Combining ability assessment of agronomic characteristics of 8 inbred sweet corn lines

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ABSTRACT

This study was conducted to evaluate 28 sweet corn hybrid combinations to determine the combination ability of 8 lines of sweet corn inbred (K60, R111, N1, N4, N5, N7, N8 and N12) of a S8 generation. The results showed that the yield of hybrid combinations was in a range of 14.2 to 23.7 tons/ha. Especially, the hybrid combination THL9 had a yield of 23.7 tons/ha, reached the soluble solids content of 13.9%. Meanwhile, the yield of the hybrid combination THL14 reached 21.4 tons/ha and its soluble solids content reached 13.6%. This result was higher than Golden Cob which was the control variable in this study, and had a yield of 17.4 tons/ha and a soluble solids content of 12.2%. Evaluating the combining ability of the yield and total soluble solids content of 8 lines of sweet corn showed that the N4 lines had a higher combining ability than the other lines in terms of fresh corn yield and total soluble solids content. R111 line and N4 line could combine good productivity ($\hat{S}ij$: 2,433*) and total soluble solids content ($\hat{S}ij$ reached 0.963*).

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1. Introduction

Sweet corn (*Zea mays* L. *saccharata*) is a common corn mutant that is characterized by a high sweet and low starch contents that lead to a distinctive flavor, texture and aroma characteristics. The "sweetness" trait is controlled by simple recessive genes or by double or triple binding genes (Nayara et al., 2017). Sweet corn is a high source of tocopherols, vitamin C, carotenoids, and phenolic so it is considered to being an important vegetable for cultivation purposes worldwide (Juvik, 2009). In Vietnam, since many studies on sweet corn are only concerned in the early years of the 21st century, the achievements in research on planting techniques and corn varieties are still limited. Currently, sweet corn varieties on the market are mainly imported ones, seed source is not active at production. So on, high seed prices lead to increased production costs for farmers. Research on the selection of domestically dominant varieties of sweet corn aiming to create potential varieties which are highly adaptable to the natural condition in Vietnam, contributing to proactively source of varieties, reducing seed costs and increasing economic efficiency for farmers (Nguyen & Le, 2018).

Base on a study by Ferh (1987), research on sweet corn breeding, traits related to quality are interested. However, high yield still remains the main goal of a corn breeding program. Accordingly, scientists concern about the methods of yield improvement and quality of sweet corn. So that, developing elite lines is the best strategy to improve those criteria. Evaluation of the individuals in a population selects good strains in that population. To select good lines in a population, it is necessary to have an assessment of the many varieties in that population. Then use the hybrids to combine the selected lines to create the dominant hybrids. Studies on combining different corn cultivars are an important step in a breeding program as it is crucial to selecting suitable complementary lines to produce the F1 hybrid which achieves high yield and good quality (Solomon et al., 2012). According to this current necessary, the study assessment of the combination ability of 8 sweet corn inbred lines in the S_8 generation in Ho Chi Minh City is conducted to determine the combining ability of the self coordinating lines for high yield and good quality.

2. Material and Methods

2.1. Material

Twenty-eight sweet corn hybrid combinations were bred by the Griffing (1956) (method IV) method from 8 lines of inbred sweet corn in S_8 generation (K60, R111, N1, N4, N5, N7, N8 and N12) which were selected and developed at Nong Lam University Ho Chi Minh City. Golden Cob variety was imported and distributed by East-West Seed Company. This variety was used as a control variable. The sweet corn kernels used were hybrid kernels harvested one month before the sowing date.

2.2. Methods

2.2.1. Experimental arrangement method

The 8 S_8 inbred lines of sweet corn were cultivated in Nong Lam University Ho Chi Minh City in the 2020 Spring-Summer crop and selected individuals to perform the rotation to create 28 single hybrid combinations. The experiment aims to evaluate the growth and yield of 28 F1 sweet corn hybrid combinations which was conducted in the Summer-Autumn crop of 2020. This single-factor experiment was arranged in a randomized complete block design consisting of 29 treatments (28 hybrid combinations and 1 control - Golden Cob); 3 replicates (Table 1). The area of each experimental plot was 5 m x 2.8 m = 14 m^2. Each experimental plot had 4 rows. The planting distance was 70 x 25 cm.

