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SELECTION IN YIELD OF WHEAT (*Triticum aestivum L.*) LINES IN MIDDLE LAND AND UPLAND

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ABSTRACT

Development of wheat can be carried out by cultivating wheat which is able to adapt well and has high productivity in Indonesia. The research was conducted in middle latitude and upland located in Dadaprejo and Cangar with the altitude of 560 m and 1650 m above sea level respectively from May to December 2011. The materials used in this research comprised thirteen wheat lines and two treated varieties. The experiment conducted in each location was arranged using randomly blocked design repeated three times. The data obtained in each location were analysed with variant analysis which was then followed by advanced experiment using 5% LSD. The result showed that six wheat lines were able to adapt and produced higher yields than Selayar varieties in the upland, namely 38, 82, G-17, G-20, H-14, H-19 and in the middle land obtained three lines that is line 82 , G-17 and H-19. Difference of yield decreases between upland and middle land is significant (14.09%).

Keywords: wheat, selection, yield, middle land, upland

INTRODUCTION

Wheat (*Triticum aestivum L*.) is one of the staple foods in the world which constitutes the main ingredient in flour that is mostly used in processed food products such as instant noodles, cake and so forth. High carbohydrates and protein are mostly found in wheat flour instead of other kinds. In Indonesia, wheat plays an important role, for almost all processed food products are consumed in daily basis. Interestingly, the consumption of instant noodles far outweighs that of other processed food products made of corn and cassava.

The increase of wheat consumption has impact on the import of wheat. Flour consumption, for example, grew from 9.9 kg per capita in 2002 to 17.11 kg per capita in 2007 which was around 12% of food consumption in Indonesia. Moreover, the import of wheat seeds reached 5.85 million tons equal to 4.3 million tons of flour consumption. It is predicted that the wheat consumption will keep increasing 6% per annum in Indonesia (Aptindo, 20011), and this will significantly affect the foreign exchange of the country.

To reduce such a dependency of wheat production on other countries, the development in wheat requires continual action. Breeding programme on wheat can also be proposed to obtain well-adapting varieties with high productivity.

Climatic factors determining the growth and production are rainfall, temperature and humidity (Azwar,1987; Bahar *et al.*, 1988 and Ismal, 1984). High temperature is able to reduce the plant age and other output components such as the number of leaf, plant height, productive seedling and number of flower (Rawson, 1987). Setyawati (1989) said that the optimum temperature for wheat to growth is 10 ºC to 24 ºC. Lower temperature can increase the yield but photosynthesis metabolism and growth of the wheat can decrease when the temperature is over 35ºC. Moreover, it causes the plant to die when the temperature reaches over 40ºC.

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To grow, wheat requires at least 2°C to 4°C, optimum temperature from 15°C to 25°C, and at most around 37°C. Meanwhile, seed germination requires relatively low temperature and high humidity, for the pathogenic fungi are inactive in such temperature. Seed germination requires air temperature of 12^{o}C to 16^{o}C, while more seedling roots grow from 12^{o}C to 16^{o}C in soil temperature. At 28^{o}C to 32^{o}C, roots are formed before plumula, and, on the other way around, plumula emerges before the roots at 28^{o}C to 32^{o}C.

Wheat cultivation in Indonesia requires varieties which are able to adapt well in tropical regions that the wheat can produce high yields followed by appropriate cultivation techniques (Bahar and Kaher, 1989). Middle lands and uplands have become the target for wheat cultivation in Indonesia. Several research show that the potential yield of wheat in upland such as Malino (1350 m asl) can achieve 3-5 t.ha^{-1} (Hamdani *et al.*, 2002), in Tosari (1850 m asl) potential yield reached 6,5 t.ha^{-1} (Pabendon *et al.*, 2010). In middle land in the Urut Sewu Boyolali (675 m asl) the yield of wheat reached 0,71-2,34 t.ha^{-1} . In Dau and Tumpang (Malang) (600 m asl) the yield reached 1,52 t.ha^{-1} and 1,89 t.ha^{-1} (Ashari *et al.*, 2012). This research was aimed at obtaining expected wheat lines with high yield potency in middle land and upland.

