PERFORMANCE EVALUATION OF EIGHTEEN GRAIN CORN VARIETIES CULTIVATED IN BRIS SOIL

ABSTRACT

In Malaysia, grain corn is mostly used as poultry feed. Grain corn is an important crop that plays a major role in the food, feed, and seed industries. This study aims to evaluate and identify the best hybrid variety with high yield, wide adaptability, and high stability when cultivated in BRIS soil for recommendation to growers or farmers. The field experiment was conducted in MARDI Bachok with BRIS soil type. All 18 hybrid lines' performances were evaluated based on yield, days to 50% pollen shed, plant height, total cob number, cob weight with husk, and cob weight without husk. This study used modified basic agronomic practices in terms of planting and maintenance of grain corn in the field. The result showed that dry yield production does not show a significant difference between the 18 hybrid varieties tested, but these results are mostly the highest compared to cultivation in Kelantan, Malaysia, over past years. Days to 50% pollen shed, plant height, ear placement height, cob girth, cob weight with no husk, and core weight showed a significant difference between all grain corn hybrids tested. Out of 18 hybrids, DK9979C and P4554 variety showed higher yields (12.9 tons/ha) compared to others. Meanwhile, variety GWG111 had the lowest yield (8.4 tons/ha), whereas the rest of the variety had a moderate yield (average 9 to 11 tons/ha). These results indicate that BRIS soil can potentially be used as an alternative for high-yield production.

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

1. INTRODUCTION

Grain corn has received much attention and is a higher priority in Malaysia at this time [1]. This crop is the primary source of livestock feed, mainly ruminant and non-ruminant livestock such as cattle and chickens. In Malaysia, the planting area of corn cultivation is limited due to the relatively high production cost. Most livestock feeders import grain corn from abroad. According to the Department of Statistics Malaysia 2016 sources, Malaysia has imported grain corn of about 3.7 million Mt, which involves an estimated import value of up to 3.09 billion ringgits [2]. The effect of this very high import requires a careful strategy to reduce the import of grain corn.

"One of the best steps is to introduce new varieties that can be adapted and suitable for cultivation in our country. MARDI, which serves as an agricultural research agency, plays a vital role in implementing grain corn research focusing on the development of high-yield varieties according to the suitability of land and weather in Malaysia, good agronomic practices, post-harvest management, pest and disease monitoring, agricultural technology utilization, management and value-added corn residues and market intelligence" [3]. Grain corn is a primary source of energy formulated in livestock feed and is an essential component for monogastric animals such as chickens and pigs. This is because grain corn has the highest nutritional energy value among other grains, besides having very low nutrient value variation between locations and planting periods [4]. This ensures that livestock receive a balanced and consistent diet, which is crucial for their health and productivity [5].

According to Nor et al. [6], “Malaysia imported four million tons of grain corn in 2018, indicating an increase of 42% compared to 2010”. “However, no domestic grain corn production was recorded in Malaysia. Furthermore, the currency speculation crisis that affected the Malaysian ringgit resulted in higher expenses concerning imported grain corn” [7]. “This situation is a considerable risk to Malaysian food security. Hence, it will affect the cost of poultry feed, primarily in poultry production, by up to 70% of the total cost” [8]. “So far, Malaysia is still wholly dependent on the import of grain corn. In 2020, Malaysia imported 4.1 metric tons (mt) of corn [9]. Therefore, in 2016, the government developed a grain corn planting program in Malaysia to produce a local supply of grain corn with a target of 30% by 2032, aiming to reduce dependence on imports” [6]. Mohd. Ekhwan et al., [10] “describe the BRIS (Beach Ridges Interspersed with Swales) soil as problematic in Malaysia”. “It lacks in many aspects. Although BRIS soils are regarded as problematic lowland soils for agriculture because of their very sandy texture and concomitant infertility, agricultural activities in such soils have recently been increasing” [11]. This study aims to evaluate some suitable varieties for planting in different types of soil. All the best hybrid corn varieties with high yield, wide adaptability, and high stability were evaluated for cultivation in BRIS soil as a recommendation to the growers or farmers [12].

