The Genotype and Crop Age Effect on Nutritive Value of Corn Forage

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ABSTRACT

Background: The Corn crop (*Zea mays*) was one type of feed crop which is a good source of crude fiber for ruminant. Corn crops had several types of genotypes and each genotype had its advantages in terms of productivity and nutritional content.

Methods: The study was conducted from January to May 2018, at the Agricultural Research and Development Research Studio located at Arjasari Village, Arjasari District, Bandung Regency, West Java, in Indonesia. The purpose of this study was to determine the effect of various genotypes and crop ages on crude protein, crude fiber, crude fat, energy and Nitrogen free extract of Corn forage. This research was designed with an experimental method using a Completely Randomized Design. The treatments in this study were the genotype of Corn crop and the crop age.

Result: The results of the statistical analysis showed that the interaction of genotype and age gave different results on Nitrogen free extract and crude fiber at 5% significant level test. Genotype and age interaction did not give different results on Energy, Crude Fat and Crude Protein at 5% significant level test.

Key words: Corn genotype, Harvest time, Nutritional forage.

INTRODUCTION

The development of Corn in Indonesia has very good prospect as one of the most important sources of carbohydrate after the rice. Indriani *et al.* (2019), states that ruminant productivity depends on the availability of high-quality forage. Furthermore Kabir *et al.* (2019) states that farmers grow Corn crop to be consumed as food and feed. The opinion of Basit *et al.* (2018) informs that there is very important need to develop Corn varieties genetically to obtain the forage yields and higher nutritional quality.

Updating agronomic adaptation, yields and quality are required in order to get new plant genotypes in the area (Mut *et al.*, 2015). Genetic characters are controlled by the action of additive genes and can be used for plant improvement through selection (Singh *et al.*, 2019). Resistance genotypes will help varieties against viral diseases and controlling plant viruses (Sravika *et al.*, 2019). According to Banotra *et al.* (2017) the plant growth and development is influenced by the selection of cultivars and varieties for different yields, quality and maturity of plants. Islam *et al.* (2020) said that the best genotypes improving rice varieties.

Superior hybrids reduce the negative influence of environment and increase the positive factors of hybrid yields (Yuwariah *et al.*, 2020). One effective tool in influencing the production and the forage quality of maize crop is the selection of suitable maize genotypes (Hakl *et al.*, 2017). Sufficient genetic diversity, heritability and genetic advancement under normal and heat stress environments are suitable for breeding improvement programs (Thapa *et al.*, 2019). Vaswani *et al.* (2016) showed two varieties of maize harvested at 70-80 DAP (days after planting) and resulted green, fresh, good quality and palatable forages were efficient for ruminant feed. According to Cahya (2018),

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harvest age determines the quality of Corn crops. The selections of crop characteristics is an effective way to develop the high production crop (Verma *et al.*, 2015).

Various genotypes of corn crops animal feed differ substantially in their chemical composition (Vaswani *et al.*, 2016). The research on genotype can select the high quality crop as systematic method of crop development in the future (Chowdhury *et al.*, 2020). The genotype advantage correlated with wide adaptation and growth strength in the rain fed conditions (Giridhar *et al.*, 2016). Rochana *et al.* (2016) states that crude protein is very important for the life and ruminants growth. Crude protein helps in breaking crude fibers derived from forage and providing amino acids for ruminants. According to Salama (2019) the lowest crude protein is at the highest harvest age with the highest crude

fiber. Hartadi *et al*. (2005) stated that Total Degestible Nutrient (TDN) values was influenced by crude protein, crude fiber, crude fat and Nitrogen free extract (NFE). Higher composition will increase the forage TDN value and vice versa. NFE level is influenced by forage feed water content, ash, crude protein, crude fat and crude fiber.

MATERIALS AND METHODS

The study was conducted from January to May 2018, at the Agricultural Research and Development Research Studio (SPLPP) at 800 m AGL and 3500 mm/year rainfall located in Arjasari Village, Arjasari District, Bandung Regency in the West Java. The research used three maize genotypes which are containing high crude protein. This research was conducted by an experimental method. The design used was a Completely Randomized Design (CRD) with a factorial pattern of 3 x 3 which was repeated 6 times. There were 54 experimental units:

a. The first factor was Maize genotype
   G1: 1x4 (DR10 x DR 18)
   G2: 3x4 (MDR 741 x DR18)
   G3: VAR B DR14 x DR18
b. The second factor was the age of Maize crop
   U1: 80 DAP
   U2: 90 DAP
   U3: 100 DAP
c. Response design
   Observation of forage quality included the crude protein, crude fiber, crude fat, energy and NFE.

