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Estimation of heterosis for grain yield and its related traits in maize (*Zea mays* L.)

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Abstract

Heterosis plays an important role in achieving improvement in crop production. 22 F1 hybrids obtained by crossing eleven lines and two testers in a line × tester fashion were used to derive the information on degree of heterosis over mid, better and standard check in maize. Twenty two crosses and their parents including one check Palam Shankar Makka-2 were evaluated in a Randomized Block Design with two replications. Grain yield per plant recorded the standard heterosis ranged from -62.54 (KI-13- 315 x HKI-1040) to 44.40% (KI-13-182 x HKI-1105) and significant positive standard heterosis recorded by five hybrids over the check viz., KI-13-182 x HKI-1105 (44.40%), KI-36 A x HKI-1040 (27.29%), KI-3A x HKI-1040 (19.71%), KI-7C x HKI-1040 (11.86%) and KI-13- 315x HKI-1105 (11.74%) These hybrids also showed high heterosis for many yield contributing traits in desirable directions. Therefore, these hybrids can be utilized in future for developing high yielding hybrids and inbreds having promising performance can be used in future maize breeding programs to exploit hybrid vigour.

Keywords: Heterosis, Line × Tester Analysis, *Zea mays* L

Introduction

Maize (*Zea mays* L.) is the world leading cereal crop. It belongs to grass family, *Poaceae*. It is native to America and was cultivated about 8, 000 years ago. It is grown at altitude from sea level to 3300 meters above sea level and from 50ºN to 40ºS latitude as a multi-use crop in temperate, sub-tropical and tropical regions of the world (Ihsan *et al*., 2005) [12]. It is highly cross pollinated crop as about 95% of the pistillate flowers on a cob receive pollen from nearby plants and about 5% of the kernels as result of self-pollination. Maize crop having desirable attributes with high yield potential and improvement in average yield per hectare can certainly be made, if stable performance and high yielding genotypes are developed. Identification of such desirable genotypes in a mixed or base population is one of the main objectives of plant breeders (Khan *et al.*, 2004) [13]. Line x tester performance of experimental lines is one of the prime selection criterions in hybrid breeding programme of maize (Misevic *et al.*, 1989 [14]. The improvement in vigour and yield potential of inbred lines and development of better cultural practices, single crosses were adopted for commercial cultivation. The recent trend is to go for single crosses than for double crosses, as the single crosses are the highest yielder under most favorable environments, show higher uniformity than the double and three way crosses. Moreover, seed production in single crosses involves lower cost than do the double crosses. Keeping these situations in view, an attempt was made to develop single crosses through Line x Tester analysis.

Hybrid varieties are the first generations of (F1) from crosses between two pure lines, inbred lines, open pollinated varieties, clones, or other populations that are genetically dissimilar. The production and development of hybrid maize is one of the breakthroughs and greatest accomplishments of plant breeding. Breeding strategies based on selection of hybrids require expected level of heterosis. Heterosis is important in breeding program especially for cross pollinated crop and is a great achievement to meet the world's food needs (Duvick, 1999) [10].

It is a well-known fact that one of the top breakthroughs in modern agriculture came with the discovery of heterosis. Heterosis is a base breeding programmes especially for cross pollinated crops like maize. It is an important tool to increase the crop production in the form of F1 hybrids (Praveen Singh, 2015) [6]. The heterotic studies can offer the possibilities to exploit the valuable hybrid combinations in the future plant breeding programmes and commercial utilization. Therefore, the heterosis is widely exploited and used by plant breeders to enhance the yield of many crops. The occurrence of adequate hybrid vigour is an important pre-requisite for fruitful production of hybrid varieties (Amanullah *et al*., 2015). Standard heterosis is estimated over standard commercial hybrid. The study of standard heterosis among maize germplasm is essential in maximizing the effectiveness of cultivars selection especially in cross pollinated crops. It has practical importance in plant breeding. It is also referred as useful or economic heterosis. Therefore, the present study was planned to estimate the extent of heterosis over better parent and standard check for yield and yield related traits in 22 hybrids and their parents to identify potential hybrid for future breeding process.

