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Characteristics of Waesungri Maize (*Zea mays* L.) Inbred with Multi Tillers and Ears for Crude Forage Use

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ABSTRACT

Major characteristics of new Waesungri maize inbred line has multi-tiller and ears: five to six tillers and seven to eight ears per plant and flowering date of Waesungri was delayed about 18 and 24 days compared to Mo17 U.S line and IK_4 Korean local lines, respectively. Number of ears, fresh and dry weight per plant were significantly different among all tested hybrids including Waesungri/Sinkihong hybrid under different planting times and densities. Especially, both fresh and dry weight of IK_1/FR140//Waesungri F_1 hybrid were significantly higher at high planting density. In kernel weight per unit area, Waesungri/Sinkihong hybrid was high at high density and IK_1/FR140//Waesungri hybrid was high at low planting density. As results of analysis of variance, flowering date was shown a significantly different both planting times and varieties, while other characters including stem height were shown very variable in interactions with enviromental factors .

Key Words : Inbred line, Multi-tiller and ears, Fresh and dry weight, High and low planting density

INTRODUCTION

New forage crops demand is absolutely needed for increase crude feeding . Many crop breeders have been and is working for development of new forage crops. Recently, Food Policy of Ministry of Agricultural in Korea is planning to raise up to 60% of the self-supplied ratio of crude feed from 34% at present until 2004 year. For achieving these aims, Choe *et al.* collected maize genetic resources from domestic and exotic maize lines since 1981 and planted for development of new forage crop with having multi-tiller and ears for the last 20 years.

From experimental results during that time, Choe *et al.* (1988,1992,1994) have developed a few of inbred lines such as IK_1(Choe and Lee, 1992), IK_2, IK_3 and IK_4(Choe *et al.*,1994). These inbred lines have multi-ears and tillers per plant. They reported facts that all hybrids crossed with these lines were increased both fresh and dry weight compared to check U.S hybrid with non-tiller(Choe *et al.*,1992),(Lee and Choe,1988,1999) and (Runtger and Crowder, 1967).

Accordingly, we tried to find the major agricultural characteristics of new developed Waesungri line, which it planted at two different planting times and planting densities.

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MATERIALS AND METHODS

Five lines including Waesungri inbred line were used in this study. They were IK_1/LE , FR805/IK_3, IK/FR140, Sinkihong, and FR1130//IRI/Bonghaw inbreds. These lines were crossed reciprocally. Six hybrids including U.S hybrid P3349 with non-tiller as check were planted at farm of College of Agriculture, Chungnam National University in 2000. Experiment was designed with factorial design at different planting times(1st: 22th April, 2nd: 17th May) in main plot, planting densities(DI: 70×30cm, DII: 70×40cm) in subplot. Fertilizer level were N-20kg, P_2O_5-10kg, and K_2O-10kg per 10a. Two kernels per hill were planted in 5m length and then fixed as one plant by thinning at three to four leaves stages. Major characteristics investigated were flowering dates, stem heights, tillers per plant, ear heights, ears per plant and fresh and dry weight per 10a. These datas were analysed by New-mystat.

RESULTS AND DISCUSION

Characters of Waesungri inbred

As shown in Table 1, flowering date of Waesungri inbred line was delayed about 20 days and weight of 100 kernels was lighter than IK_4, and stem height was also higher about 10cm but number of tillers per plant have two to three more than the IK_4. In case of the Mo17 U.S line with non-tiller, flowering dates was fast about 24 days and weight of 100 kernels was heavier than Waesungri.

Characters of hybrids crossed with Waesungri

Flowering dates of all tested hybrids were delayed compared to check hybrid, P3349. Especially Waesungri/Shinkihong, F_1 hybrid was delayed about 20 days than check (Table 2).

Stem diameters of all hybrids were similar to check hybrid regardless of planting times and plant densities. Ear heights of all hybrids were appeared highly about 40 to 50cm than check. Number of tillers per plant appeared from 2.2 to 5.0 and number of ears per plant appeared highly as 2.3 to 10.0.

Choe *et al.*(1992, 1998) and Lee and Choe(1988) have already reportd that these characters were very important for increasing fresh and dry weight.

