International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 12 Issue 1 ǁ January 2024 ǁ PP. 324-330

Evaluation of Agronomic Characters of Some Local Bali Corn Accessions

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Abstract

Local accessions can be utilized if these accessions already have information about their characteristics. Calculation of phenotypic and genotypic variance, heritability and correlation between traits is a supporting basis for genetic improvement of a trait. This research aims to determine the agronomic characteristics of several local Balinese corn accessions as well as Genetic Variations Coefficient (GVC) and Phenotypic Variations Coefficient (PVC) and correlations between observed variables. The research used a randomized block design consisting of 9 accessions and repeated 3 times so that there were 27 experimental plots. The research results showed that Belok Sidan Barak gave the highest grain yield/ha (7.50 tons), which was not significantly different from Pangkung Paruk Barak (6.95 tons) and Bayung Gede Barak (5.50 tons) which was supported by cob diameter, cob weight and the highest harvest index (4.83 cm, 160.35 g and 45.99 respectively). Plant yield variables were strongly correlated with number of leaves (r=0.67), cob length (r=0.82), cob diameter (r=0.89), cob weight (r=0.98), dry stover weight (r=0.90), and 1000 seeds weight (r=0.72). Selection will be more efficient and effective if carried out on the characteristics of number of leaves, cob diameter, cob weight, grain yield/plant, grain yield/ha, dry weight of grain/plant, dry root weight per plant, dry stover weight /plant and harvest index, each of which has a high value of heritability, GVC and PVC.

Keywords: *accession, character, evaluation, local corn.*

Date of Submission: 19-01-2024 Date of acceptance: 02-02-2024

I. INTRODUCTION

Corn is classified as a plant that is intensively cultivated in the world [31]. Superior corn can be obtained through plant breeding programs. Plant breeding is an effort to increase the ability of plants by improving plant characteristics so that superior plants are obtained [40]. The main requirement in efforts to form new superior varieties is the availability of genetic material with wide diversity [3]. Planning and implementing breeding programs to improve quantitative traits depends on the amount of genetic diversity as well as the expertise of the breeder [1]. From this genetic diversity, the required genotypes will be obtained according to the objectives of plant breeding. This genetic diversity will be obtained from germplasm collections which include, among other things, local species. N'da et al. [24] stated that the formation of superior varieties is very dependent on local accessions. These local resources are raw materials used by breeders to improve the quality and productivity of corn. Nasution and Buri [23] stated that farmers generally plant new superior varieties thereby eroding local varieties, while local types play an important role in creating new varieties, so local accessions need to be preserved. To form this superior variety, local accessions need to be characterized first. Characterization aims to determine the important characteristics of an accession which will make it easier to choose in the formation of superior varieties [34]. Local accessions can be utilized if these accessions already have information about their characteristics [3]. Calculation of phenotypic and genotypic diversity, heritability and correlation between traits is a supporting basis for genetic improvement of a trait [2, 7, 36]. Heritability is the ratio of genotypic variance to total phenotypic variance for a trait in a population and shows the components of a character that are transferred to the next generation. The heritability value is a measure of how easily a character can be inherited, where a high heritability estimate indicates that genetic factors play a greater role in the appearance of a character. However, if the heritability is low, it indicates that environmental influences play a greater role than genetic factors [12, 19, 21]. Correlation measures the relationship between traits and can have positive or negative values [16, 17]. This correlation value is important for direct or indirect selection of characters related to results [2]. This research aims to determine agronomic traits, correlation between observed variables, heritability, genetic variation and phenotypic variation of several local Balinese corn accessions.

II. MATERIALS AND METHODS

Research was carried out at the Experimental Garden of the Faculty of Agriculture, Udayana University and at the Plant Breeding and Seed Technology Laboratory, Faculty of Agriculture, Udayana University, Bali Province, Indonesia. In this experiment, 9 local Balinese corn accessions were tested as a result of previously carried out exploration activities. The tools used were soil processing tools, sprayers, irrigation pipes, meters, scales, ovens and stationery. The materials used were 9 local Balinese corn accessions resulting from exploration, namely: Pangkung Paruk Barak, Pangkung Paruk Putih, Putih Purwakerti, Ketan Bunutan Abang, Bayung Gede Barak, Injin Daup, Nusa Penida Putih, Belok Sidan Barak, and Belok Sidan Ketan [28], Urea fertilizer, TSP and KCL, furadan as well as insecticides and fungicides.