Material and Methods

Eleven newly developed medium maturing inbred lines and two inbred testers maintained at Experimental Farm of SAREC, Kangra, were used for this study. Using 11inbreds and 2 testers, 22 hybrid combinations were obtained by crossing them in a Line x Tester design during *Kharif,* 2017. The experimental material consisting of a total of 36 entries (22 F1s, 13 parents and 1 check) were sown in randomized block design with two replications during *Kharif,* 2018. Each experimental unit was represented by two rows of 2 m length with inter and intra-row spacing of 60 cm and 20 cm, respectively. Standard agronomic practices were followed and plant protection measures were taken when required to ensure normal growth and development of the plants. At maturity, 10 ears from the consecutive plants in middle of row of each experimental unit were harvested for recording data on grain yield/plant (g), shelling (%), ear length (cm), ear diameter (cm), days to 50 per cent tasseling, days to 50 per cent silking, plant height (cm), ear height (cm) rows/ear and kernels/row. After harvest, the kernels were air dried until a grain moisture content of 15% was achieved and then 1000-kernel weight (g) was recorded. However, days to 50 per cent tasseling and days to 50 per cent silking were recorded on plot basis. The mean values were utilized for estimation of heterosis over mid, better and standard parent using standard procedures. Heterosis over better parent (BP) was calculated as per Fonseca and Patterson (1968) [4] and standard heterosis (SH) was calculated as per Meredith and Bridge (1972) [5] using Palam Shankar Makka-2 as standard check.

Results and Discussion

The range of heterosis over the mid, better and standard parent for 11 characters are presented in Table 2. The range of heterosis exhibited by hybrids over the standard parent for grain yield per plant was -62.54 to 40.40 per cent (Table 2). Negative heterosis is considered as desirable for days to 50 per cent tasseling and silking for developing hybrids with early maturity. Sixteen hybrids for days to 50 per cent tasseling, one hybrid for days to 50 per cent silking exhibited significant negative standard heterosis over the check Palam Shankar Makka-2. Among 22 hybrids, significant negative relative heterosis and heterobeltiosis far day to 50% tasseling was recorded by 5 hybrids and 9 hybrids respectively, while for silking significant negative relative heterosis and heterobeltiosis was recorded for one testcross only. Hence, these hybrids can be utilized in rainfed conditions to avoid drought stress. These results were in conformity with earlier reports of Appunu *et al*. (2007) [2], Saidaiah *et al*. (2008) [7], Avinashe *et al*. (2013) [3], Shah *et al*. (2014) [9] and Nagarajan and Nallathambi (2017) [11].

Among 22 hybrids, 4 hybrids for plant height, 15 hybrids for ear height, 1 hybrid for ear girth, 20 hybrids for number of kernels per row and two hybrids for shelling percentage recorded significant positive standard heterosis over the standard check Palam Shankar Makka-2. From all the three type of heterosis, high and significant heterosis was recorded by KI-13-315 x HKI-1105, KI-13-179 x HKI-1105, KI-13-3-1 x HKI-1105 and KI-21A x HKI-1040 for plant height and ear height, KI-13-182 x HKI-1105, KI-13-179 x HKI-1105 and KI-13-315 x HKI-1105 for ear length, KI-13-182 x HKI-1105 for ear girth, KI-13-182 x HKI-1105, KI-13-179 x HKI-1105, KI-36A x 1105 and KI-3AxHKI-1040 for number of kernels per row, KI-3AxHKI-1040 and KI-36A x HKI-1040 for shelling (%), KI-7C x HKI-1105, KI-13-182 x HKI-1105, KI-3A x HKI-1105, KI-13-3-1x HKI-1105, KI-13-194xHKI-1105, KI-13-179 x HKI-1105 and KI-7C x HKI-1040 for 1000-kernel weight, KI-13-182 x HKI-1105, KI-36 A x HKI-1040, KI-3A xHKI-1040 and KI-7C x HKI-1040 for grain yield per plant (Table 3a-3e). It was clearly indicated that heterotic reaction for yield and yield traits expressed only in selected cross combinations which showed that expression of heterosis due to divergence of parental genotypes as well as the variations among the alleles involved in the expression of traits. Further, this shows the predominant role of non-fixable and non-allelic interactions. Therefore, these crosses could be commercially exploited for getting higher yield in maize. Similar results of commercial exploitation of maize crosses were reported by Singh *et al*. (2010) [8], Avinashe *et al*. (2013) [3] and Nagarajan and Nallathambi (2017) [11].

From the present study, it could now be predicted that some promising hybrids *viz*., KI-13-182 x HKI-1105, KI-36 A x HKI-1040, KI-3A x HKI-1040, KI-7C x HKI-1040 and KI-13- 315x HKI-1105 may be critically evaluated for its superiority and stability in performance across the locations over years in various agro-climatic zones of Himachal Pradesh.

