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Agronomic Characters of Wheat (*Triticum aestivum* L.) Grown Using Two Cropping Systems in Medium Land of Palopo City

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Abstract

Wheat (*Triticum aestivum* L.) is a staple food for most of world population and has a good prospect considering the great potential of land to be planted with this plant species which contains carbohydrate of 70% and protein of 3%. The development of this commodity was started from agricultural extensification and production increase through the implementation of cropping system. This study was aimed to provide information on suitable cropping system for wheat cultivation and to examine the effect of cropping system on the increase in wheat production in medium land of Palopo City. This study was conducted in farmer land in Kambo Village, Mungkajang Subdistrict of Palopo City, South Sulawesi at elevation of ± 600 m asl from June until September 2017. This research uses two factor factorial in randomized block design. The first factor consisted of two cropping systems, namely line up system (S_1) and Hazton system (S_2). While, the second factor included two varieties, namely Guri 4 variety (V_1) and Guri 6 variety (V_2). Study result for vegetative phase showed that the best plant height was obtained using line up cropping system in Guri 4 variety (S_1V_1) with average of 73.91 cm. Implementation of Hazton cropping system in Guri 4 variety (S_2V_1) resulted in the best flag leaf area with average of 40.23 cm^2. Hazton cropping system implementation in Guri 6 variety (V_2S_2) indicated the best green color with average value of 11.00 unit. Furthermore, application of line up cropping system (S_1) produced the best total tiller number with average of 18.22 tillers. Therefore, it is concluded that the use of Hazton cropping system was able to increase the wheat production and Guri 4 Variety is expected to adapt to grow in the medium land of Palopo City

Keywords: cropping system, extensification, medium land, production, wheat

A. Introduction

Wheat *Triticum aestivum* L.) is a cerealia plant from the family of Poaceae (Gramineae) originated from subtropical area with optimal temperature of 20°C. This commodity contains great benefits and nutrients, the high component of functional food and storage quality makes wheat becomes a staple food for more than one-third of world population (Porter, 2005). Therefore, consumption and demand of wheat flour in Indonesia experienced increase from 2011 to 2012 with a value of 6% and the supply was mostly depended on wheat import. This situation has encouraged the government in the development and cultivation of tropical wheat which is adapted to the agro-ecosystem of Indonesia.

The development of wheat in Indonesia can be done in highland, medium land, and lowland. However, this commodity will compete with other horticultural commodities that have higher economic value if it is grown in highland. The development of wheat in lowland faces obstacle of high temperature stress. Althuhaish, A.A.K., Miftahudin, Trikoesoemaningtyas & Sudirman, Y. (2014), reported that climate in highland is extremely different from climate in the lowland or medium land at the same latitude. Declining elevation along with the increasing temperature inhibit the growth and development of wheat plant. Yamin (2014) reported that decrease in median value of F4 generation for all agronomic characters in Cisarua (600 masl) was caused by the effect of temperature and water availability. Moreover, wheat farming at high temperature was able to hamper plant growth, number of tiller, and leaf area, as well as declined the yield and yield component (Altuhaish *et al*., 2014). Unfortunately, wheat development in medium area also faces obstacle due to the limited number of planting location thus agricultural extensification is required.

Extensification is the expansion of agricultural land by utilizing areas that have not been used before. Extensification effort is conducted by opening new land for agriculture such as the utilization of forest area. To increase the production and productivity of wheat in Indonesia, particularly in forest area, wheat varieties with the ability to be cultivated in tropical area can be grown by adopting the conventional system, namely jajar legowo and Hazton, thus the production target can be achieved along with the effort to increase sustainable production of wheat.

One of breakthroughs in productivity increase can be done through the implementation of cultivation using jajr legowo cropping system (Ikhwani, G.R.P., Eman, P., & Mukramin, A.K. (2013). The type of jajar legowo cropping system consists of (1) JAJAR LEGOWO 2 : 1, where every two rows of width twice the distance within rows; (2) jajar legowo 4 : 1 , where every four rows of plants is interspersed with one empty row at width of twice the distance within rows (Wahyu, 2012). Cropping system of legowo 4 : 1 type 1 is legowo cropping system in which all rows obtain the inserted plant and is possible to be applied in less fertile land (Abdulrachman, S., Made, J. M., Nurwalen, A., Indra, G., Priyatna, S., & Agus, G. 2013). The adventages of jajar legowo cropping system implementatin (Sembiring, 2001) include: increasing number of plant at the both outersides of each set of legowo and creating oppurtunity in the development of production system for other commodity. Hazron method is a technology that has been developed in several provinces to increase rice productivity. The number of rice seed used in the method is approximately 20 – 30 seed/planting hole, while it is commonly 2 – 3 seed/planting hole (Dirjen Tanaman Pangan, 2016).