2. MATERIAL AND METHODS

2.1 Germplasm

Eighteen treatments (variety) were selected for trials in this study (Picture 1). The varieties involved were V1(P4546), V2(P7875), V3(P3582), V4(P4554), V5(P3537), V6(P3136), V7(GWG111), V8(GWG888), V9(GWG5002), V10(GWG5005), V11(GT709), V12(GT722), V13(GT822), V14(DK9979C), V15(DK9950C), V16(DK9919C), V17(DK9898C), and V18(DK6818C).

Picture 1: Eighteen treatments (variety) were selected for trials in this study

2.2 Experimental sites

Five locations were chosen for their evaluation: MARDI Seberang Perai, Pulau Pinang (northern area, mineral soil), MARDI Serdang (middle western/central area, mineral soil), MARDI Bachok, Kelantan (eastern area, sandy soil), MARDI Kluang (southern area, mineral soil) and PPK Bakri, Labis (farmer's plot, mineral soil) [13]. The study was conducted at the MARDI Bachok, Kelantan field, which involves a 0.5 ha covered area. The soil type is Beach Ridges Interspersed with Swales (BRIS) soil in the Rudua Series, whereas sandy soil has the coordinates 5.97838 and 102.42752.

2.3 Experimental design

The treatments were arranged in a randomized complete block design (RCBD) with 18 levels of treatment with three replicates**.** Each genotype plot consisted of seven rows with a length of 5 m for each row, whereas the planting distance was 20 and 75 cm within and between rows, respectively. Two seeds were sown at each point, but only one seedling was allowed to grow after a week after emergence for a final plant population density of 66,666 plants per ha. Data were recorded from five central rows of each plot to reduce the border effects. The plant density of this plot is 25 cm x 75cm, with a population estimated at 66,666 plants per ha.

2.4 Crop management

Processed chicken dung was applied as an organic matter at the rate for Bris soil 6000 kg/ha. Fertilizers were used at 120 kg N, 60 kg P, and 60 kg K ha^{-1} as recommended for the area. Nitrogen was applied twice: at ten days and 30 days after planting. The fertilizer rate of this plot was NPK (120:60:60) for basal and top dressing (Two applications). Fertilizers were applied to each plot 10 and 30 days after sowing (DAS). The corn will be harvested when the average cob moisture content is below 30%. Chemical control for pests and diseases was implemented when a disease or insect infestation was observed in the plot area. The rain gun sprinkler system, designed for high-pressure water delivery, was strategically positioned to cover experiment field areas. Irrigation scheduling was done twice per day at 8.30 am and 2.30 pm. The watering was applied to ensure soil moisture levels were maintained between 70% and 90% of field capacity.

2.5 Parameter collection

All parameters for data collection are i) morphological data, which included days to 50% pollen shed, plant height, and cob height, ii) yield components such as cob length (m), cob girth (m), cob weight with husk (g), cob weight with no husk (g), core weight (g) and grain moisture (%) (Four plants sample were selected at each triangle of experiment plot), iii) crop cutting test (CCT) for 1 ha yield estimation at 14% moisture content. All the data, such as agronomic, yield (CCT), and yield components, were recorded at harvest.