Table 1: Details of the lines, testers and check used in the study

Sr. no	Inbred line	Stage	Source (Origin)
1.	KI-3A	S_5	AICRP on maize, Kangra
2.	KI-7C	S_5	AICRP on maize, Kangra
3.	KI-21A	S_5	AICRP on maize, Kangra
4.	KI-28B	S_5	AICRP on maize, Kangra
5.	KI-36A	S_5	AICRP on maize, Kangra
6.	KI-36B	S_5	AICRP on maize, Kangra
7.	KI-13-3-1	S_6	AICRP on maize, Kangra
8.	KI-13-179	S_6	AICRP on maize, Kangra
9.	KI-13-182	S_6	AICRP on maize, Kangra
10.	KI-13-194	S_6	AICRP on maize, Kangra
11.	KI-13-315	S_6	AICRP on maize, Kangra
12.	KI -57	HKI-1040	CCSHAU, Karnal
13.	KI -58	HKI-1105	CCSHAU, Karnal
14	Palam Sankar Makka-2	Hybrid	CSKHPKV, Palampur

Table 2: Range of heterosis for 11 yield and yield related traits in maize

Characters	Mid parent heterosis	Better parent heterosis	Standard heterosis
Days to 50% tasseling	-6.00 -3.70	-7.84 -3.16	-8.91 - (-) 2.97
Days to 50% silking	-31.13 -4.48	-33.64 -2.24	-31.78 -0.00
Plant height (cm)	17.75 -55.59	11.47 -44.38	-11.26 -14.07
Ear height (cm)	3.17 -61.35	-7.58 -41.92	-8.45 -24.41
Ear length (cm)	18.91 -86.36	21.01 -83.04	-0.70 -43.86
Ear girth (cm)	20.59 -58.06	9.67 -51.05	-13.23 -10.15
No. of kernel rows per ear	30.00 -61.90	18.18 -55.56	-23.53 -0.00
No. of kernels per row	17.24 -88.00	11.48 -62.07	3.03 -42.42
Shelling (%)	0.41 -21.17	-0.61 -19.01	-14.48 -4.91
1000- kernel weight (g)	70.52 -129.81	61.20 -109.04	-6.35 -17.46
Grain yield/plant (g)	88.24 -564.04	75.34 -468.71	-62.54 -44.40

Table 3a: Heterosis over mid-parent (MPH), better parent (BPH) and standard heterosis (SH) for ear height (cm), days to anthesis and days to silking of 22 testcrosses with two testers

Line × Tester		Days to 50% tasseling			Days to 50% silking		
		MPH (%)	BPH (%)	SH (%)	MPH (%)	BPH (%)	SH (%)
KI-3A	HKI-1040	3.70ns	3.16ns	-2.97ns	4.48ns	2.94ns	-1.87ns
	HKI-1105	-2.08ns	-4.08ns	-6.93**	0.00ns	-2.86ns	-4.67ns
KI-7C	HKI-1040	-2.54ns	-5.88*	-4.95ns	-31.13**	-33.64**	-31.78**
	HKI-1105	-6.00**	-7.84**	-6.93**	-6.98ns	-9.09ns	-6.54ns
KI-21A	HKI-1040	-2.54ns	-5.88*	-4.95ns	-2.83ns	-6.36ns	-3.74ns
	HKI-1105	-5.00*	-6.86**	-5.94*	-5.12ns	-7.27ns	-4.67ns
KI-28 B	HKI-1040	-5.15*	-7.07**	-8.91**	-4.35ns	-5.71ns	-7.48ns
	HKI-1105	-3.55ns	-4.04ns	-5.94*	-0.95ns	-0.95ns	-2.80ns
KI-36A	HKI-1040	-4.08ns	-6.93**	-6.93**	-4.31ns	-6.54ns	-6.54ns
	HKI-1105	-5.53*	-6.93**	-6.93**	-4.72ns	-5.61ns	-5.61ns
KI-36 B	HKI-1040	-1.51ns	-5.77*	-2.97ns	-1.41ns	-5.41ns	-1.87ns
	HKI-1105	-5.94**	-8.65**	-5.94*	-5.56ns	-8.11ns	-4.67ns
KI-13-3-1	HKI-1040	-1.06ns	-2.11ns	-7.92**	-1.48ns	-1.96ns	-6.54ns
	HKI-1105	-1.57ns	-4.08ns	-6.93**	-0.97ns	-2.86ns	-4.67ns
KI-13-179	HKI-1040	-1.55ns	-3.06ns	-5.94*	-1.44ns	-3.74ns	-3.74ns
	HKI-1105	-4.08ns	-4.08ns	-6.93**	-5.66ns	-6.54ns	-6.54ns
KI-13-182	HKI-1040	1.55ns	0.00ns	-2.97ns	2.88ns	0.94ns	0.00ns
	HKI-1105	0.00ns	0.00ns	-2.97ns	-1.42ns	-1.89ns	-2.80ns
KI-13-194	HKI-1040	-1.04ns	-2.06ns	-5.94*	0.48ns	-0.95ns	-2.80ns
	HKI-1105	-3.59ns	-4.08ns	-6.93**	-2.86ns	-2.86ns	-4.67ns
KI-13-315	HKI-1040	1.08ns	-1.05ns	-6.93**	0.00ns	-1.96ns	-6.54ns
	HKI-1105	-0.53ns	-4.08ns	-6.93**	0.49ns	-2.86ns	-4.67ns