The amount of fertilizer for 1 ha: Lime: 500 kg/ha + 10 tons of cow manure/ha + Inorganic fertilizers (kg/ha): 140 kg N - 80 kg P_2O_5 - 90 kg K_2O. Applied technical procedures and evaluation criteria, monitoring methods were based on the National Technical Regulation (QCVN 01-56: 2011/BNNPTNT, MARD (2011)) on testing for Value of Cultivation and Use of Corn varieties promulgating by the Ministry of Agriculture and Rural Development.

2.2.2. Monitoring criterias

Criteria of growth: Number of leaves, plant height, stalk height, stem diameter, harvesting time.

Criteria of corn morphology, yield and quality: the shape of husk cover, the color of the husk, length of ear, diameter of the ear, weight of ear, number of kernels, the color of kernels, the soluble solids content of kernels (Brix) and yield of the fresh ear.

2.2.3. Data processing method

Data of experiments were collected and calculated on computers according to ANOVA statistical analysis method and LSD ranking test by using SAS software 9.1. Using software of Quantitative Genetics by Ngo & Nguyen (1996) to analyze variance and evaluate inbred combination ability.

2.3. Time and location

The experiment was conducted in Spring-Summer and Summer-Autumn crop in 2020 in Thu Duc, Ho Chi Minh City on sandy loam soils (% sand:silt:clay, respectively 69:11:20); slightly acidic soil (pH H_2O and pH KCl were 6.0 and 5.2, respectively); nutritional content as the organic matter was low (1.3%); low total protein and potassium. Apply additional lime, manure, nitrogen and potassium during the experiment.

3. Results and Discussion

3.1. Agronomic characteristics, productivity and quality of 8 parental lines

The results of monitoring the growth and development of 8 parental lines in Spring-Summer 2020 conditions (Table 2) showed that the difference in time of pollen dispersal and silk emergence of the lines was not large, ranging from 1 - 2

Table 1. Origin of hybrid combinations (THL)

♀ \ ♂	K60	R111	N1	N4	N5	N7	N8	N12
K60		THL1	THL2	THL3	THL4	THL5	THL6	THL7
R111			THL8	THL9	THL10	THL11	THL12	THL13
N1				THL14	THL15	THL16	THL17	THL18
N4					THL19	THL20	THL21	THL22
N5						THL23	THL24	THL25
N7							THL26	THL27
N8								THL28
N12								

Table 2. Morphological characteristics and constituent factors of productivity and quality of 8 parental lines in the Spring-Summer crop 2020

Line	PD (DAS)	NPR (DAS)	H (cm)	Row/Ear	COH	FW (g)	RP (tons/ha)	Brix (%)	COK	Scent
N1	48	49	184.9^{ab}	15.3^{a}	Green	291.2^{ad}	15.8^{ab}	11.5	YO	F
N4	48	50	190.1^{a}	14.9^{a}	Green	311.4^{a}	16.6^{a}	12.0	Y	F
N5	48	50	160.3^{bc}	14.9^{a}	Green	256.7^{cd}	12.5^{bc}	11.8	Y	LF
N7	49	50	187.4a	14.4^{a}	DG	288.9^{ad}	15.5^{ab}	11.3	LY	LF
N8	48	49	150.0^{c}	10.7^{b}	Green	243.5^{d}	11.7^{c}	11.8	LY	LF
N12	48	50	186.4a	15.1^{a}	Green	260.0^{bcd}	13.6^{abc}	11.0	Y	F
K60	47	48	189.5^{a}	14.9^{a}	DG	293.8^{abc}	16.1^{ab}	11.2	YO	F
R111	49	48	173.7^{abc}	17.3^{a}	Green	305.2^{ab}	16.1^{ab}	12.9	YO	F
CV%			5.6	7.6		8.8	12.8	5.3		
F_{value}			7.0^{**}	8.3^{**}		2.9^{*}	2.9^{*}	2.7^{ns}		