The design used in this research was a randomized block design with 9 treatments of local Balinese corn accessions with 3 replications so that there were 27 experimental plots. Land cultivation was carried out by plowing, hoeing and forming plots. Planting distance 25x80 cm and one plant per hole. Basic fertilizer was given at the same time as planting, namely 150 kg Urea/ha, 100 kg SP36/ha and 100 kg KCL/ha spread at a distance of 15 cm from the planting hole. Additional fertilizer was given at the same time as weeding, namely 3 weeks after planting at a dose of 100 kg Urea/ha. The variables observed were growth components, yield components and plant yields. Data were analyzed using analysis of variance, Genetic Variations Coefficient (GVC), Phenotypic Variations Coefficient (PVC), Broad Sense Heritability and correlation between traits referring to Knight [16] and Jilo et al. [43].

III. RESULT AND DISCUSSION

Selection for desired traits in crop improvement will be effective if there is diversity in the genotypes tested (Alam et al, 2022). The results of research on nine accessions of local Balinese corn as a result of exploration show very significant differences in the variables of number of leaves, cob weight, grain yield /plant, grain yield /ha and dry yield /plant, have a significant differences in the variables of maximum plant height, leaf width, cob diameter, dry root weight /plant and harvest index and had no significant effect on the variables leaf length, cob length, 1000 seeds weight and dry stover weight /plant. This shows that genetic improvement is possible by selecting for the characters of number of leaves, cob weight, grain yield /plant, grain yield /ha, dry yield /plant, maximum plant height, leaf width, cob diameter, dry root weight /plant and harvest index.

The average accession tested was a tall plant with significant differences. The tallest accession was Bayung Gede Barak (265.33 cm) which was not significantly different from Pangkung Paruk Barak (244.66 cm), Pangkung Paruk Putih (233.77 cm) and Injin Daup (231.61 cm) and the shortest was Nusa Penida Putih (187.16 cm). The tallest plants were followed by the highest number of leaves (15.00 leaves), but the shortest plants did not give the lowest number of leaves (9.22 leaves). The least number of leaves was given by Ketan Bunutan Abang (8.77) although it was not significantly different (Table 1). This shows that the stems of each accession have different internode lengths. The accessions tested on average have long leaves that are not significantly different. Leaf width among accessions was significantly different (Table 1) with the widest leaf given by Belok Sidan Ketan (8.69 cm) and the narrowest leaf was Injin daup (6.70 cm).

Tabel 1. Average plant height, number of leaves, leaf length and leaf width

No	Accession	Plant height (cm)	Number of leaves (leaflets)	Leaf length (cm)	Leaf width (cm)
1	Pangkung Paruk Barak	244.66 ab	11.55 b	79.14 a	7.94 abc
2	Pangkung Paruk Putih	233.77 ab	10.88 b	75.73 ab	8.32 ab
3	Putih Purwakerti	219.44 bc	10.22 bc	75.27 ab	7.87 abc
4	Ketan Bunutan Abang	217.05 bc	8.77 c	71.59 ab	7.94 abc
5	Bayung Gede Barak	265.33 a	15.00 a	77.74 a	8.31 ab
6	Injin Daup	231.61 ab	14.00 a	67.62 b	6.70 d
7	Nusa Penida Putih	187.16 c	9.22 c	74.01 ab	7.12 bcd
8	Belok Sidan Barak	210.44 bc	14.22 a	71.96 ab	6.88 cd
9	Belok Sidan Ketan	219.83 bc	11.00 b	73.79 ab	8.69 a

Notes: Mean values followed by the same letter in the same column are not significantly different in Duncant test at 5% level.

In terms of yield variables, Belok Sidan Barak gave the highest grain yield/ha (7.50 tons) which was not significantly different from Pangkung Paruk Barak (6.95 tons) and Bayung Gede Barak (5.50 tons). The high yield of Belok Sidan Barak was supported by high grain yield/plant (140.68 g), dry yield/plant was also the highest (122.84 g) (Table 3). The high grain yield was supported by high yield components and growth components. The average cob length of the nine accessions was not significantly different but Belok Sidan Barak had the highest cob diameter (4.83 cm) and the highest cob weight (160.35 g) which was not significantly different from the highest cob weight (168.57 g) given by Pangkung Paruk Barak (Table 2). When viewed from the growth components, Belok Sidan Barak plants were not too tall (210.44 cm) compared to the others, the number of leaves was large (14.22 leaves) but the leaves were relatively short and narrow (71.96 cm and 6.88 cm) (Table 2). With the appearance of vegetative parts like that, the weight of stover obtained is also low at 131.51 g which is not significantly different from the lowest stover weight of White Purwakerti (125.44 g) (Table 4). Under these conditions, Belok Sidan Barak is the most effective accession in utilizing sunlight as indicated by the highest harvest index value of 45.99.

