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Botanical Characteristics, Fresh Yield and Table Qualities of CNU Waxy Corn Hybrids

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ABSTRACT A total of CNU 28 hybrids were developed at the CNU Corn Breeding Lab. were evaluated to identify new cultivars in botanical characteristics, fresh yield per 10a and taste qualities. Most of these hybrids were stable in environmental stresses such as lodging, disease and insects. Stem height ranged from 115.0 to 239.3 cm, and ear height ranged from 30.7 to 107.0 cm. The ear height to stem height ratio was showed low than 50% of standard as a stable plant type to lodging. The range of ear length was 14.2 cm to 23.0 cm. Especially, CNU 13H-73 was very longest ear as a 23 cm. The fresh yield per 10a was high in purple of CNU13H-79 hybrid than control hybrid Miheuckchal, and CNU13H-73 in white hybrid was similar Yeonnong check hybrid. The 100-kernel weights in CNU13H-3 and CNU13H-9 hybrids were higher than that of the control hybrid. CNU13H-98 among hybrids had a 100-kernel weight of 20.32 g, which was heavier than that of the control hybrid Daehackchal Gold 1. The average pericarp thickness was 41.4 μm, CNU13H-46 among hybrids had a very thin pericarp as a 35.5 μm. The mean sugar content of the used hybrids was 14.95 brix%; CNU13H-73 and CNU13H-55 had higher than Mibak2 as a control hybrid.

Keywords : waxy corn, hybrid, fresh yield, genetic resources

Corn has been and is regarded as an important crop not only as food for animals and humans but also as raw material for bio-ethanol. Recently, an attempt was made for growth enhancement and increased production of corn, but the goals were not achieved because of variable environmental conditions and cultivar limitations. Therefore, the development of corn hybrids with high productivity is required.

Domestic corn case also have been affected in cultivation and production because of low income and decreasing self-sufficiency rate of corn as livestock forage. To solve the problems, Cha (2010) suggested that the development of corn hybrids by heterosis was important to increase its yield.

Choi *et al.* (2011) reported that the advancement in domestic corn breeding was achieved by targeting for yield increase in white-colored corn. Furthermore, corn breeding in quality and quantity of corn were achieved by implementing the heterosis theory(Shull, 1908; Johnson *et al*., 1972; Tollenaar *et al*., 1992; Crow, 1998).

MATERIALS & METHODS

Plant materials

The 28 hybrids that were developed at the Corn Genetics and Breeding Laboratory of Chungnam National University (CNU) and four control hybrids including Mibak2 were used in this experiment. The pedigrees of these hybrids and their parents is shown in Table 1.

Cultivation methods

To identify the botanical characteristics of colored corn hybrids, 28 hybrids were planted two kernels per hill at the Corn Genetics and Breed farm on April 15, 2013. The plant density was 70 cm×30 cm. Pre-emergence herbicide treatment done and black-white combined vinyl mulching was practiced after sowing. To inhibit nematodes, soil pesticides were applied at a concentration of 2 kg/10a before mulching. These hybrids after sowing were thinned to one plant per hill at the three-leaf stage. The fertilizer level of N-P_2O_2-K_2O per 10a was 20-15-10 kg. Pesticides for corn earworm control were injected about 65 days after germination

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Table 1. CNU hybrids and their inbred lines developed from the domestic collection corns.