The formula for CCT yield is shown below;

$$\text{CCT Yield at (14\%) (kg/ha)} = \frac{\text{Total cob weight with no husk (kg) x 1 ha}}{\text{CCT area (m}^2\text{)}}$$

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

2.6 Data analysis

Data obtained were subjected to statistical analysis using analysis of variance (ANOVA) procedures to test the significant effect of all the variables investigated using SAS version 9.1 [14]. Means were separated using the Duncan Multiple Range Test (DMRT) as the test of significance at p ≤0.05

3. RESULTS AND DISCUSSION

3.1 Plant growth performance

Table 1 presents the variance analysis (ANOVA) results for 18 tested grain corn hybrids. All hybrids showed an average of 102 days of maturity in BRIS soil. Some of the characters in this study showed significant effects of planting season except for cob length, cob weight with husk, 1000 grain weight, grain moisture, and CCT-yield characters. All hybrids only took 52 days on average to produce 50% flowering. According to Abendroth [15], kernel development proceeds through several distinct leaf staging protocols; the kernel growth stage for an entire field is defined when at least 50% of the plants in a field have reached that stage. Yield per hectare was insignificant between all hybrids, with an average of 11195.8 kg/ha. Compared to mineral soil, the corn will be harvested at 110–120 DAS with an average yield of 4586 kg/ha [16]. 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 [13].

Table 1: ANOVA analysis, mean squares value (hybrid and rep), mean performance and coefficients of variation (c.v.) for 17 characters measured on 18 grain corn hybrids evaluated

Source	Hybrid	Rep	Average	CV
Days to 50% pollen shed	14.5 **	172.3 **	52.5	3.1
Maturity date	0	0	102	0
Plant height (m)	0.09 **	0.03 *	2.27	3.9
Ear placement height (m)	0.03 **	0.03 *	1.07	8.0
Cob length (mm)	276.2 ns	322.0 ns	175.3	7.9
Cob girth (diameter)	17.1 **	3.15 ns	47.8	2.8
Yield component: Cob weight	2148.4 ns	21263.3 **	234.9	16.2

with husk (g)				
Yield component: Cob weight with no husk (g)	2294.8 *	17646.9 **	207.4	16.1
Core weight (g)	152.02 **	69.9 ns	45.5	14.4
Grain weight (g)	1817.2**	1107.8 ns	178.2	15.4
1000 grain weight (g)	4051.9 ns	2887.3 ns	392.4	14.3
Total plant no	292.6 ns	131.9 ns	125.6	14.8
Total Cob	361.2 ns	133.3 ns	120.5	17.1
Cob weight with husk (kg)	24.4 ns	11.5 ns	29.9	14.8
Cob weight with no husk (kg)	21.2 ns	30.4 ns	25.5	16.6
Grain moisture (%)	3.9 ns	20.0 **	29.1	5.9
CCT- yield (14% moisture content) (kg/ha)	3613151.1 ns	5842781.9 ns	11195.8	16.7

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

3.2 Yield performance

However, the CCT yield was not significantly different among all the hybrid varieties tested. Comparison between varieties for plots in Bachok, V14 (DK9979C) showed the highest yield compared to the others of 12945 kg/ha followed by V4 (P4554) and V18 (DK6818C) 12851 kg/ha and 12056 kg/ha respectively (Figure 1). However, the yield for control varieties V1 (P4546) is slightly less than V14, which is only 10500 kg/ha. On average, most of the results obtained are on average above 11196 kg/ha for all varieties. This value, however, was not significant with all other hybrids. This result suggests that all selected hybrids by farmers performed similarly to control hybrid P4546. However, these results show that the yield for all varieties evaluated is still high when compared to the average yield for peninsular Malaysia, and MARDI has tested the average result for commercial-scale planting, and the economic data showed that it is not cost-effective[17]. Yields ranged from 1.31 tonne/ha to 4.6 tonne/ha based on the trials at two estates in Peninsular Malaysia. A report from Mohamad Hifzan [3] also said the average yield of grain corn tested in Kelantan is about 3.7 to 4.5 tons per hectare.