The next step was data analysis using the Anova method for variance analysis. The analysis used Duncan's multiple range test to find out the differences in mean value. Statistical calculations completed by the SAS 9.4 version software.

RESULTS AND DISCUSSION

Table 1 to 5 showed the results of the reseach observation as the output of statistical calculations. The tables describe the results of NFE, crude fiber, crude protein, energy and crude fat.

Table 1 showed genotype and crop age interaction on NFE for all treatments. Based on genotypic variance and crop age, the NFE showed significant differences. The genotypes gave different percentages of NFE at various harvest ages. The genotype and crop age interaction on NFE content (% NFE) reached the highest on genotype G1 (50.9767%) at 100 days and did not differ from genotype G1 at 90 days (49.8233%), G2 at 100 days (49.823%), G3 at 90 days (48.4233%) and G3 at 100 days (49.6817%). In the Same age of 90 days, the genotype G2 (47.5567%) had NFE significantly lower than G1 (49, 8233%) and G3 (49.4233%). High NFE levels in 100 days of harvest was may be due to the accumulation of sugar in the stems and the corn seed cause a sweet taste. These carbohydrates will increase the NFE levels in the forage. In young plants (80 days) the NFE was significantly lower than old plants

(100 days). According to Rochana *et al* (2016), NFE levels are strongly influenced by forage nutrient content.

Plants grow on field can express their genotypic advantages very well. According to Ruswandi and Syafi'i (2016) the genotypic adaptation produce different responses based on the environment. Research by Ilmawan (2017) shows that corn crop environment affects the age of harvest. The results of Ammodu *et al*. (2014) study showed that Shimaz Corn NFE content of 91 DAP was 53.6% and significantly lower than WASA Corn 1 NFE (56.6%). Harvest at 105 DAP, the Shimaz NFE content (49.1%) was significantly lower than WASA 1 NFE (52.1%). Likewise the harvest at 119 DAP, Shimaz NFE (48.1%) was significantly lower than WASA 1 NFE (51.7%).

Table 2 showed the genotype and harvest age interaction on crude fiber content. The results of variance showed that corn forage crude fiber was strongly influenced (P <0.05) by genotype and age of harvest. The genotypes gave different percentages of crude fiber at various harvest ages. The highest crude fiber was found in G2 at 80, 90 and 100 days witch were 31.3350%, 31.9167% and 32.6433% respectively and did not differ to G3 at a crop age of 100 days (32.1250%). Interaction of genotype and crop age for G3 (VAR B DR14xDR18) showed the crude fiber increased with increasing crop age. According to Haryani *et al*. (2018) the crude fiber increases as the crop age increase. Opinions from Lemaire and Belanger (2020) suggest that analysis of genetic and environmental variations helps a better understanding of genotype-environment-management-production interactions and forage quality. The results of Hajar *et al*. (2019) showed that Sorghum crude fiber forage gave different value for different varieties. Variety 12 FS9006,

Table 1: Genotype and crop age interaction effect on NFE (%) of corn crop forage.

Treatment	Genotype NFE (%)		
	G1 (1x4)	G2 (3x4)	G3 (Var B)
Crop age			
80	47.3133 c	48.5017 bc	47.0583 c
90	49.8233 ab	47.5567 c	49.4233 ab
100	50.9767 a	49.823 ab	49.6817 ab

Note: Different small font on the table show the significant different (P<0.05).

Table 2: Genotype and crop age interaction effect on crude fiber (%) of corn crop forage.

Treatment	Genotype crude fiber (%)		
	G1 (1x4)	G2 (3x4)	G3 (Var B)
Crop age			
80	30.0600 cd	31.3350 abc	29.8550cd
90	29.3033 d	31.9167 ab	30.5600 bcd
100	30.2917 cd	32.6433 a	32.1250 a

Note: Different small font on the table show the significant different (P<0.05).

13FB7001 and 12549001 reached 30.12%, 28.09% and 31.71% respectively.

Table 3 showed the average crude protein content of Corn forage G1 (DR10xDR18 1x4), G2 (MDR741xDR18 3x4) and G3 (VarBDR14xDR18) were similar and they were 8.8978%, 8.8339% and 8.4706% respectively. Average crude proteins for various ages reached the highest at 80 DAP. The crude protein content of 80 DAP, 90 DAP and 100 DAP were 9.7122%, 8.9656% and 7.5244% respectively. This was in line with Haryani *et al.* (2018) that crude protein content is inversely proportional to grass age. The crude protein content decreases with increasing cutting age. According to Burton *et al.* (1967), the quality of forage decreases with increasing crop age. The genotype and crop age interactions are not significantly different. The results of Amasaib *et al.* (2016) explained that genotype had no effect on crude protein content of *Cyamopsis tetragonoloba* (Guar), namely the Gm1 and Gm3 genotypes. The forage with a high nutrient can be recommended for ruminants. Therefore, to produce high nutritional need to increase the nutrient intake of plants (Susilawati *et al.*, 2019).