Among hybrids used the FR1130-IRI-Bonghwa/Waesungri and the IK1-FR140/Waesungri hybrids were superior to other test hybrids in total fresh and dry weight (Fig.1), but ear heights of these hybrids were to be appeared higher than others. Therefore, we supposed that tillering hybrids with low ear height(i.e., IK/LE line) had to introduce for a new multi tillering hybrid development in the future because author reported these hybrids had some problems such as lodging and early senecence.

Analysis of variance for major agronomic characteristics for five hybrids presented in Table 2. Most of characters including flowering dates showed a significant in interaction of planting times and hybrids, however, number of ear per plant showed a significant at only planting densities.

From these results, we could find the fact that

Table 1. Major agronomic characters of Waesungri inbred line.

Lines	Flower dates(day)	Stem height(cm)	Tillers /plant(no)	Ear height(cm)	Ears /plant(no)	100 kernels.wt(g)
Waesungri	96	136	5~6	115	8~9	12
IK4[a]	78	125	3~4	105	5~6	18
Mo17[b]	72	165	0	121	1	25

[a] Check tiller line(reported in 1994 by Choe *et al.*)

[b] Check non-tiller U.S line.

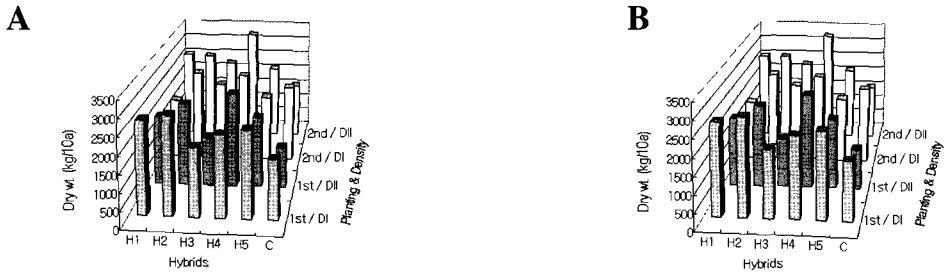

Fig.1. Comparisons of fresh(A) and dry(B) weight in six hybrids at different densities and planting times.

Remark: H1 : IK1-LE/Waesung, H2 : FR1130-IRI-BongHaw/Waesung, H3 : FR805-IK3/Waesung
H4 : IK1-FR140/Waesung, H5 : Waesung/SinkiHong, C : P3349
Planting dates; 1st : April 22th, 2nd : May 17th
Planting densitys; D_I, : 70×30cm D_{II} 70×40cm

Table 2. Analysis of variance for major agricultural characteristics of six hybrids including check.

SV	df	Flower -ing	Stem height	Ear height	Tiller number	Ear number	Leaf length	Leaf width	Fresh weight		Dry weight	
									Stem + Leaf	Ear	Stem + Leaf	Ear
Reps.	2	6.9	872.7	393.8	0.1	0.9	76.8	0.5	4515050.5	1073141.4	54918.7	304484.0
Treat.	23	375.3**	1336.2**	1299.3**	6.6*	19.8**	204.9**	3.1**	6597259.0**	492538.0	344600.3**	248864.3
Planting (A)	1	2977.3**	17174.2**	3430.7**	10.1**	74.0**	2346.1**	2.6	12543673.0*	3593162.8**	46086.2*	1401030.2**
Density (B)	1	3.17	854.2	0.3	0.13	58.7**	2.4	0.3	187747.6	83160.9	247913.8*	34274.7
Hybrids (C)	5	702.6**	1019.7*	4755.9**	24.4**	48.6**	116.3	8.9**	19713596.0**	328108.8	913423.5**	476570.2*
A×B	1	4.0	544.4	58.8	0.1	3.1	0.1	2.9	983480.8	408302.1	864477.3*	88392.0
A×C	5	379.9*	615.1	244.2	2.8**	4.8	224.1**	2.6**	3998683.5	335268.3	160483.0	97785.4
B×C	5	23.8*	567.0	140.3	0.4	7.6	44.3	0.3	2009700.0	346623.3	99362.3	197878.9
A×B×C	5	23.1*	230.0	138.6	0.5	2.9	88.1	1.6	1882433.0	438749.1	180196.9	67802.2
Error	46	5.1	296.7	213.7	0.7	2.4	53.5	0.7	2003629.0	288741.9	171024.3	179899.1

*,** : Significant at 5% and 1% levels, respectively.

flowering dates of tillering hybrid was controlled by genetic factors, while other characteristics were shown very variable by cultureal methods such as planting time or planting density.