Triny, S., Kadir, E., Suhartatik & Sutisna. (2004), stated that cropping system of legowo 2 : 1 was able to increase rice productivity to 18.1%. Natawijaya (2012) reported that Oasis strain has high tolerance to high temperature stress, while HP1744 strain is sensitive to high temperature. Srihartanto, E., Sri, & Suwarti, W.B. (2013), mentioned that implementation of jajar legowo cropping system in hybrid corn grown in inceptisol soil was able to increase the productivity of Bima hybrid corn of 46.8% (10.55 t/ha). Yamin (2014) reported that F3 generation (Oasis x HP1744) in highland (±1100 mdpl) obtained the best performance, namely O/HP-21, O/HP 93, O/HP 82, O/HP 6, O/HP 104, O/HP 22, O/HP 37, O/HP 115, and O/HP 30 and were used for selection on F4 generation in medium land. Strains of F4 generation in medium land that obtained better performance than founder of Oasis and Selayar (National Variety) according to the selection index were strains of O/HP12-23, O/HP 78-2, O/HP82-15, and O/HP 93-3.

This study was aimed to provide information on suitable cropping system to wheat cultivation and to examine the effect of cropping system on wheat production increase in medium land of Palopo City.

B. Methodology

The research was conducted at farmer land in Kambo Village, Mungkajang Subdistrict of Palopo City, South Sulawesi at elevation of ± 600 m asl from June until September 2017. This study used experimental design of factorial with two factors in randomized block design. The first factor consisted of two varieties, namely Guri 4 variety and Guri 6 variety. While the second factor consisted of two cropping systems, namely Hazton method (S_1) and Conventional method (S_2). Each factor was repeated three times. Land processing was done manually using hoe. Land processing was aimed to improve the condition of soil to be used. Planting through Hazton method was done using *tugal* system at a planting distance of 25 cm x 25 cm. Each planting hole was planted with 30 wheat seeds. while, planting with conventional method was done using *line up*, in which no distance was created within rows, yet the distance between rows was 25 cm.

Fertilizing was conducted 2 (two) times, the first one was at a dose of 150 kg/ha Urea, 200 kg/ha SP36, and 100 kg/ha KCl which was done at the age of ± 10 HST (Days After Planting). The second fertilizing at a dose of 150 kg/ha Urea was performed at the age of 30 HST. Number of wheat plant sample observed and measured was 50% of plant population. Agronomic characters measured and observed included plant height (cm), flag leaf area (m^2), flag leaf greenness using BWD (Leaf Color Chart), and total tiller number.

C. Discussion

1. Recapitulation of Variance of Several Agronomic Characters of Wheat

The difference between population variance value of Guri 4 and Guri 6 on several agronomic characters in medium land of Palopo is presented in Table 1. Result of variance analysis in Table 1 shows that the character of flag leaf area and flag leaf greenness was not significantly different at α level of 5% and 1%. Moreover, a highly significant effect was found in the character of plant height for variety factor as well as significant effect on the character of total tiller number for cropping system factor.

Table 1. Recapitulation of variance of several agronomic characters of wheat in medium land

Vegetative Character	Character of Variety (V)	Cropping System (S)	V*S	CV (%)
Plant Height	**	tn	*	9.21
Flag Leaf Area	tn	tn	tn	7.10
Flag Leaf Greenness	tn	tn	tn	7.59
Total Tiller Number	tn	*	tn	26.89

Description: * = Significantly different at α level = 5%; ** = highly significant α = 1%; tn = not significant

The difference of variance and coefficient of variance (%) for each character shows the phenotype variation of wheat population used. This finding was caused by the effect of environment and gene expression from the genetic material used and its expressivity. Natawijaya (2012), mentioned that the difference of several phenotypes for each variety on each agronomic character was caused by gene expression.