Hybrids	Seed Color	Pedigree of Cross Parent	
		Female	Male
CNU13H-3	White	CNU12' - 145 Ⓧ	CNU12'- 245 Ⓧ
CNU13H-9		CNU12' - 248 Ⓧ	CNU12'- 345 Ⓧ
CNU13H-16		CNU12' - 368 Ⓧ	CNU12'-1137 Ⓧ
CNU13H-23		CNU12' - 480 Ⓧ	CNU12'- 368 Ⓧ
CNU13H-24		CNU12' - 480 Ⓧ	CNU12'- 576 Ⓧ
CNU13H-26		CNU12' - 517 Ⓧ	CNU12'- 558 Ⓧ
CNU13H-27		CNU12' - 517 Ⓧ	CNU12'- 57 Ⓧ
CNU13H-29		CNU12' - 519 Ⓧ	CNU12'- 668 Ⓧ
CNU13H-34		CNU12' - 742 Ⓧ	CNU12'- 761 Ⓧ
CNU13H-35		CNU12' - 655 Ⓧ	CNU12'- 663 Ⓧ
CNU13H-36	Yellow	CNU12' - 659 Ⓧ	CNU12'- 651 Ⓧ
CNU13H-39		CNU12' - 668 Ⓧ	CNU12'- 593 Ⓧ
CNU13H-40		CNU12' - 668 Ⓧ	CNU12'- 630 Ⓧ
CNU13H-44		CNU12' - 683 Ⓧ	CNU12'- 604 Ⓧ
CNU13H-46		CNU12' - 874 Ⓧ	CNU12'- 190 Ⓧ
CNU13H-55		CNU12' - 571 Ⓧ	CNU12'- 780 Ⓧ
CNU13H-69		CNU12' -1270 Ⓧ	CNU12'-1271 Ⓧ
CNU13H-70		CNU12' -2460 Ⓧ	CNU12'-1646 Ⓧ
CNU13H-71		CNU12' - 892 Ⓧ	CNU12'- 896 Ⓧ
CNU13H-72		CNU12' - 952 Ⓧ	CNU12'- 975 Ⓧ
CNU13H-73	Purple	CNU12' -1281 Ⓧ	CNU12'-1285 Ⓧ
CNU13H-74		CNU12' - 988 Ⓧ	CNU12'- 986 Ⓧ
CNU13H-75		CNU12' - 724 Ⓧ	CNU12'- 651 Ⓧ
CNU13H-77		CNU12' - 651 Ⓧ	CNU12'- 724 Ⓧ
CNU13H-79		CNU12' - 532 Ⓧ	CNU12'- 651 Ⓧ
CNU13H-80		CNU12' -2460 Ⓧ	CNU12'-1646 Ⓧ
CNU13H-96		CNU12' - 975 Ⓧ	CNU12'- 939 Ⓧ
CNU13H-97		CNU12' -2364 Ⓧ	CNU12'- 133 Ⓧ
CNU13H-98		CNU12' - 61 Ⓧ	CNU12'- 801 Ⓧ
Mibak 2†(White)		Ganwon Corn Expri.(2005)	
Yeonnong†(White)		Choe *et al*. (2005)	
Miheuckchal†(Purple)		Ganwon Corn Expri. (2004)	
Daehackchal Gold1† (Yellow)		Lee *et al*. (2009)	

†Control hybrids

and other cultivation managements were based on corn cultivation methods described in RAD.

Evaluation of botanical characteristics

To compare the botanical characteristics among hybrids, The major characters such as stem height and ear height were examined at tasseling stage. Ear characteristics related to marketability, such as ear length, ear diameter and kernel setting. Pericarp thickness related to edible corn were examined by Micrometer and sugar content did by Refractometer about 35 days after fertilization.

RESULTS & DISCUSSION

Major botanical characteristics

The major agronomic characteristics of the 28 hybrids were presented in Table 2. Stem height range appeared to be 115.0 cm to 239.3 cm and CNU13H-69 among hybrids showed the highest value, while that of CNU13H-79 was the lowest. Ear height ranged from 30.7 cm to 107.0 cm, and the purple Miheuckchal hybrid of them showed the highest value. Mean ear length of hybrids was 18.2 cm and the yellow Daehackchal Gold1 showed the highest value (23.0 cm). Mean of ear diameter was 43 mm. CNU13H-29 among these hybrids showed the highest value (47.2 mm). In days to tasseling and silking, CNU13H-24 were very fast as 60.7 days and 63.7 days, respectively.

100-kernel weight showed range from 11.52 g to 21.74 g, and their mean was 17.6 g. Among hybrids CNU13H-9 was the heaviest and CNU13H-70 was the lightest.

In white hybrids, the first attached ear weight per plant was the highest in Mibak2, and followed by CNU13H-73 with an ear weight of 87.8g. This trend was similar to Yeonnongchal check hybrid. In yellow corn, Daehakchal Gold1 among the hybrids showed the highest ear weight as a 136.9 g (Lee *et al.*, 2009).

In purple colored hybrids, CNU13H-79 showed the highest ear weight (132.6 g), but check Miheukchal showed an ear weight of 107.5 g. 100 kernel weight was the highest in CNU13H-9 as a 21.74 g and followed by CNU13H-3 and Mibak2 as 21.74 g and 21.62 g, respectively.