HETEROSIS OF HYBRIDS

In allogamy such as maize, the heterosis degree of hybrids is one of very important factors in crop breeding. The degree of heterosis for major characteristics of the five tillering hybrid maize was calculated by the $F_1-\frac{1}{2}(P_1+P_2)/\frac{1}{2}(P_1+P_2)$ x 100(%) formula.

Stem height, ear height ear length, and 100 kernel weight were appeared higher than other characters, while tillers/plant, leaf length and width were shown a decreasing trend in heterosis(Table 3).

Concering these reasons, we thought that Waesungri inbred line had two to three more tillers per plant and leaf character was also more broaden and longer than other inbred lines. Accordingly, hybrids crossed with Waesungri line may be useful for a forage crop development. However, we have to select prudentially to achive the breeding goal of F_1 hybrid with low ear height because hybrids used in this study were very variable according to cross combination.

Table 3. Degree of heterosis for agronomic characteristics of five hybrids at different planting densities and planting times.

Planting time	Planting density	Hybrids	Day to flowering	Stem hight	Ear height	Tiller number	Leaf lenght	Leaf width	Ear lenght	100 k. weight
1st	DI	H1	5.40	8.67	21.83	-17.78	10.17	-11.24	28.84	28.33
		H2	9.57	31.05	49.45	9.09	11.17	-0.61	27.91	43.36
		H3	9.83	16.80	25.58	-11.69	4.31	-2.35	19.50	36.74
		H4	15.81	39.36	51.68	-14.29	17.93	1.80	24.77	63.24
		H5	1.87	21.21	25.38	-12.50	0.00	0.56	5.04	20.14
	DII	H1	4.28	25.49	28.62	-26.67	14.73	-11.24	34.70	33.11
		H2	8.40	32.17	51.24	-3.90	9.09	-4.24	29.74	48.95
		H3	8.67	19.47	27.28	16.88	5.44	-1.18	19.50	41.85
		H4	17.97	25.54	59.46	-16.67	13.64	17.37	27.49	66.91
		H5	3.00	22.31	19.24	-10.00	0.00	3.91	7.54	21.58
2nd	DI	H1	7.62	2.62	6.42	-28.89	21.25	0.59	26.89	26.96
		H2	13.09	15.86	51.24	-11.69	-11.69	11.52	30.65	41.96
		H3	13.29	6.08	21.34	9.09	-17.23	0.00	17.08	35.46
		H4	17.97	19.21	32.23	-4.76	-1.52	22.16	23.87	61.76
		H5	2.66	3.58	6.49	27.00	-17.24	-1.68	6.71	20.14
	DII	H1	7.62	9.31	26.61	-8.89	-0.91	18.84	27.87	26.28
		H2	11.92	22.05	43.28	-1.30	-2.60	3.03	27.91	40.56
		H3	12.14	6.62	18.80	-3.90	-19.50	-2.35	14.65	34.19
		H4	15.81	8.26	42.93	0.00	-4.04	-4.19	22.97	53.68
		H5	0.40	6.34	6.49	30.00	-5.75	-16.20	6.71	18.71

H1 : IK1-LE/Waesung, H2 : FR1130-IRI-BongHaw/Waesung, H3 : FR805-IK3/Waesung
H4 : IK1-FR140/Waesung, H5 : Waesung/SinkiHong, C : P3349
Planting dates; 1st : April 22th, 2nd : May 17th
Planting densitys; DI, : 70×30cm DII 70×40cm

Heterosis degree of total fresh and dry weight of FR1130-IRI-Bonghwa/Waesungri and IK_1-FR140/ Waesungri were appeared higher as over 50%, while that of number of tillers per plant in most hybrids appeared negative values. Lee *et al.*(1992, 1999), Choe *et al*(1994, 1998) and (Runtger and Crowder, 1967) pointed that it might be a ideo-type to breed a tillering hybrids because increaing of tillers per plant appeared a negative correlation with ear height, lodging or yield.

The fresh and dry weight of both FR1130-IRI-BongHaw/Waesung and IK1-FR140/Waesung hybrids were to be appeared higher about 50% than other hybrids. Therefore, new tillering hybrid has to cross with low ear height gene for avoiding lodging.

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