In the same column, numbers with the same letter do not had a statistically significant difference; ^{ns}: no significance; *: significant difference at the level of $\alpha = 0.05$; **: very significant difference at the level of $\alpha = 0.01$. PD = Pollen Dispersal, SE = Silk Emergence, H = Height of plant, COH = Color of Husk, FW = Fresh Weight, RP = Real Productivity, COK= Color of Kernel, DAS = Days After Sowing, DG = Dark Green, Y= Yellow, YO = Yellow-Orange, LY = Light Yellow, F = Fragrant, LF = Light Fragrant.

days, the difference between pollen dispersal and silk emergence was so favorable for the process of pollination and fertilization.

Through monitoring some agronomic characteristics of the parental lines, the plant height of the lines ranging from 150 to 190.1 cm. The number of rows/ear of experimental lines varied from 10.7 to 17.3 rows/ear. The line with the highest number of rows/ear was R111 with 17.3 rows/ear and the lowest was that of N8 with 10.7 rows/ear. The color of the husk of the parent lines ranges from green to dark green.

The weight of ear with husk leaves of the sweet corn lines in the experiment ranged from 243.5 to 311.4 g, of which, the N4 line had the largest weight of ear with the largest husk leaves of 311.4 g.

The actual yield of a fresh ear of sweet corn lines in the experiment ranged from 11.7 to 16.6 tons/ha. The N4 line had the highest net yield of 16.6 tons/ha, followed by the R111 and the K60 line at 16.1 tons/ha, the line N1 at 15.8 tons/ha, the line N7 at 15.5 tons/ha. This result was equivalent to the research results of Van et al. (2019) on these pure lines in the S7 self-pollination life. This shows that the 8 lines of sweet corn studied had stable yields.

Corn kernel's color was assessed at the time when the ear was ripe. Yellow to orange color was popular in the market. The lines involved in the experiment had a kernel color ranging from light yellow to yellow-orange. In which, N1, K60, R111 lines were yellow-orange, N4, N5, N12 were yellow.

3.2. Morphological characteristics of 28 corn hybrid combinations in the Summer-Autumn crop 2020

Monitoring the growth and development time of the hybrid combinations in the experiment was

Table 3. Some morphological characteristics of 28 corn hybrid combinations in the Summer-Autumn crop 2020

Hybrid Combination	Harvest date (DAS)	Leaves/plant (Leaves)	Height of plant (cm)	Height of ear set (cm)	Stem diameter (mm)
THL1	72	18.6	203.4^{abc}	98.2^{ab}	2.8
THL2	73	19.0	190.0^{ae}	78.5^{cd}	2.9
THL3	71	18.1	213.0^{ab}	93.3^{ad}	3.2
THL4	73	18.4	198.7^{ad}	92.4^{ad}	2.8
THL5	73	18.6	204.0^{abc}	84.7^{be}	2.9
THL6	72	18.7	198.9^{ad}	87.7^{ad}	2.9
THL7	74	18.2	199.4^{ad}	88.8^{ad}	2.9
THL8	70	18.2	218.6a	100.5^{a}	3.0
THL9	71	19.3	209.1^{abc}	89.3^{ad}	2.8
THL10	72	18.1	206.8^{abc}	92.4^{ad}	2.8
THL11	72	18.1	201.1^{ad}	94.1^{abc}	2.9
THL12	74	18.2	206.0^{abc}	96.8^{abc}	3.0
THL13	72	18.3	188.9^{be}	86.1^{ae}	2.9
THL14	70	19.2	208.9^{abc}	88.0^{ad}	2.8
THL15	72	17.7	196.9^{ae}	96.5^{abc}	2.7
THL16	72	18.1	192.4^{ae}	79.5^{cbd}	3.2
THL17	72	18.1	202.7^{ad}	99.4^{a}	2.8
THL18	73	18.6	201.0^{ad}	90.2^{ad}	2.9
THL19	72	18.3	207.5^{abc}	89.1^{ad}	2.9
THL20	72	18.3	207.3^{abc}	87.2^{ad}	2.8
THL21	74	17.7	209.0^{abc}	84.6^{be}	3.1
THL22	73	18.5	183.2^{cde}	83.8^{be}	2.9
THL23	73	18.2	203.2^{abc}	91.4^{ad}	3.1
THL24	74	17.7	174.2^{de}	73.3^{d}	2.8
THL25	74	17.5	181.8^{cde}	79.6^{cbd}	2.8
THL26	72	18.0	202.5^{ad}	89.9^{ad}	2.9
THL27	72	17.7	203.4^{abc}	95.0^{abc}	2.9
THL28	74	18.6	170.6^{e}	87.3^{ad}	2.8
Golden (Control)	72	16.9	195.9^{ae}	82.4^{ad}	2.9
CV%	-	4.1	7.3	8.2	6.3
Fvalue	-	1.3^{ns}	1.7^{*}	2.4^{**}	13^{ns}

