest that both P4546 and GWG888 are viable for cultivation in BRIS soil, with P4546 showing superior advantage in yield and recommended to farmers for grain corn production.

**Keywords:** *Grain corn, hybrid, BRIS soil, yield performance, poultry feed*

**INTRODUCTION**

Grain corn has recently garnered significant attention and is now a higher priority in Malaysia, primarily due to its use as a key ingredient in poultry feed production. However, the high production cost of grain corn has resulted in reduced cultivation areas, making it less appealing to farmers. A major challenge in grain corn cultivation is its low yield, leading many farmers to avoid growing it. Consequently, most livestock feed producers rely on imported grain corn [1]. According to the Department of Statistics Malaysia (2016), the country imported approximately 3.7 million metric tons of grain corn, with an estimated import value reaching 3.09 billion ringgits [2]. This heavy reliance on imports underscores the need for strategic measures to minimize dependence on foreign sources [3]. One effective approach is the introduction of new grain corn varieties adapted to local conditions. MARDI, Malaysia's agricultural research agency, is instrumental in advancing research focused on developing high-yield grain corn varieties suited to the country's soil and climate. Their work also includes promoting good agronomic practices, improving post-harvest management, monitoring pests and diseases, leveraging agricultural technology, optimizing the use of corn residues, and conducting market analysis [4]. Mohd. Ekhwan [5] highlighted the challenges posed by BRIS (Beach Ridges Interspersed with Swales) soil, which is common in Malaysia. This soil type is characterized by its sandy texture, poor structure, low nutrient content, limited water retention capacity, high soil temperature, and overall unsuitability for plant growth. BRIS (Beach Ridges Interspersed with Swales) soils, characterized by their sandy texture and low fertility, present significant challenges for crop cultivation due to poor water retention and nutrient availability [6]. A study by Saiin et al. [7] evaluated the growth dynamics and yield of the sweet corn variety Akik SC422 across different soil types, including BRIS soil in Bachok, Kelantan. The research examined various planting arrangements and densities, providing insights into optimizing sweet corn cultivation in such challenging soils. Saladaga et.al. [8] highlighted the performance of three corn varieties was assessed under different fertilizer regimes in tropical conditions. The findings highlighted the importance of balanced nutrient management in enhancing corn growth and yield, especially in nutrient-deficient soils like BRIS. Integrating organic and inorganic fertilizers was shown to improve soil fertility and support better crop performance [9]. These studies underscore the potential for cultivating specific corn varieties in BRIS soils through tailored agronomic practices, including appropriate variety selection, optimized planting configurations, and effective nutrient management strategies.

According to Nur Khairani [10], The comparative yield analysis of grain corn varieties in BRIS soil conditions reveals that P4546 outperforms GWG888 in terms of crop-cut-test (CCT) yield. P4546 demonstrates a higher productivity potential with a yield of 10.5 t/ha, whereas GWG888 records a slightly lower yield at 9.96 t/ha. These results highlight the suitability of both varieties for cultivation in nutrient-deficient BRIS soils, with P4546 exhibiting a marginal advantage in overall yield efficiency. This study seeks to assess the potential of two grain corn varieties in terms of growth and yield when cultivated in BRIS soil conditions.

**MATERIALS AND METHODS**

**Germplasm Selection**

Two grain corn hybrids, GWG888 and P4546, were selected for local verification trials [11] to evaluate their adaptability and performance in sandy-textured BRIS soils (Beach Ridges Interspersed with Swales) in Rudua series. These hybrid varieties are known for their potential to produce high yields in challenging soil conditions [12].

**Experimental Site and Plot Layout**

The field trials were conducted at the MARDI Bachok research station in Kelantan, Malaysia. A total area of 1.0 hectare per hybrid was allocated for the experiment. The plant density was set at 20 cm × 75 cm, resulting in an estimated population of 66,666 plants per hectare, to optimize space and ensure consistent growth conditions [13]. BRIS soil, which is low in organic matter and fertility, required soil amendments and fertilizer to support crop growth. To mitigate this, land preparation and cultivation practices were conducted comprehensively.