* Significant at 5%, ** Significant at 1%, ns- Non-Significant

Table 3b: Heterosis over mid-parent (MPH), better parent (BPH) and standard heterosis (SH) for plant height (cm) and ear height of 22 testcrosses with two testers

Line × Tester		Plant height (cm)			Ear height (cm)		
		MPH (%)	BPH (%)	SH (%)	MPH (%)	BPH (%)	SH (%)
KI-3A	HKI-1040	17.75**	11.47**	-9.52**	3.17ns	-7.58**	-8.45**
	HKI-1105	30.54**	28.80**	4.55ns	13.72**	8.06**	7.04*
KI-7C	HKI-1040	20.23**	18.16**	-11.26**	17.44**	14.12**	-5.16ns
	HKI-1105	23.31**	20.27**	-4.98ns	19.89**	15.79**	3.29ns
KI-21A	HKI-1040	37.12**	27.91**	7.14**	27.60**	12.90**	15.02**
	HKI-1105	20.74**	17.31**	-1.73ns	15.48**	8.29**	10.33**
KI-28 B	HKI-1040	35.82**	35.82**	-1.52ns	45.12**	42.51**	11.74**
	HKI-1105	30.00**	24.66**	-1.52ns	32.76**	22.63**	9.39**
KI-36A	HKI-1040	30.13**	23.66**	-0.43ns	15.05**	4.39ns	0.47ns
	HKI-1105	28.90**	27.69**	2.81ns	20.51**	16.10**	11.74**
KI-36 B	HKI-1040	25.00**	23.88**	-10.17**	36.05**	29.94**	1.88ns
	HKI-1105	40.63**	33.70**	5.63*	35.67**	22.11**	8.92**
KI-13-3-1	HKI-1040	26.44**	25.15**	-7.36**	42.95**	33.53**	4.69ns
	HKI-1105	42.01**	37.53**	8.66**	46.87**	29.47**	15.49**
KI-13-179	HKI-1040	37.87**	33.13**	-3.46ns	53.90**	41.92**	11.27**
	HKI-1105	55.69**	44.38**	14.07**	60.12**	39.47**	24.41**
KI-13-182	HKI-1040	25.22**	21.69**	-6.49*	39.70**	39.29**	9.86**
	HKI-1105	33.89**	32.05**	4.33ns	46.37**	37.89**	23.00**
KI-13-194	HKI-1040	40.44**	33.73**	-3.03ns	52.48**	38.32**	8.45**
	HKI-1105	42.22**	30.14**	2.81ns	49.08**	27.89**	14.08**
KI-13-315	HKI-1040	26.79**	21.49**	-11.90**	42.57**	29.34**	1.41ns
	HKI-1105	53.27**	41.10**	11.47**	61.35**	38.42**	23.47**

* Significant at 5%, ** Significant at 1%, ns- Non-Significant

Table 3c: Heterosis over mid-parent (MPH), better parent (BPH) and standard heterosis (SH) for ear length (cm) and ear girth (cm) of 22 testcrosses with two testers