MATERIALS AND METHODS

The research was conducted from May to December 2011 in two locations such as Dadaprejo and Cangar with different altitude, rainfall and temperature between those locations. Dadaprejo had the altitude of ± 560 above sea level, rainfall of ± 1700 mm/year, daily average temperature of ± 24^{o}C, while Cangar had the altitude of ± 1650 m above sea level, rainfall of ±1500 mm/year, and daily average temperature of ± 20^{o}C. The materials used were thirteen expected lines of wheat and two treated varieties (Table 1).

The experiment applied Randomly Blocked Design in each location and was repeated thrice. Thirteen lines of wheat and three treated varieties were used in this research. The wheat lines used in this experiment were selected from the last experiment (Ashari *et al.*, 2012). The data were analysed using variant analysis, followed by the multiple comparison test using Least Significant Difference (LSD) in 5% level.

Table 1. Lines of wheat tested

No	Lines/varieties	No	Lines/varieties
1	28	9	H-14
2	38	10	H-19
3	80	11	H-20
4	82	12	H-21
5	G-1	13	162
6	G-17	14	Dewata
7	G-20	15	Nias
8	H-1		

RESULTS AND DISCUSSION

With the altitude of 560 m above sea level, the temperature of ±25^{o}C, and the rainfall of ± 1700 mm/year, Dadaprejo (7°54'54" Southern Latitude 112°35'19"Eastern Latitude) had fertile soil with alfisol type with micro and macro environment suitable for wheat planting. Moreover, Cangar, which had the altitude of 1700 m above sea level, the average temperature of 18^{o}C, had better micro and macro environment in which the planting environment represented the sub tropic area where wheat usually grows.

Among the lines tested, the difference in seed colour was not found, where the thirteen lines and the two treated varieties produced the same colour of seeds: brown. Such a qualitative character was more influenced by genetic factors than by environmental ones. The observation conducted in this research involved general characters such as flowering time (das), harvest time (das), plant height (cm), number of seedlings, tassel length, number of spikelet,1000 seed weight, dry seed yield.

Table 2. Heritability and coefficient of Variance of wheat character in Dadaprejo and Cangar

No	Characters	Heritability		CV (%)	
		Cangar	Dadaprejo	Cangar	Dadaprejo
1	Flowering time (das)	0.45	0.50	1.78	2.10
2	Harvest time (das)	0.07	-0.02	4.36	4.88
3	Plant height(cm)	0.26	0.52	8.27	6.34
4	Number of seedlings	0.75	0.56	3.56	7.41
5	Spike Length (cm)	0.25	0.47	11.15	4.34
6	Number of Spikelet	0.25	0.42	3.62	4.24
7	Number of seeds/tassel	0.24	0.46	9.45	7.71
8	1000 seed weight (g)	0.003	0.02	6.98	7.67
9	Dry seed yield (ton.h-1)	0.06	0.27	19.09	17.09

The result of heritability and coefficient of variance of wheat character in Cangar and Dadaprejo showed that almost all the character had a low heritability and coefficient of variance. It showed that the variance between lines in same character was homogeneous because the source of lines was the result of continuous selection in the last experiment so the character phenotype was the same. The heritability result cannot be used as selection criteria to get high yield wheat variety. In Dadaprejo, the coefficient of genetic diversity ranged from 12.10% - 17.09%, which was considered low. The coefficient of genetic diversity in Cangar was considered low, for it ranged from 2.10% to 17.09%.

It was found that the wheat had faster flowering time and harvest time in the middle land Dadaprejo than that of the upland Cangar. Such a difference was due to the diverse latitude which brought different temperature. The moderate temperature in Dadaprejo, which was around 24^{o}C, triggered massive respiration in plant which led the plant to having faster life cycle. On the other hand, Cangar, with its average temperature of around 18^{o}C, tended to cause the plant to have longer life than that planted in middle land since the area of Cangar represented the subtropic area where the wheat is usually grown. The lines that flowered faster in two locations were 38, Dewata and Selayar.