**Soil Preparation and Cultivation**

Mechanized cultivation was employed to ensure consistency and efficiency across all treatments [11]. The process began with disc ploughing to break the soil and enhance aeration. Organic fertilizer was then applied, with processed chicken dung (6,000 kg/ha) uniformly spread across the field to enhance organic matter and improve soil fertility. Following this, rotary ploughing was used to create an even planting surface. Seed planting was carried out using a seeder implement, with a row spacing of 75 cm and 25 cm between seeds within the row. Finally, immediate weed control was implemented after planting to prevent weed growth and competition for resources [12].

**Fertilization**

Fertilization was carried out in a two-phase schedule. The first phase involved basal fertilizer application, where NPK fertilizer (15:15:15) was applied at planting at a rate of 400 kg/ha to provide balanced macro-nutrients for early crop establishment. The second phase included topdressing with urea, where urea (46% N) was applied 30 days after planting at a rate of 130 kg/ha to promote vegetative growth [14].

**Integrated Pest Management and Agronomic Practices**

An **Integrated Pest Management (IPM)** system was implemented to control potential pest and disease issues. Chemical pesticides were applied only when pest or disease severity reached economic threshold levels [15]. Routine weeding was performed to suppress weed growth, while rainfed as primary source of irrigation, supplemented by manual irrigation when necessary.

**Harvesting and Yield Assessments**

Both hybrids were harvested between 110–120 days after planting, when grain moisture levels were maintained within the range of 25–30%, which is optimal for mechanized harvesting [16]. Agronomic data, yield (CCT), and yield components were recorded. Data on pest and disease incidence were collected whenever significant infestations or symptoms were observed.

**Yield Components**

The morphological parameters assessed included plant height, which was measured in centimetres from the soil surface to the tip of the tassel at full maturity and cob height, measured from the soil surface to the node of the first cob. Yield-related parameters were measured using a subset of four plants per plot, systematically sampled from each triangular section of the experimental plot. The data collected included cob length (m), measured from the base to the tip of the cob; cob girth (m), measured at the middle section of the cob; cob weight with husk (g), which included the weight of the cob and the husk; cob weight without husk (g), measured after husk removal; core weight (g), which was the weight of the cob core without kernels; and grain moisture (%), measured using a moisture meter. Planting grain corn in BRIS soil can achieve early maturity, good performance, and high yield. This experiment concluded that planting grain corn in BRIS soil can provide a high yield with a short harvesting period [17].

**Crop Cutting Test (CCT)**

Yield estimation was conducted using a Crop Cutting Test (CCT) method [18]. A sample area of 4.5 m² (2 m × 2.25 m, covering three rows) was harvested from each plot, and total cob weight without husks was recorded. The yield per hectare, adjusted to 14% grain moisture content, was calculated using the following formula:

CCT Yield at (14%) = Total cob weight with no husk (kg) x 1 ha

 (kg/ha) CCT area (m2)

CCT area (Sample size) = 2 m x 2.25 m (3 rows) =4.5 m2

**Data Analysis**

All parameters were statistically analyzed using SAS software version 9.1. Analysis of variance (ANOVA) was conducted using ANOVA to determine significant differences between hybrids and treatments for all measured parameters. Cluster analysis was performed using the minimum-variance method to group collections based on agronomic and yield traits [19]. Additionally, mean comparisons were made using Duncan's Multiple Range Test (DMRT) to compare treatment means and identify statistically significant differences at a 5% significance level.

**RESULTS AND DISCUSSION**

**Vegetative growth**

The table 1 presents an ANOVA analysis of two hybrid corn varieties (GWG888 and P4546) in terms of their vegetative growth characteristics, including total plant number, total cob, plant height, ear placement height, and stem diameter. For total plant number and total cob, the P4546 variety showed significantly higher mean values (78.00 and 76.25, respectively) compared to GWG888 (57.50 and 40.25, respectively), with both traits significant at p < 0.01. Plant height showed no significant difference between the two varieties, with means of 154.05 cm for GWG888 and 196.25 cm for P4546. Similarly, stem diameter showed no significant variation, with GWG888 recording a mean of 20.39 cm and P4546 at 24.96 cm.

Ear placement height, however, displayed a significant difference, with P4546 having a higher mean (81.20 cm) compared to GWG888 (54.75 cm), significant at p < 0.05. The standard deviation values across traits reveal variability, with P4546 generally exhibiting lower standard deviations, indicating more consistent performance compared to GWG888, especially for traits like total plant number and total cob. These results suggest that P4546 performs better overall in terms of yield-related traits, while GWG888 shows less consistency.