In the same column, numbers with the same letter do not had a statistically significant difference; ns: no significance; *: significant difference at the level of $\alpha = 0.05$; **: very significant difference at the level of $\alpha = 0.01$.

the basis for arranging the structure and planting seasons properly and applying appropriate technical measures for good growth and development. promote seed potential.

Results in Table 3 show that the harvesting time of fresh ear of the hybrid combinations in the experiment ranged from 70 - 74 DAS. The hybrid combinations with the shortest harvest time (70 - 71 DAS) were THL14, THL9, THL8, THL3. The combinations with the longest harvest time (74 DAS) were: THL7, THL12, THL21, THL25, THL24, THL28.

The viability was an important criterion for evaluating the potential of a plant variety. One of the important morphological features of corn was the number of leaves/plant and the height of the plant. The experimental results showed that the total number of leaves/plants of the hybrid combinations was from 17.5 to 19.3 leaves. The hybrid combination THL9 had the highest total number of leaves/plant (19.3 leaves), the lowest was the hybrid combination THL25 (17.5 leaves), the number of leaves of the Golden Cob control variety was 16.9 leaves.

One of the important morphological features of corn was plant height. Through the plant height, we can preliminarily evaluate the growth and development of hybrid combinations. Plant height and corn stacking height were closely related to the resistance of corn to fall, affecting the yield of the corn variety.

In this experiment, the plant height of the hybrid combinations ranged from 170.6 – 218.6 cm. The plant height of the hybrid combinations showed a statistically significant difference. The THL8 combination had the highest plant height of 218.6 cm, the lowest plant height of THL28 was 170.6 cm.

Plant height and corn stacking height were closely related to the resistance of corn falling, affecting the yield of the corn variety. At the experimental results, the corn set height of the combinations varied according to the plant height, ranging from 73.3 to 100.5 cm. The stem diameter of the hybrid combinations did not have a statistically significant difference, ranging from 2.7 – 3.2 cm. The combination THL3 and THL16 had the largest stem diameter of 3.2 cm, the combination N1/N5 had the smallest stem diameter of 2.7 cm.

3.3. Morphological characteristics of the ear of 28 sweet corn hybrid combination

The length and diameter of an ear were strongly correlated with corn mass. In the experiment, corn length ranged from 18.1 to 21.8 cm, the THL9 combination had the longest corn length of 21.8 cm, the shortest corn length was 18.1 cm of the combination THL25. The corn length of the sweet corn hybrid combinations in this experiment was statistically significant (Table 4).

The ear diameter of sweet corn hybrid combinations ranges from 46.2 to 5.5 mm. The control variety Golden had a length of 20.7 cm and a diameter of 50.2 mm. The difference in ear diameter of the hybrid combinations was not statistically significant.

In the current corn variety selection, the Kernel-row number trait characteristic was an important indicator to evaluate the potential yield of corn variety. The current popular corn varieties usually had 16 rows of kernels/ear. In this study, the hybrid combinations had several rows of kernels ranging from 16.3 to 18.7 rows, with no statistically significant difference.

For the commercial value of fresh ear, the color of kernels was an important criterion to consider and select to meet the goal of selecting corn varieties suitable to the tastes of consumers. The hybrid combinations in this experiment had yellow to orange-yellow kernels, their color was shiny and even, meeting the breeding target.