Table 2. Average cob length, cob diameter, cob weight and 1000 seed weight

No.	Accession	Cob length (cm)	Cob diameter (cm)	Cob weight (g)	1000 seed weight (g)
1	Pangkung Paruk Barak	16.28 ab	4.82 a	168.57 a	311.71 ab
2	Pangkung Paruk Putih	15.08 ab	3.99 ab	108.01 bc	274.33 ab
3	Putih Purwakerti	15.02 ab	3.53 ab	103.62 bc	261.31 ab
4	Ketan Bunutan Abang	12.32 ab	3.26 b	60.82 c	240.23 ab
5	Bayung Gede Barak	17.95 a	4.82 a	141.94 ab	318.55 a
6	Injin Daup	13.35 ab	4.01 ab	99.40 bc	298.21 ab
7	Nusa Penida Putih	9.81 b	2.71 b	75.54 c	188.66 b
8	Belok Sidan Barak	17.83 a	4.83 a	160.35 a	307.44 ab
9	Belok Sidan Ketan	15.14 ab	3.97 ab	91.40 bc	299.69 ab

Notes: Mean values followed by the same letter in the same column are not significantly different in Duncant test at 5% level.

The lowest grain yield/plant and grain yield/ha were obtained in Ketan Bunutan Abang accession (41.30 g and 2.23 tons), which was not significantly different from Nusa Penida Putih (53.80 g and 2.87 tons) (Table 3). This low yield is also supported by the low cob length, cob diameter, cob weight and 1000 seeds weight (12.32 cm, 3.26 cm, 60.82 g, 240.23 g in Ketan Bunutan Abang and 9.81 cm, 2.71 cm, 75.54 g and 188.66 g in Nusa Penida Putih) (Table 2). In terms of growth components, Ketan Bunutan Abang had the lowest number of leaves (8.77 leaves), which was not significantly different from Nusa Penida Putih (9.22 leaves), but Ketan Bunutan Abang had relatively wide leaves (7.94 cm), which was not significantly different from the widest leaves of the accession Belok Sidan Ketan (8.69 cm) (Table 1), and the lowest dry root weight (10.46) (Table 4).

Correlation measures the relationship between two traits or variables [16]. The correlation value indicates the closeness of the relationship between two variables, which is useful for researchers for indirect selection (Adhikari, 2018). Correlations are categorized as weak (0.0-0.3), moderate (0.3-0.7) and strong (0.7-1.0). Moore et al. (2015) categorized very weak ($r < 0.3$), weak ($0.3 < r < 0.5$), moderate ($0.5 < r < 0.7$) and strong ($r > 0.7$). From the above description, when viewed from the correlation value, it turns out that the grain yield variable is strongly correlated (0.7-1.0) with the number of leaves ($r = 0.67$), cob length ($r = 0.82$), cob diameter (0.89), cob weight (0.98), dry stover weight (0.90), and 1000 seed weight (0.72) (Table 6). Similar results were obtained by Reddy and Jabeen [30], Synrem et al. [39] and Pandey et al. [27] on cob length and 100 seed weight, Soumya and Kamatar [35] on cob weight and Devasree et al. [8] for cob length, cob weight and 100 seed weight. This indicates that the variables of number of leaves, cob length, cob diameter, cob weight, dry stover weight, and 1000 seed weight need to be prioritized in selection to increase yield [8, 25].

Table 3. Average grain yield/plant, grain yield/ha, dry yield/plant.

No	Accession	grain yield/plant (g)	grain yield/ha (tons)	dry yield/plant (g)
1	Pangkung Paruk Barak	130.38 ab	6.95 ab	113.23 a
2	Pangkung Paruk Putih	92.95 bcd	4.95 bcd	80.45 bc
3	Putih Purwakerti	78.21 cde	4.17 cde	66.06 bc

4	Ketan Bunutan Abang	41.90 e	2.23 e	68.87 bc
5	Bayung Gede Barak	103.19 abc	5.50 abc	91.76 ab
6	Injin Daup	78.00 cde	4.16 cde	55.83 c
7	Nusa Penida Putih	53.80 de	2.87 de	62.70 bc
8	Belok Sidan Barak	140.68 a	7.50 a	122.84 a
9	Belok Sidan Ketan	71.68 cde	3.82 cde	62.01 bc

Notes: Mean values followed by the same letter in the same column are not significantly different in Duncant test at 5% level.