Line × Tester		Ear length (cm)			Ear girth (cm)		
		MPH (%)	BPH (%)	SH (%)	MPH (%)	BPH (%)	SH (%)
KI-3A	HKI-1040	30.17**	26.89**	5.96ns	29.46**	27.19**	-10.77**
	HKI-1105	43.89**	40.71**	11.58**	26.02**	23.63**	-9.85**
KI-7C	HKI-1040	30.47**	27.73**	6.67ns	34.90**	27.53**	-3.08ns
	HKI-1105	52.25**	48.25**	18.60**	25.21**	22.67**	-6.77**
KI-21A	HKI-1040	36.86**	35.71**	13.33**	29.06**	21.77**	-7.08**
	HKI-1105	41.78**	36.32**	11.93**	22.06**	19.35**	-8.92**
KI-28 B	HKI-1040	18.91**	18.91**	-0.70ns	20.65**	9.67**	-9.23**
	HKI-1105	26.87**	21.01**	1.05ns	21.74**	14.50**	-5.23*
KI-36A	HKI-1040	47.96**	37.39**	14.74**	21.19**	13.49**	-12.00**
	HKI-1105	60.00**	55.56**	17.89**	26.79**	23.02**	-4.62*
KI-36 B	HKI-1040	64.49**	47.90**	23.51**	24.30**	17.96**	-11.08**
	HKI-1105	60.10**	50.46**	14.04**	29.88**	27.76**	-3.69ns
KI-13-3-1	HKI-1040	23.37**	23.11**	2.81ns	20.59**	12.11**	-11.69**
	HKI-1105	36.87**	30.80**	8.77*	21.70**	17.19**	-7.69**
KI-13-179	HKI-1040	58.47**	47.48**	23.16**	43.48**	35.00**	-8.62**
	HKI-1105	85.75**	81.02**	37.19**	30.86**	18.99**	-13.23**
KI-13-182	HKI-1040	48.92**	44.54**	20.70**	30.73**	29.55**	-12.31**
	HKI-1105	86.36**	83.04**	43.86**	58.06**	51.05**	10.15**
KI-13-194	HKI-1040	41.39**	32.77**	10.88**	28.95**	24.58**	-9.54**
	HKI-1105	48.24**	45.83**	10.53*	22.62**	22.36**	-10.77**
KI-13-315	HKI-1040	35.82**	33.88**	15.09**	43.57**	42.60**	-2.15ns
	HKI-1105	64.86**	55.10**	33.33**	25.65**	21.94**	-11.08**

*, ** indicate level of significance at 5% and 1%, respectively

Table 3d: Heterosis over mid-parent (MPH), better parent (BPH) and standard heterosis (SH) for no of kernel rows/ear and no of kernels/row of 22 testcrosses with two testers

Line × Tester		No of kernel rows/ear			No of kernels/row		
		MPH (%)	BPH (%)	SH (%)	MPH (%)	BPH (%)	SH (%)
KI-3A	HKI-1040	55.56**	55.56**	-17.65*	57.01**	52.73**	27.27**
	HKI-1105	50.00**	36.36**	-11.76ns	38.18**	31.03**	15.15**
KI-7C	HKI-1040	40.00**	27.27*	-17.65*	38.32**	34.55**	12.12*
	HKI-1105	36.36**	36.36**	-11.76ns	41.82**	34.48**	18.18**
KI-21A	HKI-1040	50.00**	36.36**	-11.76ns	17.24**	11.48ns	3.03ns
	HKI-1105	36.36**	36.36**	-11.76ns	39.50**	36.07**	25.76**
KI-28 B	HKI-1040	40.00**	27.27*	-17.65*	43.93**	40.00**	16.67**
	HKI-1105	36.36**	36.36**	-11.76ns	36.36**	29.31**	13.64**
KI-36A	HKI-1040	30.00*	18.18ns	-23.53**	31.58**	27.12**	13.64**
	HKI-1105	36.36**	36.36**	-11.76ns	47.01**	45.76**	30.30**
KI-36 B	HKI-1040	50.00**	36.36**	-11.76ns	56.19**	49.09**	24.24**
	HKI-1105	36.36**	36.36**	-11.76ns	37.04**	27.59**	12.12*
KI-13-3-1	HKI-1040	40.00**	27.27*	-17.65*	25.66**	22.41**	7.58ns
	HKI-1105	36.36**	36.36**	-11.76ns	29.31**	29.31**	13.64**
KI-13-179	HKI-1040	44.44**	44.44**	-2.53**	49.51**	40.00**	16.67**
	HKI-1105	40.00**	27.27*	-17.65*	66.04**	51.72**	33.33**
KI-13-182	HKI-1040	36.84**	30.00*	-23.53**	60.82**	41.82**	18.18**
	HKI-1105	61.90**	56.55**	0.00ns	88.00**	62.07**	42.42**
KI-13-194	HKI-1040	**30.00***	18.18ns	-23.53**	45.79**	41.82**	18.18**
	HKI-1105	36.36**	36.36**	-11.76ns	32.73**	25.86**	10.61*
KI-13-315	HKI-1040	50.00**	36.36**	-11.76ns	36.36**	36.36**	13.64**
	HKI-1105	36.36**	36.36**	-11.76ns	45.13**	41.38**	24.24**