The color of the husk was an indicator that directly affects the commercial value of fresh corn ear and attracts consumers to choose. Traders often give priority to fresh corn that was bright green from light to dark. For the 28 hybrid combinations in this experiment, all the colors of the husks ranged from light green to dark green, of which only the hybrid combinations THL5, THL8, THL13 had light green husk, meeting market tastes.

3.4. Fresh ear yield of 28 sweet corn hybrid combinations

An important criterion in corn breeding was the high yield of the fresh ear, because this was a synthetic indicator, reflecting the most concentrated, accurate ability to grow and develop as well as the ability to adapt to environmental conditions of each hybrid combination.

The results in Table 5 showed that the weight of corn with husk leaves ranged from 324.8 – 487.5 g. The THL9 combination had the largest amount of corn with the largest husk leaves 487.5 g, the combination THL28 had the lowest weight of corn with the lowest husk leaves at 324.8 g. The ratio of unhusked ear/husked ear (%) was an indicator of interest in breeding. Normally, this ratio was low, the ear with a thick shell was difficult to peel, but it can be preserved for a long time. If this rate was high, the ear was thin, the storage time was short, and the ear quickly grows old. Current commercial varieties of corn had this ratio of around 73-75%. The control variables in the experiment Golden Cob had 75.4% of the ear without husk leaves/corn with husk leaves. While 2 hybrid combinations with high yield, THL9 and THL14 had the rate of unhusked ear/husked ear (%), respectively 77.2 and 73.9%.

The number of effective ears per plant, planting density, and ear weight were factors that directly affect the yield of corn. Actual yield was the result and ultimate goal of the production process or the evaluation and research of hybrid combinations. The actual yield of the hybrid combinations in the experiment ranged from 14.2 to 23.7 tons/ha.

Table 4. Morphological characteristics of corn of 28 sweet corn hybrid combinations

Hybrid Combination	Length of ear (cm)	Diameter of ear (mm)	Kernel-row number	Color of kernel	Husk covering (Point)	Color of husk
THL1	19.1^{bc}	48.8	18.1	Y	VT	Green
THL2	19.3^{abc}	48.0	18.2	Y	VT	Green
THL3	21.2^{ab}	53.1	18.3	YO	VT	Green
THL4	20.6^{abc}	49.3	17.4	Y	T	Dark Green
THL5	19.3^{bc}	48.2	17.6	Y	VT	Light Green
THL6	19.3^{abc}	47.0	16.7	Y	VT	Dark Green
THL7	19.1^{bc}	49.5	16.9	YO	T	Green
THL8	21.3^{ab}	52.8	18.7	YO	VT	Light Green
THL9	21.8^{a}	52.3	16.5	YO	VT	Dark Green
THL10	19.1^{bc}	51.8	16.7	Y	VT	Green
THL11	20.6^{abc}	48.8	16.3	Y	VT	Green
THL12	20.6^{abc}	48.5	18.3	Y	T	Dark Green
THL13	18.3^{c}	51.3	16.5	YO	T	Light Green
THL14	21.8^{a}	53.5	16.8	YO	VT	Dark Green
THL15	19.7^{abc}	51.7	17.7	Y	VT	Green
THL16	19.0^{bc}	46.8	18.0	Y	VT	Dark Green
THL17	19.0^{bc}	49.4	16.5	Y	VT	Green
THL18	18.6^{c}	49.8	17.5	Y	T	Green
THL19	20.3^{abc}	49.8	18.7	Y	VT	Green
THL20	20.6^{abc}	49.9	17.7	Y	VT	Green
THL21	20.4^{abc}	47.5	16.9	YO	T	Green
THL22	18.5^{c}	49.3	17.1	YO	T	Green
THL23	19.8^{abc}	48.6	17.1	Y	VT	Green
THL24	18.4^{c}	46.2	16.4	Y	T	Green
THL25	18.1^{c}	48.9	17.3	Y	T	Green
THL26	19.1b^{c}	49.7	17.8	Y	T	Green
THL27	20.3^{abc}	48.7	16.8	Y	VT	Dark Green
THL28	18.3^{c}	49.2	16.6	Y	T	Green
Golden (Control)	20.7^{abc}	50.2	16.9	Y	VT	Green
CV (%)	5.0	5.2	7.2			
F_{value}	3.64**	1.57^{ns}	1.46^{ns}			

In the same column, numbers with the same letter do not had a statistically significant difference; ^{ns}: no significance; **: very significant difference at the level of $\alpha = 0.01$. Y= Yellow, YO = Yellow-Orange, Husk cover - Point 1: Very Tight, Point 2:Tight.