Table 4. Average dry root weight/plant, dry stover weight/ plant and harvest index

No	Accession	dry root weight (g)	dry stover weight (g)	Harvest index (%)
1	Pangkung Paruk Barak	22.00 b	178.46 b	35.95 ab
2	Pangkung Paruk Putih	14.68 b	143.56 bc	33.74 ab
3	Putih Purwakerti	14.20 b	125.44 c	32.66 b
4	Ketan Bunutan Abang	10.46 b	130.04 c	31.93 b
5	Bayung Gede Barak	33.71 a	261.97 a	23.62 b
6	Injin Daup	21.65 b	135.48 bc	26.35 b
7	Nusa Penida Putih	12. 86 b	145.66 bc	28.12 b
8	Belok Sidan Barak	13.58. b	131.51 c	45.99 a
9	Belok Sidan Ketan	12.89 b	140.66 bc	29.37 b

Notes: Mean values followed by the same letter in the same column are not significantly different in Duncant test at 5% level.

Table 5: Correlation values between observed variables

VP	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1													
2	0.580	1												
3	0.437	-0.070	1											
4	0.438	-0.246	0.629	1										
5	0.674	0.707	0.402	0.283	1									
6	0.715	0.801	0.323	0.108	0.924	1								
7	0.524	0.677	0.480	-0.050	0.826	0.903	1							
8	0.835	0.722	0.367	0.106	0.506	0.610	0.535	1						
9	0.298	0.451	0.444	-0.063	0.710	0.768	0.882	0.256	1					
10	0.425	0.670	0.377	-0.107	0.823	0.890	0.978	0.400	0.895	1				
11	0.298	0.451	0.444	-0.063	0.710	0.768	0.882	0.256	1.000	0.895	1			
12	0.757	0.782	0.166	0.201	0.884	0.935	0.733	0.578	0.516	0.722	0.516	1		
13	0.42	0.67	0.38	-0.11	0.82	0.89	0.98	0.40	0.89	1.00	0.89	0.72	1	
14	-0.286	0.028	0.006	-0.253	0.362	0.330	0.468	-0.455	0.701	0.595	0.701	0.167	0.595	1

Description:

1. plant height, 2. number of leaves, 3. leaf length, 4. leaf width, 5. cob length, 6. cob diameter, 7. cob weight, 8. Dry root weight, 9. Dry stover weight, 10. grain yield/plant, 11. dry yield/plant, 12. 1000 seed weight, 13. Grain yield/ha, 14. harvest index.

The genetic diversity and heritability of tested accessions are key to efficiency in plant breeding programs [26, 19, 32]. The amount of genetic diversity is not useful enough for breeders without being complemented by information on heritability estimates that show the amount of inherited traits from existing diversity [38]. The existence of genetic diversity can be seen from the value of the Genetic Variations Coefficient (GVC) but the level of inheritable diversity will be seen from the heritability value [29]. Estimating the heritability of the observed variables can be the basis for further analysis in selecting the desired characters from a genotype [11]. Heritability is classified as low (<0.2), medium (0.2-0.4) and high (>0.4) [1]. Heritability values ranged from 0.08 (low) in 1000 seed weight to high (0.88) in number of leaves. The variable cob length had a low heritability value (0.18), leaf length and harvest index had moderate heritability values (0.26 and 0.36) while the rest of the plant height, number of leaves, leaf width, cob weight, grain yield/plant, dry yield/plant, dry root weight and dry stover weight had high heritability values (0.42; 0.88; 0.47; 0.59; 0.65; 0.59; 0.48 and 0.59) (Table 6). The same heritability for cob weight and grain yield/plant was obtained by [37], namely 0.59 and 0.60. This high heritability value indicates that genetic factors play a greater role in the appearance of these characters than environmental factors [1, 3, 12]. Traits with high heritability values have the possibility to be inherited [20]. Ogunniyan and Olakojo [26], stated that characters with high heritability values will provide high genetic progress values in plant breeding activities. High heritability makes it possible to determine the direction and manner of selection [17, 41].