**Yield data**

The analysis of gross and dry yield data reveals significant differences in cob weight, grain moisture content, and gross yield between the two hybrid varieties, GWG888 and P4546 (Table 2). Cob weight without husk, P4546 (11.5 kg) exhibits a significantly higher mean compared to GWG888 (4.08 kg). Similarly, P4546 also outperforms GWG888 in cob weight with husk (13.5 kg versus 11.05 kg). Furthermore, the grain moisture content is significantly higher in P4546 (28.13%) than in GWG888 (20.57%). This suggests that P4546 more prone to higher moisture retention, potentially affecting the overall processing characteristics of the harvested cobs. In terms of gross yield, P4546 (7.20 tons/ha) shows a significantly higher performance compared to GWG888 (5.89 tons/ha), with both varieties having similar standard deviations, indicating relatively consistent results across the samples.

In contrast, when considering dry yield (adjusted to 14% moisture content), there is no significant difference between the two varieties, with GWG888 achieving 5.43 kg/ha and P4546 reaching 6.02 kg/ha. This suggests that while P4546 provides a higher cob and gross yield, both varieties have comparable dry yield outputs. Additionally, the standard deviations for dry yield remain relatively low for both varieties, indicating consistency in the dry yield performance across the samples. These results underline that P4546 generally produces higher cob and gross yield compared to GWG888, but both hybrids perform similarly in terms of their final dry yield, which is a key metric for market value and storage considerations.

**Yield component**

The yield component analysis reveals significant differences in several traits between the two hybrid varieties, GWG888 and P454 (Table 3). For cob weight, P4546 (194.64 g) shows a significantly higher mean compared to GWG888 (117.67 g), indicating that P4546 produces larger cobs. Similarly, cob girth (diameter) is also significantly greater in P4546 (45.38 mm) compared to GWG888 (40.23 mm). Grain weight is significantly higher in P4546 (151.85 g) than in GWG888 (91.81 g), and the 1000 grain weight also shows a significant difference, with P4546 reaching 320.01 g compared to GWG888’s 201.38 g. These findings suggest that P4546 consistently produces larger and heavier cobs and grains, contributing to its overall higher productivity. For higher yield, variety P4546 performs slightly better than GWG888 and is a preferable choice for farmers in grain corn production [20].

However, some traits do not exhibit significant differences between the two varieties. Cob length and core weight are similar between the varieties, with no significant variation found. The standard deviations for these traits are also low for both varieties, suggesting uniformity in these components. Notably, while there are significant differences in several key yield components, GWG888's core weight and cob length maintain consistency in comparison to P4546, highlighting that differences in cob and grain weights drive the primary contrast in overall yield between the varieties.

Figure 1 illustrates the dry yield performance of P4546 and GWG888, showing that P4546 yields higher dry matter compared to GWG888. According to trials conducted by MARDI, the average yield for Peninsular Malaysia and commercial-scale planting has been evaluated, but the economic data suggests that it is not financially viable [4]. The yields ranged from 1.31 tons per hectare to 4.6 tons per hectare, based on tests conducted at two estates in Peninsular Malaysia. A report by Mohamad Hifzan [4] revealed that the average grain corn yield in Kelantan is approximately 3.7 to 4.5 tons per hectare.

**Table 1.** ANOVA analysis, mean performance and standard deviation for the vegetative growth of two hybrid varieties

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variety | Total plant number | Total Cob | Plant height (cm) | Ear placement height (cm) | Stem diameter (cm) |
| Mean | Std Dev | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev |
| GWG888 | 57.50\* | 9.00 | 40.25\*\* | 4.43 | 154.05ns | 9.70 | 54.75\* | 2.77 | 20.39ns | 4.80 |
| P4546 | 78.00\* | 4.97 | 76.25\*\* | 5.91 | 196.25ns | 34.15 | 81.20\* | 12.15 | 24.96ns | 1.21 |