Line H-20 and H-21 had more numbers of seedlings in both locations (Table 3 and Table 4) than the other lines and treated varieties, while line G-17 had the least seedlings. The more seedlings meant the more tassels per plant, for one seedling could produce at least one tassel of wheat.

Selayar line had the lowest average of plant height in both locations. Cangar had higher average of plant height than Dadaprejo, which was due to the different environmental condition affecting the wheat growth.

The result showed that the average number of tassels per m^2 in the middle land of Dadaprejo was 9.61 cm, while it was 11.84 cm in the upland of Cangar. The number of tassels in the upland was bigger than that in the middle land. The number of tassels per m^2 in Dadaprejo ranged from 8.10 cm to 10.7 in which Selayar variety had the shortest tassels, while line 162 had the longest tassels. Meanwhile, in Cangar, the shortest tassels were found in Selayar variety, and the longest ones (15.37 cm) were in line G-20.

Selayar constituted the line having the lowest average of plant height in both locations. The average of plant height in Cangar was higher than that in Dadaprejo, which was caused by different environmental condition affecting the wheat growth.

The result indicated that there were differences either in the middle land of Dadaprejo or the upland Cangar. The significant difference found in the number of spikelet per tassel was mainly caused by genetic factors. In Dadaprejo, the number of spikelet per tassel ranged from 16.92 to 20.67 where Selayar line had at least 16.92, while line 28, 80, 162, G-17, H-4 and Dewata had the most number of spikelet per tassel. In Cangar, Selayar variety had the least number of spikelet per tassel, while the most number (21.03) was produced from line 28.

It was found in the middle land of Dadaprejo that the average number of seeds per tassel (52.42) was considered low, while it was considered high (58.27) in the upland of Cangar.

In the middle land, it was found that the average of 1000 seed was 44.24 g, which was considered high, while it was considered high in the upland at 48.12. In Dadaprejo, line H-19 had the most 1000 seed weight (48.08 g), while line 38 and G-1 had the most weight of 50.72 and 50.53 g respectively in Cangar. The weight of 100 seeds could be referred as one of criteria in selecting and determining the potency of wheat crops (Bahar, 1987 and Azwar *et al.,* 1988).

Table 6. Yield dry seed weight (ton.h^{-1}) in two locations and decreases of yield

No	Lines	Cangar		Dadaprejo		Decreases (ton)	Decreases Percentage (%)	
		Mean		Mean				
1	28	4.12	abc	3.52	abc	0.60	14.55	*
2	38	4.92	bc	4.03	bc	0.88	18.00	*
3	80	4.12	abc	3.66	abc	0.46	11.25	tn
4	82	4.84	bc	4.38	c	0.45	9.41	tn
5	162	3.98	ab	3.51	abc	0.47	11.69	tn
6	G-1	3.18	a	2.70	a	0.47	14.94	tn
7	G-17	5.48	c	4.35	c	1.13	20.62	*
8	G-20	4.82	bc	4.03	bc	0.80	16.51	*
9	H-1	4.10	ab	3.54	abc	0.56	13.66	*
10	H-14	4.79	bc	3.99	bc	0.80	16.63	*
11	H-19	4.85	bc	4.14	c	0.71	14.64	*
12	H-20	3.98	ab	3.51	abc	0.47	11.69	tn
13	H-21	3.21	a	2.73	a	0.47	14.79	tn
14	DEWATA	4.36	abc	3.90	bc	0.46	10.56	tn
15	SELAYAR	3.38	a	3.08	ab	0.30	8.89	tn
	Mean	4.27		3.67		0.60	14.09	*