2. Plant Height (cm)

Observation result in Table 2 shows that treatment of V_2S_1 resulted in the best average of plant height which was not significantly different from other treatments. Guri 6 combined with Hazton cropping system produced an average of 102.09 cm which was classified into the tall group.

Table 2. Plant height average of wheat (*Triticum aestivum* L.) planted in medium land which consists of factors of variety (V) and cropping system (S)

Variety (V)	Cropping System (S)	
	S1	S2
V_1	40.53 ^{d}	55.66 ^{c}
V_2	102.09 ^{a}	98.02 ^{b}

Description: values followed by similar letter is not significantly different in DMRT test at α level of 0.05 (4.99)

According to Budiarti (2005), wheat plant height is classified into: short group (53.5-65.2 cm), medium group (65.2-76.9 cm) and tall group (>76.9 cm). Subagyo (2001), reported that population phenotype appearance for the height character of plant cultivated in highland reached 102 cm.

3. Flag Leaf Area

Observation result for the character of flag leaf area is presented in Figure 1 below. Interaction between varieties of Guri 4 that used conventional cropping system resulted in the best leaf area with average of 40.23 cm. Increase in leaf area was caused by high reception of solar radiation intensity. Gardner, F. P., R. B. Pearce & R. L. Mitchell (1991), reported that there was efficiency in the reception of sunlight.

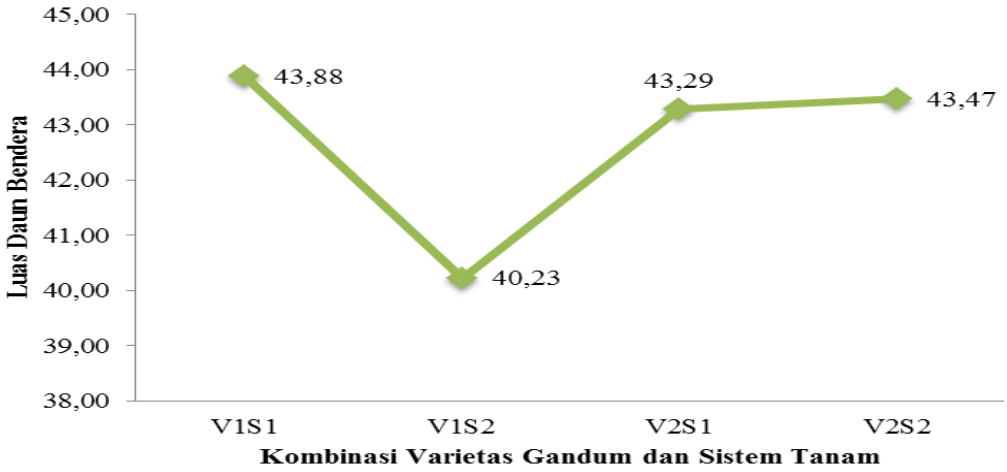

Figure 1 Character of flag leaf area in several combinations of wheat variety and cropping system

Leaf area index is directly proportional to transpiration rate in plants. Wider leaf area will cause plant to loose water. Prijono & Teguh (2016), reported that higher leaf area index of plant means higher transpiration rate of plant. Suyitno (2012), stated that leaf area of plant affect transpiration rate since wider leaf contains more stomata which results in high transpiration rate.

4. Flag Leaf Greenness

Graph of flag leaf greenness presented in Figure 2 shows that treatment of combination between Guri 6 variety and conventional cropping system resulted in the best flag leaf greenness with average of 11.00.