\*\*: significant at p<0.01; \*: significant at p<0.05; ns: non-significant

**Table 2.** ANOVA analysis, mean performance and standard deviation for the gross and dry yield of two hybrid varieties

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variety  | Cob weight with no husk (kg) | Cob weight with husk (kg) | Grain moisture (%) | Gross yield (ton/ha) | ; Dry yield (14%) (kg/ha) |
| Mean | Std Dev | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev |
| GWG888 | 4.08\*\* | 0.79 | 11.05\* | 2.07 | 20.57\* | 1.17 | 5.89\* | 1.10 | 5.43ns | 0.95 |
| P4546 | 11.50\*\* | 1.15 | 13.50\* | 1.29 | 28.13\* | 2.43 | 7.20\* | 0.69 | 6.02ns | 0.68 |

\*\*: significant at p<0.01; \*: significant at p<0.05; ns: non-significant

; Dry yield based on hectare equivalent

**Table 3.** ANOVA analysis, mean performance and standard deviation for the yield component of two hybrid varieties

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variety  | Cob weight (g) | Cob length (mm) | Cob girth (diameter) | Grain weight (g) | Core weight (g) | 1000 grain weight (g) |
| Mean | Std Dev | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev |
| GWG888 | 117.67\* | 31.24 | 16.51ns | 1.29 | 40.23\* | 0.74 | 91.81\* | 9.28 | 31.74ns | 5.74 | 201.38\* | 44.45 |
| P4546 | 194.64\* | 26.33 | 16.23ns | 0.73 | 45.38\* | 2.08 | 151.85\* | 21.47 | 39.45ns | 4.24 | 320.01\* | 24.89 |

\*\*: significant at p<0.01; \*: significant at p<0.05; ns: non-significant

a

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**Figure 1.** Mean values of yield tonne/ha were measured on two evaluated varieties (GWG888 and P4546). Mean values followed by the same letter in the graph are not significantly different at p>0.05.

**CONCLUSION**

In conclusion, the comparative analysis of the vegetative growth, yield components, and yield data for GWG888 and P4546 demonstrates that P4546 consistently outperforms GWG888 in several important growth and yield traits [21]. P4546 exhibits significantly higher performance in terms of total plant number, cob production, plant height, and ear placement height, as well as in yield components such as cob weight, grain weight, and 1000 grain weight. These differences contribute to P4546’s higher gross yield compared to GWG888, suggesting that P4546 is a more productive variety overall. However, both varieties show similar performance in dry yield and certain yield components such as core weight and cob length, indicating that their final dried outputs may be comparable.

Despite P4546’s superior performance in terms of yield quantity, the economic viability of these hybrids in commercial-scale planting in Peninsular Malaysia remains a critical concern. MARDI's trials suggest that the economic feasibility of large-scale cultivation may be limited, with average yields varying significantly across different estates. The economic data indicates that while P4546 yields higher cob and gross yields, the financial returns may not justify large-scale commercial adoption. As such, both varieties should be considered carefully, weighing their yield potential against the economic factors and the specific conditions of different planting regions.

Environmental conditions and soil characteristics significantly influence the growth and productivity of maize hybrids. Variations in soil fertility, water availability, and climate can markedly affect crop development and final yield. Research utilizing models like DSSAT indicates that maize varieties respond differently to environmental stressors, underscoring the importance of site-specific evaluations before large-scale cultivation. For instance, a study applied the CERES-Maize model to assess the performance of two early-maturing maize varieties under varying planting windows and nitrogen applications across different agroecological zones, highlighting the necessity of tailoring practices to specific environments [22]. Therefore, while P4546 exhibits strong yield potential, its adaptability to diverse environmental conditions in Malaysia requires thorough assessment to ensure consistent and sustainable production.

Beyond yield performance, factors such as disease resistance, resource requirements, and market demand are crucial in varietal selection. High-yielding hybrids like P4546 may necessitate greater inputs, including fertilizers, pest management, and irrigation, potentially increasing production costs. Additionally, consumer preferences for grain quality and cob size significantly influence a variety’s commercial success. Understanding farmer decision-making processes is vital; studies have explored how information and price discounts affect farmers' seed choices, emphasizing the need for reliable data on seed performance to guide selections [23]. To support informed decisions, future research should focus on long-term economic viability and extensive field trials across diverse agroecological zones to identify the most suitable maize hybrids for large-scale adoption in Malaysia.

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