The hybrid combination THL9 had the highest net yield of 23.7 tons/ha. Next was the hybrid combination THL14 reached 21.4 tons/ha.

The quality of sweet corn varieties was an indicator that consumers always care about. In the evaluation and selection of sweet corn varieties, Brix degree was an important indicator in the evaluation of corn quality. The results in Table 5 shows that the soluble solids content (Brix) of the hybrid combinations was over 11%, ranging from 11.8 – 13.9%. The Brix of the hybrid combinations was not statistically significant. Most of the hybrid combinations participating in the experiment had an aroma and less tip cap when boiled and eaten fresh.

3.5. Determining the combination ability of 8 sweet corn lines

The combining ability of parents to pass on to their offspring the traits of the associated parents in hybrid combinations. The ability to coordinate was divided into two categories: the general combining ability (GCA) and the specific combining ability (SCA).

Table 5. Fresh ear yield of 28 sweet corn hybrid combinations

Hybrid combinations	Weight of husked ear (g)	Weight of unhusked ear (g)	Ratio of unhusked ear/husked ear (%)	Yield (tons/ha)	Brix (%)
THL1	451.3^{abc}	301.7^{ad}	66.8	19.3^{abc}	13.3
THL2	449.8^{abc}	277.5^{be}	61.7	19.1^{abc}	12.2
THL3	453.0^{abc}	338.7^{abc}	74.8	21.4^{ab}	12.8
THL4	380.0^{ae}	285.8^{be}	75.2	18.2^{abc}	13.7
THL5	447.3^{abc}	277.0^{ve}	61.9	19.6^{abc}	12.5
THL6	380.7^{ae}	245.7^{de}	64.5	19.5^{abc}	12.2
THL7	383.7^{ae}	294.2^{ad}	76.7	17.9^{bc}	13.3
THL8	478.7^{ab}	339.7^{abc}	71.0	21.3^{ab}	13.5
THL9	487.5^{a}	376.2^{a}	77.2	23.7^{a}	13.9
THL10	400.8^{ae}	323.7^{ad}	80.7	17.7^{bc}	13.7
THL11	436.2^{ad}	285.3^{be}	65.4	17.8^{bc}	13.0
THL12	425.7^{ae}	302.7^{ad}	71.1	18.1^{abc}	13.5
THL13	413.2^{ae}	298.7^{ad}	72.3	18.6^{abc}	11.8
THL14	487.3^{a}	360.2^{ab}	73.9	21.4^{ab}	13.6
THL15	411.7^{ae}	330.3^{ad}	80.2	18.6^{abc}	12.5
THL16	429.5^{ae}	254.0^{cde}	59.1	19.9^{abc}	13.5
THL17	392.0^{ae}	279.2^{be}	71.2	19.4^{abc}	12.0
THL18	392.7^{ae}	317.2^{ad}	80.8	17.5^{bc}	13.6
THL19	426.2^{ae}	334.8^{abc}	78.6	19.6^{abc}	13.2
THL20	445.2^{abc}	320.0^{ad}	71.9	19.7^{abc}	13.8
THL21	396.8^{ae}	278.3^{be}	70.1	15.9^{bc}	13.2
THL22	431.5^{ae}	260.3^{cde}	60.3	18.2^{abc}	12.2
THL23	375.2^{cde}	302.2^{ad}	80.5	18.8^{abc}	13.4
THL24	335.3^{de}	207.5e	61.9	14.3^{c}	11.8
THL25	349.0^{cde}	276.8^{be}	79.3	15.4^{c}	12.0
THL26	364.3^{cde}	293.2^{ae}	80.5	17.9^{bc}	12.5
THL27	366.3^{cde}	298.3^{ad}	81.4	17.9^{bc}	13.5
THL28	324.8^{e}	260.7^{cde}	80.2	14.2^{c}	12.7
Golden (control)	424.5^{ae}	320.2^{ad}	75.4	17.4^{bc}	12.2
CV (%)	10.1	10.7	-	11.7	9.0
F_{value}	3.2**	3.8**	-	2.7**	1.0^{ns}