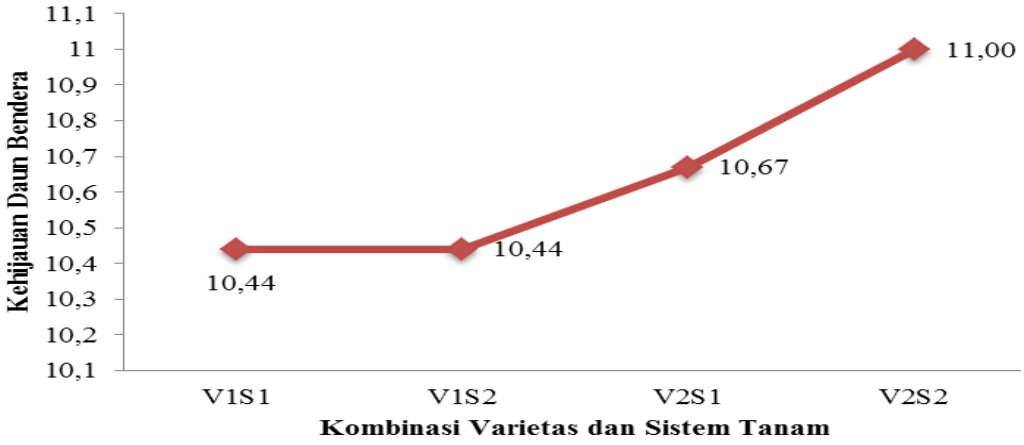

Figure 2 Character of flag leaf greenness in several combinations of wheat variety and cropping system

The green color of leaf is caused by color pigment known as chlorophyll located inside the chloroplast. Nelson & Larson (1988), said that the number of chloroplast tends to follow the increasing leaf area; thus the number of chlorophyll also increases since there will be more leaf area exposed to the sunlight which further contributes to the development of green leaf.

According to Rostini, N., Baihaki, A., Setiamihardja, R., & Suryatmana, G. (2003), leaf with high amount of chlorophyll and are able to maintain the presence of chlorophyll in longer period is like a factory inside plant which has production machine in large number and can work for a long time, thus producing photosynthate in large quantity (Mutiah, 2013).

5. Total Tiller Number

Table 3 shows that the best total tiller number was found in cropping system of S2 at average of 89.50. However, it is still uncertain that the total tiller number will become productive tiller in overall since the energy obtained will be distributed to all tillers thus the chance to distribute energy to seed production activity will be reduced. Therefore, higher number of seed per planting hole will also result in more productive tillers as in Hazton method.

Table 3 The average of total tiller number of wheat (*Triticum aestivum* L.) grown in medium land which consists of factor of variety (V) and cropping system (S)

Variety (V)	Cropping System (S)		Mean
	S1	S2	
V1	59.11	77.33	77.33
V2	50.22	101.67	101.67
Mean	54.67 ^{b}	89.50 ^{a}	

Description: Values followed by similar letter is not significantly different in DMRT test at α level of 0.05 (7.71)

Kartaatmadja & Fagi (2000), mentioned that the number of seed per planting hole will affect the existing population, which further will influence the growth of productive tiller and the yield of rice production. Masdar (2006), added that the increasing number of seed per planting hole tends to increase plant competition, both between plants in one planting hole and between planting holes which will create impact on the decreasing total tiller number.

6. Morphological Performance of Wheat in Medium Land

Genotype performance in medium land is depicted in Figure 3 which shows that the performance for vegetative character (± 3 months). The difference of performance between Guri 4 and Guri 6 variety which used conventional and Hazton cropping system was caused by environmental condition which particularly included the effect of intensity and duration of radiation, effect of temperature, and water availability in the environment where plants grow (Glover, 2007).

Figure 3. Morphological Performance of Wheat in Medium Land

Effect of temperature may extend the duration of seed filling and reduce kernel growth which further will cause loss in seed density and seed weight up to 7%. In wheat plant, both seed weight and number of seed of each panicle are highly sensitive to high temperature as shown by the decreasing number of seed per panicle along with the increasing temperature (Wahid, A., Gelani, S., Ashraf, M., & Foolad, M.R. (2007).

D. Conclusion

1. The development of wheat in Palopo City using the variety of Guri 4 and Guri 6 as well as cropping system of conventional and Hazton was able to generate performance for several characters.
2. Vegetative phase showed that the best plant height was obtained using line cropping system in Guri 4 (S_1V_1) variate at average of 73.91 cm. Implementation of Hazton cropping system in Guri 4 variety (S_2V_1) indicated that the best flag leaf area was obtained at average of 40.23 cm^2. Hazton cropping system application in Guri 6 variety (V_2S_2) showed that the best green color was at the average of 11.00 unit.

3. While, the use of larikan cropping system (S_1) resulted in the best total tiller number at average of 18.22 tillers. Therefore, it is conclude that implementation of Hazton cropping system was able to increase the production of wheat plant and Guri 4 variety was able to adapt to the condition of medium land of Palopo City.

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