The fresh yield per 10a ranged from 198.4 kg to 658.8 kg. Check hybrid Daedukchal Gold 1 showed the highest yield (658.8 kg), while CNU13H-75 showed the lowest yield (198.4 kg).

Lodging degree of the used hybrids showed strong resistance and other environmental characteristics such as disease and insects were also showed medium to light strong resistance. We judged that these results of superior lines development from domestic corn genetic resources by Lee *et al*. (2009) since 2002.

Table 2. Agronomic characteristics of waxy corn hybrids at each kernel color.

Characteristics / Hybrids	Stem height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (mm)	Days to silking (days)	Days to tassel (days)
CNU13H- 3	197.7±4.0^{c}	77.0±1.7^{b}	19.3±0.6^{a-b}	37.9±1.9^{b}	71.0±1.7^{b}	69.0±0.0^{a}
CNU13H- 9	181.7±5.5^{e-f}	31.3±0.6^{e}	17.4±0.7^{b-d}	44.0±1.8^{a}	67.3±0.6^{d}	64.3±0.6^{c}
CNU13H-16	164.3±0.6^{g}	30.7±1.5^{e}	17.1±0.7^{c-d}	44.3±7.3^{a}	64.0±0.0^{g-h}	61.0±0.0^{e}
CNU13H-23	197.3±1.2^{c}	46.3±0.6^{d}	18.3±2.2^{b-c}	41.3±1.7^{a-b}	65.3±0.6^{e-g}	62.3±0.6^{d}
CNU13H-24	188.0±1.0^{d}	58.0±0.0^{c}	18.0±1.0^{b-c}	45.3±2.2^{a}	63.7±0.6^{h}	60.7±0.6^{e}
CNU13H-26	186.3±0.6^{d-e}	58.7±0.6^{c}	15.5±1.5^{d}	41.3±0.4^{a-b}	64.3±0.6^{f-h}	61.3±0.6^{e}
CNU13H-27	181.0±1.0^{f}	44.3±0.6^{d}	18.7±1.3^{a-c}	41.8±0.9^{a-b}	65.7±0.6^{e-f}	62.7±0.6^{d}
CNU13H-73	231.3±3.2^{a}	46.7±1.5^{d}	17.2±0.2^{b-d}	43.9±2.4^{a}	66.0±1.0^{e}	63.0±1.0^{d}
Mibak 2†	203.3±2.9^{b}	86.7±1.5^{a}	18.7±0.6^{a-c}	42.7±1.6^{a-b}	69.0±0.0^{c}	66.0±0.0^{c-d}
Yeonnong†	182.3±2.1^{e-f}	86.3±2.9^{a}	20.8±1.2^{a}	40.2±1.1^{a-b}	72.7±0.6^{a}	69.7±0.6^{a}
Mean / C.V(%)	191.3 / 9.3	56.6 / 36.7	18.1 / 7.9	42.3 / 5.3	66.9 / 4.6	64.0 / 5.0
CNU13H-29	226.7±5.8^{b}	58.0±1.0^{e}	17.8±0.5^{e-g}	47.2±1.1^{a-b}	67.7±1.5^{d-e}	64.7±1.5^{e-f}
CNU13H-34	194.3±1.5^{e}	59.3±2.1^{e}	14.2±0.6^{i}	43.7±2.7^{b-d}	64.3±0.6^{g-i}	61.3±0.6^{i-j}
CNU13H-35	183.3±1.5^{g}	44.7±0.6^{g}	16.7±0.5^{g-h}	43.1±1.7^{b-d}	63.7±0.6^{i}	60.7±0.6^{j}
CNU13H-36	186.0±1.7^{f-g}	49.0±2.0^{f}	17.5±0.3^{f-g}	40.2±1.6^{d}	64.7±1.2^{f-i}	61.7±1.2^{h-j}