Remarks: Significant difference test using t-test in 5% level

Table 3. Average of quantitative characters in Cangar

No	Line	Flowering time (das)		Harvest time (das)		Number of seedlings		Plant Height (cm)		Tassel Length (cm)		Number of spikelet/tassel		Number of seeds per tassel		1000 seed weight (g)		Protein (%)
		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean
1	28	76.33	bcd	109.67	abc	7.00	bcd	95.19	b	12.14	b	21.03	c	68.67	d	49.00	a	10.50
2	38	74.00	a	106.33	abc	6.93	bc	102.33	b	11.44	ab	19.53	b	53.93	b	50.72	a	8.70
3	80	74.67	ab	107.00	abc	7.40	def	97.53	b	12.25	b	20.33	bc	60.87	bcd	48.98	a	8.20
4	82	75.33	abc	110.00	abc	6.67	ab	97.80	b	12.00	b	19.80	b	54.60	b	46.51	a	10.90
5	162	77.67	d	109.67	abc	7.60	f	91.99	b	11.09	ab	19.80	b	57.93	bc	45.76	a	11.30
6	G-1	75.00	ab	103.33	a	7.13	cde	97.35	b	12.12	b	20.07	bc	61.93	bcd	50.53	a	14.60
7	G17	77.33	cd	109.33	abc	6.27	a	94.92	b	11.71	ab	19.87	bc	57.73	bc	49.60	a	11.10
8	G-20	76.67	bcd	114.00	c	6.60	ab	99.13	b	15.37	c	20.73	bc	59.73	bcd	47.38	a	10.90
9	H-1	76.67	bcd	113.00	c	6.47	a	95.35	b	12.04	b	20.27	bc	61.40	bcd	50.05	a	12.00
10	H-14	76.67	bcd	112.33	bc	7.67	f	99.42	b	12.01	b	20.20	bc	59.40	bc	46.43	a	9.80
11	H-19	76.00	abcd	110.33	abc	6.93	bc	98.10	b	11.96	b	20.67	bc	64.20	cd	50.08	a	9.80
12	H-20	74.00	a	104.67	ab	8.67	g	117.71	c	10.81	ab	19.87	bc	54.60	b	46.07	a	8.10
13	H-21	76.00	abcd	113.33	c	8.73	g	93.76	b	11.71	ab	19.67	b	60.20	bcd	46.72	a	9.70
14	DEWATA	74.00	a	106.33	abc	7.33	cdef	98.25	b	11.30	ab	20.07	bc	58.13	bc	47.40	a	9.90
15	SELAYAR	74.00	a	109.00	abc	7.53	ef	75.59	a	9.69	a	17.07	a	42.27	a	47.43	a	7.10
	Mean	75.62		109.22		7.26		96.96		11.84		19.93		58.37		48.18		10.17
	BNT 5%	2.25		7.95		0.43		13.41		2.20		1.20		9.22		ns		

Remarks: The value followed by the same letters in one column is not significantly different at average test 5% LSD