According to Turano *et al.* (2016), the crude protein of Pearl millet grass x Napier grass hybrids 2 (PMN2), PMN3, 5344 and 4604 are the similar of 6.4%, 7.0%, 7.9% and 7.9% respectively. The results of Hajar, *et al.* (2019) showed that the crude protein of sorghum 12 FS9006, 13FB7001 and 12549001 variety were 6.62%, 6.47% and 9.18% respectively. In the study of Vaswani, *et al.* (2016) the crude protein of Corn forage HTHM 5101, DHM 117 and HM variety were 8.39%, 6.56% and 7.09% respectively. In the study of Tufail *et al.* (2020) Agaitii Berseem 2002 genotype was superior compared to LBFI (Landrace produced by local farmers) and LBMI (Landrace sold locally in the agricultural market) genotype. Agaitii Berseem 2002 produced the best quality forage if harvested at 65, 110 and 150 DAP.

There were significant variations for green forage energy among the maize genotypes (Table 4). According to Ruswandi and Syafi'I (2016) each genotype has different character in responding to their environment. Furthermore according to Ullmann *et al.* (2017) forage quality can be determined by genotypic and phenotypic. Miller *et al.* (2014) explain that for growing plants need to consider genetic variations in phenotypic plasticity to compare input substances and other environmental variables.

The average energy of the Corn forage on genotypes G1 (DR10xDR18 1x4), was significantly lower (2921.22 kcal) than G2 (MDR741xDR18 3x4) (3001.33 kcal) and G3 (VarBDR14xDR18) (3018.83 kcal). The average energy for various corn ages did not differ significantly at 80 DAP, 90 DAP and 100 DAP, which were 2970.11 kcal, 2988.78 kcal and 2082.50 kcal respectively. In the results of Turano *et al.* (2016) study, the forage energy content for Pearl millet x Napier grass 2 (PMN2) hybrid, PMN3 hybrid and 5344 hybrids are the same at 1700 kcal/kg and 4604 hybrid has 1600 kcal/kg.

Table 3: Genotype and crop age treatment effect on average crude protein (%) of corn crop forage.

Treatment	Average Crude Protein (%)	Significance
Genotipe		
G1 (1x4)	8.8978	a
G2 (3x4)	8.8339	a
G3 (Var B)	8.4706	a
Age		
80	9.7122	a
90	8.9656	b
100	7.5244	c
Interaction	Not significant	

Note: Different small font on the table show the significant different (P<0.05).

Table 4: Genotype and crop age treatment effect on average energy (kcal/kg) of corn crop forage.

Treatment	Average energy (kcal/kg)	Significance
Genotype		
G1 (1x4)	2921.22	b
G2 (3x4)	3001.33	a
G3 (Var B)	3018.83	a
Age		
80	2970.11	a
90	2988.78	a
100	2082.50	a
Interaction	Not significant	

Note: Different small font on the table show the significant different (P<0.05)

Table 5: Genotype and crop age treatment effect on average crude fat (%) of corn crop forage.

Treatment	Average crude fat (%)	Significance
Genotype		
G1 (1x4)	5.6872	b
G2 (3x4)	6.3422	a
G3 (Var B)	5.8644	ab
Age		
80	5.8789	a
90	6.0906	a
100	5.9244	a
Interaction	Not significant	

Note: Different small font on the table show the significant different (P<0.05).

In Table 5, the average crude fat G1 genotype (DR10xDR18 1x4) was significantly lower than G2 (MDR741xDR18 3x4) and was not significantly differ to G3 (VarBDR14xDR18) with were 5.6872%, 6.3422% and 5.8644% respectively. Average crude fats for various Corn ages were not significantly differ among 80 DAP, 90 DAP and 100 DAP, witch were 5.8789%, 6.0906% and 5.9244% respectively. The results of Indriani *et al.* (2018) the fat of corn crops of 8x14 genotype was 3.46% and was significantly different than others 21 genotypes.

CONCLUSION

There are interactions on genotypes and crop age that give different results on NFE and crude fiber at 5% significant level. The genotype and age interactions do not give different results on energy, crude fat and crude protein at 5% significant level.

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