CNU13H-39	164.3±4.0^{i}	41.3±0.6^{g}	15.6±1.1^{h-i}	42.5±3.3^{c-d}	64.7±0.6^{f-i}	61.7±0.6^{h-j}
CNU13H-40	216.7±5.8^{c}	56.7±1.5^{e}	14.9±0.4^{i}	44.1±2.8^{b-d}	64.3±0.6^{g-i}	61.3±0.6^{i-j}
CNU13H-44	208.7±1.5^{d}	58.0±1.0^{e}	19.1±0.4^{c-e}	40.5±2.0^{d}	64.7±0.6^{f-i}	61.7±0.6^{h-j}
CNU13H-69	239.3±0.6^{a}	81.7±5.5^{b}	21.0±0.9^{b}	45.9±2.5^{a-c}	68.3±0.6^{c-e}	65.3±0.6^{e-f}
CNU13H-70	195.7±3.1^{e}	68.3±4.6^{d}	19.2±1.1^{c-e}	45.1±3.2^{a-c}	68.3±0.6^{c-e}	65.3±0.6^{e-f}
CNU13H-71	192.0±1.0^{e-f}	61.0±1.0^{e}	15.4±0.3^{h-i}	40.7±1.0^{d}	71.7±0.6^{a-b}	68.7±0.6^{a-b}
CNU13H-96	216.7±7.6^{c}	90.7±2.3^{a}	20.4±1.1^{b-c}	42.4±3.4^{c-d}	71.0±0.0^{b}	68.0±0.0^{b}
CNU13H-97	211.0±1.0^{c-d}	73.0±2.6^{c}	20.0±1.6^{b-d}	42.7±1.3^{c-d}	69.0±0.0^{c-d}	66.0±0.0^{c-d}
CNU13H-98	206.0±4.6^{d}	74.7±2.1^{c}	18.5±0.9^{d-f}	43.1±0.9^{b-d}	69.3±0.6^{c}	66.3±0.6^{c-d}
Daehackchal Gold1†	176.3±1.2^{h}	87.3±1.5^{a}	23.0±0.6^{a}	48.7±0.9^{a}	71.7±0.6^{a-b}	68.7±0.6^{a-b}
Mean / C.V(%)	201.2 / 10.2	64.5 / 23.7	18.1 / 14.2	43.6 / 5.7	67.4 / 4.4	64.4 / 4.6
CNU13H-46	136.3±0.6^{e}	31.7±1.2^{f}	15.9±0.3^{d}	41.3±5.4^{a}	69.0±0.0^{c-d}	66.0±0.0^{c-d}
CNU13H-55	164.3±2.3^{d}	92.3±1.2^{b}	18.8±0.3^{b}	44.5±2.1^{a}	71.0±1.0^{b}	68.0±1.0^{b}
CNU13H-74	210.7±0.6^{b}	59.0±3.5^{e}	19.4±0.4^{a-b}	43.1±1.6^{a}	66.0±0.0^{f}	63.0±0.0^{g}
CNU13H-75	203.0±7.0^{b-c}	74.3±3.8^{d}	19.0±0.7^{a-b}	44.7±3.2^{a}	69.0±0.0^{c-d}	66.0±0.0^{c-d}
CNU13H-77	230.3±0.6^{a}	84.3±4.7^{c}	17.3±0.1^{c-d}	43.0±0.8^{a}	69.7±1.2^{c}	66.7±1.2^{c}
CNU13H-79	115.0±7.8^{f}	55.7±6.5^{e}	18.0±1.5^{b-c}	43.0±4.0^{a}	72.3±1.2^{a-b}	69.3±1.2^{a}
CNU13H-80	199.3±15.0^{b-c}	71.3±6.0^{d}	19.0±1.3^{a-b}	41.9±2.3^{a}	68.7±0.6^{c-e}	65.7±0.6^{c-e}
Miheuckchal†	195.0±1.0^{c}	107.0±1.0^{a}	20.4±0.7^{a}	43.0±1.8^{a}	68.7±0.6^{c-e}	65.7±0.6^{c-e}
Mean / C.V(%)	181.8 / 21.8	72.0 / 32.6	18.5 / 7.5	43.1 / 2.7	69.3 / 2.7	66.3 / 2.8
Overall mean	193.2	63.9	18.2	43.0	67.7	64.7
Total C.V(%)	13.5	30.6	10.7	5.0	4.2	4.4

The same letters in column were not significantly different at the 5% level by DMRT
*Means ± Standard Error
†Control hybrids

Table 3. Characteristics related to yield and response on environmental stress of CNU waxy corn hybrids.