Among other factors influencing the increase in yield at Bachok for all varieties are soil structure and organic matter in the Bris soil tested. An article from Mario Petkovski [18] said the soil structure affects the penetration, growth, and attachment of the root system of corn. It also regulates the balance between air and moisture, water retention capacity, and drainage, affecting erosion potential. He also said that organic matter plays a significant role in the positive characteristics of good soil. It binds the particles and determines the storage and release of nutrients. The soil's type and amount of organic matter affect the microbial activity and the availability of nitrogen, phosphorus, and sulfur. Also, the amount of organic matter contributes to the degree of absorption and degradation of agrochemical compounds. Thus, using 10 tons of chicken manure base fertilizer per hectare from the past sweet potato cultivation over the years has provided enough organic matter content required by the grain corn tested. In this study as well, it was found that pest and disease infestations were very low. This has been supportive of increased yield. Environmental factors such as soil type and dry or sunny weather could significantly influence this early flowering character. Kazan [19] and Takeno [20] claimed that plants often show accelerated flowering under stressful conditions. Plant height, grain moisture content, and CCT yield were highest at MARDI Bachok. These results suggested that MARDI Bachok was the best location for planting grain corn to achieve early maturity, good growth performance, and high yield [13].

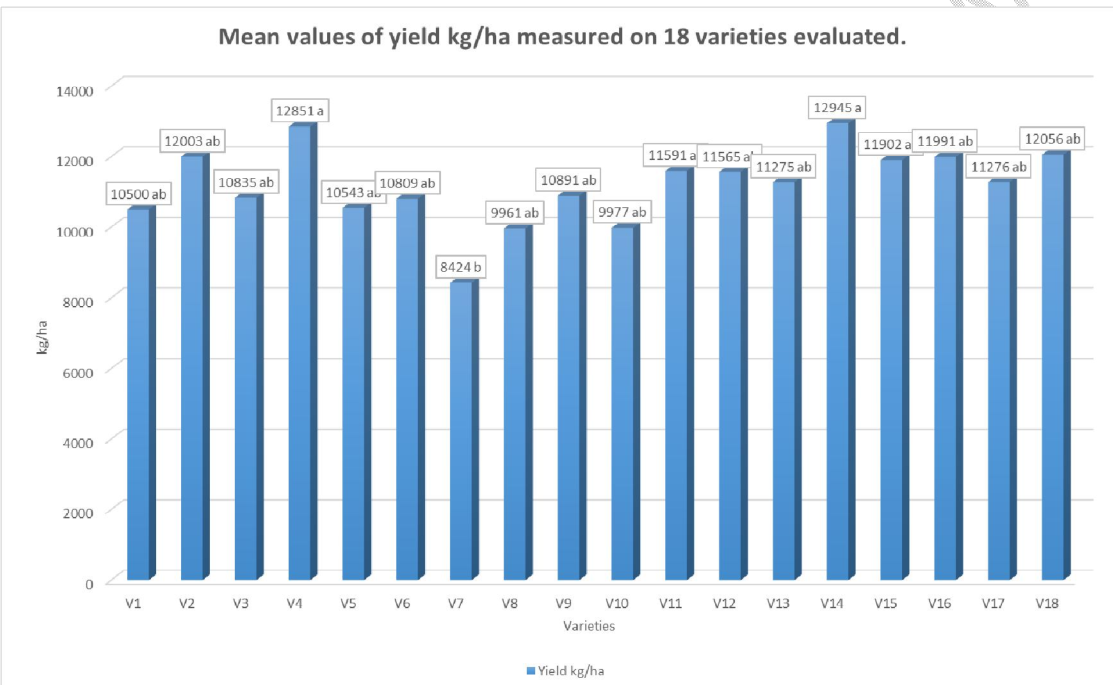

Figure 1: Mean values of yield kg/ha measured on 18 varieties evaluated. Mean values followed by the same letter in the graph are not significantly different at p>0.05

4. CONCLUSION

Cultivation of grain corn grown in BRIS soil gives high yields for all 18 varieties tested. These results showed that the performance of grain corn in BRIS soil is suitable for grain corn planting. This high yield is influenced by the availability of organic matter present in the BRIS soil and the sandy soil structure, which affects the penetration, growth, and attachment of the root system of corn. The high yield also increases because of the reduced infestation rate of pests and diseases.

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