Penotype diversity is the difference of plants in the population caused by genetic composition and growing environment [38]. Phenotypic Variations Coefficient (PVC) describes the diversity of plant traits visually [42]. A high PVC value indicates a high diversity of the observed characters. If the GVC value is close to the PVC value, it means that the diversity of a character is more due to genetic factors. The results showed that the PVC value is greater than the GVC value, this means that environmental factors affect the appearance of the observed traits [13, 33, 42]. The same results were obtained in the research [14, 22, 5, 1, 44]. According to Adhikari [1], this can be overcome by providing an optimum growing environment. The GVC and PVC values are divided into 3 categories, namely >20% high, 10-20% medium, and <10% low [44]. GVC and PVC with low values were obtained in leaf length (3.35 and 6.55). GVC with low value but medium value of PVC was obtained in plant height (8.07 and 12.53) and leaf width (7.63 and 11.09), GVC with medium value but high value of PVC was obtained in number of leaves (18.90 and 20.12), cob length (11.11 and 26.37), cob diameter (14.80 and 24.90) and harvest index (16.07 and 26.94), and GVC and PVC with high values were shown by cob weight (29.82 and 38.92), grain yield/plant (34.31 and 42.60) grain yield/ha (34.34 and 42.63) dry yield/plant (37.14 and 43.96) and dry root weight (36.17 and 52.00) (Table 6). Selection on characters with these high PVC and GVC values will allow for increased crop yield [38].

According to Effendy et al. [10] and Karyawati et al. [15] selection on characters with high heritability and diversity values will be more effective and efficient. From the results of this study, selection will be more efficient and effective when carried out on the number of leaves, cob diameter, cob weight, grain yield/plant, grain yield/ha, dry yied/plant, dry root weight, dry stover weight and harvest index, each of which has high heritability, GVC and PVC values.

The low GVC value but high PVC was shown by 1000 seed weight (6.88 and 24.43). This indicates that 1000-seed weight is strongly influenced by the environment. This condition is also evident from the very low heritability value (0.08) which indicates that the genetic role is very low for this character so it is not suitable when used as a selection variable. Ahsan et al. [4] stated that if heritability is low, it is necessary to expand diversity, for example by crossing or mutation.

Tabel 6. Heritability, Genetic Variations Coefficient (GVC) and Phenotypic Variations Coefficient (PVC) values

No	Variable Observation	H	GVC	PVC
1	Maximum plant height (cm)	0.42	8.07	12.53
2	Number of leaves (pieces)	0.88	18.9	20.12
3	Leaf length (cm)	0.26	3.35	6.55
4	Leaf width (cm)	0.47	7.63	11.09
5	Cob length (cm)	0.18	11.11	26.37
6	Cob diameter (cm)	0.35	14.8	24.9
7	Cob weight (g)	0.59	29.82	38.92
8	grain yield/plant (g)	0.65	34.31	42.6
9	1000 seeds weight (g)	0.08	6.88	24.43
10	Grain yield/ha (ton)	0.65	34.34	42.63
11	dry yield/plant (g)	0.59	37.14	43.96
12	dry root weight/plant (g)	0.48	36.17	52
13	dry stover weight/plant (g)	0.59	26.86	35.01
14	Harvest index	0.36	16.07	26.94

IV. CONCLUSION

The results of research on nine local Balinese corn accessions from exploration showed very significant differences in the variables of number of leaves, cob weight, grain yield/plant (g), grain yield/ha and dry yield/plant, significant differences in the variables of maximum plant height, leaf width, cob diameter, dry root weight/plant and harvest index and had no significant effect on the variables of leaf length, cob length, 1000 seeds weight and dry stover weight/plant. Belok Sidan Barak gave the highest grain yield/ha (7.50 tons) which was not significantly different from Pangkung Paruk Barak (6.95 tons) and Bayung Gede Barak (5.50 tons) supported by the highest cob diameter, cob weight and harvest index (4.83 cm, 160.35 g and 45.99). Crop yield variables were strongly correlated (0.7-1.0) with number of leaves (r=0.67), cob length (r=0.82), cob diameter (0.89), cob weight (0.98), dry stover weight (0.90), and 1000 seed weight (0.72). Variables with high heritability values were plant height (0.42), leaf number (0.88), leaf width (0.47), cob weight (0.59), grain yield/plant (0.65), dry yield/plant (0.59), dry root weight (0.48) and dry stover weight (0.59). The value of PVC was greater than the value of GVC. GVC and PVC with high values were shown by cob weight (29.82 and 38.92), grain yield/plant (34.31 and 42.60), grain yield/ha (34.34 and 42.63), dry yield/plant (37.14 and 43.96) and dry root weight (36.17 and 52.00). Selection will be more efficient and effective if done on the number of leaves, cob diameter, cob weight, grain yield/plant, grain yield/ha, dry yield/plant, dry root weight, dry stover weight and harvest index, each of which has high heritability, GVC and PVC values.

ACKNOWLEDGMENTS

The research team would like to thank the Head of Udayana University for providing funds so that this research can be carried out. Thanks also goes to the Head of the Faculty of Agriculture, Udayana University, Head of Institute for Research and Community Service, Udayana University and staff for all the help so that the research can run smoothly.

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