Table 4. Average of quantitative characters in Dadaprejo

No	Line	Flowering time (das)		Harvest time (das)		Number of seedlings		Plant Height (cm)		Tassel Length (cm)		Number of spikelet/tassel		Number of seeds per tassel		1000 seed weight (g)		Protein (%)
		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean		Mean
1	28	57.00	bc	90.33	ab	7.01	abc	83.12	b	9.87	b	19.48	bc	55.20	b	47.92	d	13.7
2	38	55.00	a	87.33	ab	7.21	abc	89.27	bcd	9.51	b	18.52	b	49.80	b	46.30	bcd	9.3
3	80	55.00	a	87.33	ab	7.45	bc	86.17	bcd	9.64	b	19.35	bc	50.57	b	44.38	bcd	12.5
4	82	55.00	a	89.67	ab	7.19	abc	93.94	d	9.60	b	19.18	b	53.53	b	43.13	bcd	11.5
5	162	58.00	bc	90.00	ab	7.64	c	86.36	bcd	10.07	b	19.82	bc	53.10	b	45.17	bcd	11.0
6	G-1	55.00	a	83.33	a	7.07	abc	83.98	bc	9.58	b	19.03	b	54.20	b	43.94	bcd	12.1
7	G17	58.33	c	90.33	ab	6.50	a	88.00	bcd	9.91	b	19.48	bc	56.10	b	36.53	a	11.8
8	G-20	55.00	a	92.33	b	6.67	ab	89.58	bcd	9.73	b	18.97	b	55.00	b	42.81	bcd	10.5
9	H-1	55.00	a	91.33	b	6.60	ab	83.47	b	9.52	b	18.48	b	52.00	b	45.47	bcd	13.7
10	H-14	55.00	a	90.67	b	7.86	c	90.14	bcd	9.60	b	19.47	bc	56.10	b	47.66	d	12.9
11	H-19	55.00	a	89.33	ab	7.36	abc	92.87	cd	9.53	b	18.57	b	52.37	b	48.08	d	12.7
12	H-20	58.33	c	89.00	ab	8.83	d	92.08	bcd	9.58	b	18.72	b	53.63	b	40.74	ab	12.4
13	H-21	56.33	ab	93.67	b	8.83	d	82.90	b	9.89	b	18.67	b	51.17	b	41.24	abc	12.7
14	DEWATA	55.00	a	87.33	ab	7.51	bc	94.19	d	10.04	b	20.67	c	55.33	b	43.48	bcd	12.9
15	SELAYAR	55.00	a	90.00	ab	7.75	c	67.91	a	8.10	a	16.92	a	38.13	a	46.83	cd	12.7
	Mean	55.87		89.47		7.43		86.93		9.61		19.02		52.42		44.24		12.16
	BNT 5%	1.96		7.3		0.92		9.22		0.69		1.34		6.76		ns		

Remarks: The value followed by the same letters in one column is not significantly different at average test 5% LSD

Moreover, in the upland of Cangar, the seed yields reached 4,27 ton.h^{-1}, while it was 3,67 ton.ha^{-1} in the middle land. The yield increased directly proportional with the altitude (Ashari *et al.*, 2012). In Cangar, the seed yields ranged from 3.18 ton.ha^{-1} to 5.48 ton.ha^{-1}, where the least number of yields were produced from line G-1 (3.18 t/ha), while the highest number of yields (5.48 t/ha) were found in line G-17. In Cangar there were six lines that had yield higher than Selayar control variety (38, 82, G-17, G-20, H-14 and H-19) (Table 6). The yield in Dadaprejo ranged from 2.70 ton.ha^{-1} to 4.38 ton.ha^{-1} where line G-1 had the least number of yields, while line 82 (4.38 ton.ha^{-1}), G-17 (4.35 ton.ha^{-1}) and H-19 dominated the most number of yield. The yield decreases ranged from 0,30 ton.ha^{-1} (8,89%) to 1,13 ton.ha^{-1} (20,62%). The difference of yield decreases between upland and middle land was significant (14,09%) (table 6). There were eight lines that had significant difference of yield (28, 38, G-17, G-20, H-1, H-14 and H-19). The result showed that the yield in middle land increased compared with the last experiment in middle land (Ashari *et al.*, 2012). The effect of yield difference between upland and middle land indicated that the selection had to be performed in each location.

The protein content in wheat was also found different in each treated line of both locations. The highest protein content in Dadaprejo was dominated by line H-1, and line 38 for the lowest. Meanwhile, in Cangar, the highest protein content was in line G-1, and H-20 for the lowest.

CONCLUSION

The heritability could not be used as selection method to obtain high yield wheat variety because the variability was homogeneous. Difference of yield decreasing between upland and middle land was significant (14,09%). the result showed that the selection had to be performed in each location to obtain the high yield wheat.

The six lines of wheat obtained had high yield as the selayar varieties 38, 82, G-17, G-20, H-14 and H-19 in upland and in the middle land obtained three lines i.e. 82 , G-17 and H-19.

The protein content was found different in the two locations. The highest protein content in Dadaprejo was produced in line H-1, and line 38 for the lowest. In Cangar, the highest protein content was produced in line G-1, and H-20 for the lowest.

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