* Significant at 5%, ** Significant at 1%, ns- Non-Significant

Table 3e: Heterosis over mid-parent (MPH), better parent (BPH) and standard heterosis (SH) for 1000-kernel weight (g), shelling (%) and grain yield/plant (g) of 22 testcrosses with two testers

Line × Tester		1000- kernel weight (g)			Shelling (%)			Grain yield/plant (g)		
		MPH (%)	BPH (%)	SH (%)	MPH (%)	BPH (%)	SH (%)	MPH (%)	BPH (%)	SH (%)
KI-3A	HKI-1040	74.32**	57.14**	1.27ns	21.17**	19.01**	4.91*	429.43**	374.22**	19.71**
	HKI-1105	84.21**	72.41**	11.11**	16.14**	15.99**	2.52ns	322.15**	317.64**	7.73NS
KI-7C	HKI-1040	100.61**	98.20**	5.08*	18.95**	17.10**	2.74ns	345.61**	270.07**	11.86**
	HKI-1105	115.12**	109.04**	17.46**	5.12*	4.73*	-7.43**	95.41**	81.08**	-45.27**
KI-21A	HKI-1040	101.54**	100.31**	3.65ns	9.05**	6.11**	-4.66*	206.80**	155.17**	-23.16**
	HKI-1105	89.35**	80.79**	1.59ns	11.79**	10.88**	-0.37ns	256.34**	230.79**	-0.39ns
KI-28 B	HKI-1040	91.49**	89.76**	0.00ns	17.94**	16.68**	1.35ns	263.94**	192.74**	-3.92ns
	HKI-1105	89.50**	83.62**	3.17ns	14.27**	13.28**	0.13ns	186.01**	155.40**	-16.18**

KI-36A	HKI-1040	70.52**	61.20**	-6.35**	14.61**	7.56**	4.27*	500.97**	468.71**	27.29**
	HKI-1105	86.11**	83.06**	6.35**	3.98*	-0.61ns	-3.65ns	276.35**	251.45**	-9.34*
KI-36 B	HKI-1040	97.50**	93.87**	0.32ns	16.50**	15.20**	0.16ns	437.41**	412.70**	2.43ns
	HKI-1105	88.62**	77.97**	0.00ns	9.50**	8.61**	-4.01ns	346.81**	280.52**	-1.84ns
KI-13-3-1	HKI-1040	81.08**	61.84**	6.35**	10.70**	3.52ns	1.12ns	308.47**	231.97**	6.04ns
	HKI-1105	79.69**	66.67**	9.52**	3.34ns	-1.58ns	-3.86ns	166.83**	141.15**	-22.97**
KI-13-179	HKI-1040	99.39**	99.39**	3.17ns	16.53**	16.27**	-0.71ns	564.04**	344.89**	-11.12**
	HKI-1105	97.06**	89.27**	6.35**	9.22**	7.37**	-5.10*	459.53**	253.42**	-8.83*
KI-13-182	HKI-1040	98.05**	87.12**	-3.17ns	13.95**	9.76**	0.72ns	316.43**	249.68**	2.83ns
	HKI-1105	129.81**	109.04**	17.46**	14.72**	12.61**	3.34ns	423.19**	391.06**	44.40**
KI-13-194	HKI-1040	111.00**	94.17**	0.48ns	3.95*	1.54ns	-9.48**	245.39**	227.68**	-27.05**
	HKI-1105	113.38**	89.27**	6.35**	1.20ns	0.76ns	-10.17**	88.24**	75.34**	-54.77**
KI-13-315	HKI-1040	100.31**	97.85**	2.38ns	0.41ns	0.22ns	-14.48**	103.03**	87.48**	-62.54**
	HKI-1105	94.94**	85.03**	3.97ns	17.49**	15.47**	2.06ns	423.20**	333.18**	11.74**

* Significant at 5%, ** Significant at 1%, ns- Non-Significant

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