In the same column, numbers with the same letter do not had a statistically significant difference; ^{ns}: no significance; **: very significant difference at the level of $\alpha = 0.01$.

In breeding programs, the determination of combining ability helps to select parents to join the breeding program, the specific combining ability assists breeders in identification the potential inbred lines for parental hybrid (Feirreira et al., 2018). Currently, the diallel cross which was developed by Griffing was used quite commonly in sweet corn breeding programs. In the experiment, to evaluate the general and individual coordination ability of 08 sweet corn lines, Griffing 4 model was used through a trait of agronomic properties, yield and quality of sweet corn in Table 6 and Table 7 and Table 8.

3.5.1. The general combining ability of some agronomic traits of 8 sweet corn lines

Analyzing the ability to combine some agronomic traits of 8 sweet corn lines in the experiment (Table 6), the value of plant height, number of leaves/plant, stem diameter, the diameter of the ear showed that the general combining ability of 8 lines was not a statistically significant difference.

In the length of ear, lines R111 and N4 had GCA values of 0.497 and 1.113, respectively, which were statistically significant differences, there was GCA with many other sweet corn lines to create a long corn ear. These two lines can be used as a parent for yield-enhancing hybrid corn seed development programs.

The N4 line also had a statistically significant difference in the combined value of the number of rows per ear, the soluble solids content and the yield. Thus, this line can be used for sweet corn hybrid seed production programs to produce hybrid of corn varieties with both good yield and quality.

GCA is the average performance of a genotype in a series of hybrid combinations. They defined SCA as those cases in which certain hybrid combinations perform better or poorer than would be expected based on the average performance of the parental inbred lines. Parents showing a high average combining ability in crosses are considered to have good GCA while if their potential to combine well is bounded to a particular cross, they are considered to have good SCA (Parviz et al., 2016). The GCA value for low or negative traits, the combined value of that line with other strains was not different from other incarnations, only the lines had GCA value in the properties. The high or positive status will increase the traits of interest to the breeder. This comment was consistent with the results of research in the experiment when the lines R111 and N4 had a high ability to combine in the ear length trait gave high net yield in the hybrid combination R111/N4 (THL9).

However, lines with low GCA values were not excluded from the breeding program, it was only an estimate of the likelihood of association with other lines in the breeding program (Oliboni et al., 2013). This was true with the GCA assessment of the N1 line (low GCA), but when it was the mother in the N1/N4 hybrid (THL 14) hybrid, the hybrid had high yield and good quality.

3.5.2. The specific combining ability in the fresh ear yield and soluble solids content (Brix) traits of 8 lines

The general combining ability (GCA) and the specific combining ability (SCA) estimates for productivity and quality should always be computed together to evaluate the inbred lines. This allows breeders to associate two basic criteria for

Table 6. The general combining ability of some agronomic traits of 8 sweet corn lines

Line \ Combining ability	Plant Height	Leaves/Plant	Stem diameter	Ear length	Ear diameter	Number of row/ear	Yield	Brix
K60	1.954^{ns}	0.262^{ns}	0.026^{ns}	-0.003	-0.558	0.156^{ns}	0.811 ns	-0.121
R111	6.388^{ns}	0.134^{ns}	-0.024	0.497^{*}	1.219 ns	0.122^{ns}	1.050^{ns}	0.318^{ns}
N1	2.476^{ns}	0.143^{ns}	0.009^{ns}	0.152^{ns}	0.817^{ns}	0.511^{ns}	1.173^{ns}	0.018^{ns}
N4	7.605^{ns}	0.234^{ns}	0.045^{ns}	1.113^{**}	1.400^{ns}	0.633^{*}	1.616^{**}	0.357^{*}
N5	-4.418	-0.343	-0.055	-0.320	-0.131	-0.167	-1.283	-0.065
N7	3.065^{ns}	-0.178	0.055^{ns}	0.119	-1.072	-0.167	0.236^{ns}	0.246^{ns}
N8	-5.296	-0.157	-0.010	-0.442	-1.603	-0.5	-1.841	-0.476
N12	-11.235	-0.096	-0.045	-1.115	-0.072	-0.589	-1.761	-0.276

^{ns}: no significance; *: significant difference at the level of $\alpha = 0.05$; **: very significant difference at the level of $\alpha = 0.01$.

Table 7. The specific combining ability in the yield of 8 corn lines

♀ \ ♂	K60	R111	N1	N4	N5	N7	N8	N12
K60		-1.189	-1.482	0.412^{ns}	0.090^{ns}	-0.015	1.922^{ns}	0.262^{ns}
R111			0.512^{ns}	2.433*	-0.712	-2.047	0.283^{ns}	0.720^{ns}
N1				0.010^{ns}	0.125^{ns}	-0.107	1.426^{ns}	-0.484
N4					0.662^{ns}	-0.790	-2.470	-0.257
N5						1.268^{ns}	-1.232	-0.202
N7							0.900^{ns}	0.790^{ns}
N8								-0.830
N12								

^{ns}: no significance; *: significant difference at the level of $\alpha = 0.05$.

Table 8. The specific combining ability of 8 lines in soluble solids content (Brix) trait

♀ \ ♂	K60	R111	N1	N4	N5	N7	N8	N12
K60		0.147^{ns}	-0.687	-0.359	0.236^{ns}	-0.581	-0.192	0.708^{ns}
R111			0.208^{ns}	0.963*	0.458^{ns}	-0.520	0.702^{ns}	-1.231
N1				0.869^{ns}	-0.409	0.247^{ns}	-0.498	0.269^{ns}
N4					-0.014	0.275^{ns}	0.397^{ns}	-0.803
N5						0.230^{ns}	-0.648	-0.581
N7							-0.225	0.575^{ns}
N8								0.463^{ns}
N12								

^{ns}: no significance; *: significant difference at the level of $\alpha = 0.05$.

selecting a population: high mean and the largest genetic variance possible (Cruz et al., 2012).

The value of the specific combining ability in the fresh ear yield traits had a clear difference, the R111 line had a high ability to combine specifically with the N4 line, with the value of 2.433, with a statistically significant difference at the 95% confidence level. Fresh ear yield of R111 strain was 16.1 tons/ha; line N4 was 16.6 tons/ha; the hybrid combination R111/N4 was 23.7 tons/ha; Golden Cob variety was 17.4 tons/ha. The heterosis from the hybrid combination R111/N4 exceeded the parental line average of 44.9% and surpassed the control by 36.2%. This result was in accordance with the conclusion of Oliboni et al. (2013) which indicated that the values of the individual association capacity in the yield traits and the constituent factors for productivity had statistically significant differences. Populations resulting from these lines may produce a crossbred with greater heterosis than the parents.

Assessing the specific combining ability in soluble solids content (Brix), the R111/N4 hybrid combination had the highest specific combination ability value reaching 0.963 and statistically significant differences compared to other hybrid combinations.

4. Conclusions

Under this experimental conditions, all the sweet corn hybrid combinations grew and developed well. The hybrid combinations fell, stem borers, and corn borer were negligible. The N4 line had a high ability to combine both Brix traits and fresh corn yield. The two lines of R111 and N4 had the ability to combine well characteristics of Brix and fresh corn yield.

Experimental results determined that the hybrid combination THL9 (R111/N4) achieved a fresh corn yield of 23.7 tons/ha, a total soluble solids content of 13.9%. The morphology which was shape and color met the needs of the consumer market in Vietnam. It will be contributing to proactively source of varieties, reducing seed costs, and increasing economic efficiency for farmers.

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