Characteristics / Hybrids	Ear weight (g)	Cob weight (g)	100 k. wt (g)	Lodging‡	Disease & insects (1~9)‡
CNU13H- 3	79±5.9^{h-i}	11.4±4.3^{f-h}	21.68	2	3
CNU13H- 9	80.4±4.8^{h-i}	15.1±5.0^{b-c}	21.74	2	3
CNU13H-16	67.30±0.9^{k-l}	10.1±0.6^{g-h}	19.78	1	2
CNU13H-23	68.4±1.7^{j-l}	10.6±2.1^{f-h}	16.75	1	3
CNU13H-24	81.8±2.8^{g-h}	14.2±1.4^{b-f}	16.80	1	3
CNU13H-26	76.7±3.1^{i-j}	14.2±2.4^{d-g}	18.56	3	3
CNU13H-27	58±0.9m	12.8±1.1^{e-g}	14.42	2	5
CNU13H-73	87.8±3.0^{f-g}	13.1±1.7^{b}	15.38	2	3
Mibak 2†	96.6±1.5^{d-e}	17.5±0.9^{b-c}	17.74	1	3
Yeonnong†	89.8±1.8^{f}	10.3±2.8^{b-c}	21.82	1	5
Mean	78.9	14.2	18.5	1.6	3.3
C.V (%)	14.5	20.9	14.7	43.7	28.7
CNU13H-29	112.3±0.5^{b}	22.1±0.3^{a}	19.23	2	5
CNU13H-34	52.2±0.4^{n}	9.1±1.3^{h}	12.32	2	3
CNU13H-35	45.1±2.4^{n}	13.3±4.8^{b-e}	12.60	1	3
CNU13H-36	64.3±2.0^{l}	11.5±1.2^{e-g}	14.60	1	5
CNU13H-39	100.1±5.3^{d}	13.2±3.5^{b-f}	15.20	1	1
CNU13H-40	105.8±2.3^{c}	13.6±1.6^{c-f}	15.43	2	3
CNU13H-44	72±1.4^{j-l}	17.8±2.5^{b-c}	14.52	1	3
CNU13H-69	110.4±0.8^{b-c}	17.4±1.3^{b-c}	21.41	1	3
CNU13H-70	50.8±1.6^{n}	17.8±2.5^{e-h}	11.52	1	3
CNU13H-71	69.2±2.8^{k-l}	9.9±1.7^{e-h}	18.80	1	5
CNU13H-96	110±2.3^{b}	17.6±1.6^{b-f}	19.35	2	3
CNU13H-97	90.9±2.5^{e-f}	20.9±2.4^{b-c}	20.32	2	3
CNU13H-98	111.4±3.5^{b-c}	21.7±2.3^{c-f}	20.76	3	3
Daeduckchal Gold1†	136.9±6.3^{a}	11.2±2.9^{a}	20.66	2	5
Mean	88.6	15.3	16.9	1.6	3.4
C.V (%)	32.1	26.1	19.3	40.3	33.8
CNU13H-46	74.1±3.1^{j-k}	9.5±1.2^{g-h}	17.33	1	3
CNU13H-55	95.9±2.8^{d-e}	14.7±4.3^{b-e}	17.37	1	3
CNU13H-74	101.0±2.4^{d}	12±5.2^{b-d}	20.55	1	3
CNU13H-75	40.9±1.6^{o}	13.8±4.6^{g-h}	13.16	2	5
CNU13H-77	75.2±4.8^{i-j}	15.2±2.7^{e-h}	18.37	1	3
CNU13H-79	132.6±3.1^{i-j}	15.3±2.0^{e-h}	16.39	1	5
CNU13H-80	72.1±8.5^{j-k}	16.8±2.1^{g-h}	18.94	1	5
Miheuckchal†	107.5±1.9^{b-c}	11±1.9^{a}	15.99	2	3
Mean	87.4	13.4	17.3	1.3	3.8
C.V	32.0	32.6	12.8	37.0	27.6
Total mean	83.3	14.2	17.6	0.6	3.8
Total C.V (%)	26.9	24.9	17.0	41.5	30.2

The same letters in column were not significantly different at the 5% level by DMRT
*Means±Standard Error, †Cortrol hybrids, ‡1(strong)~9(weak)

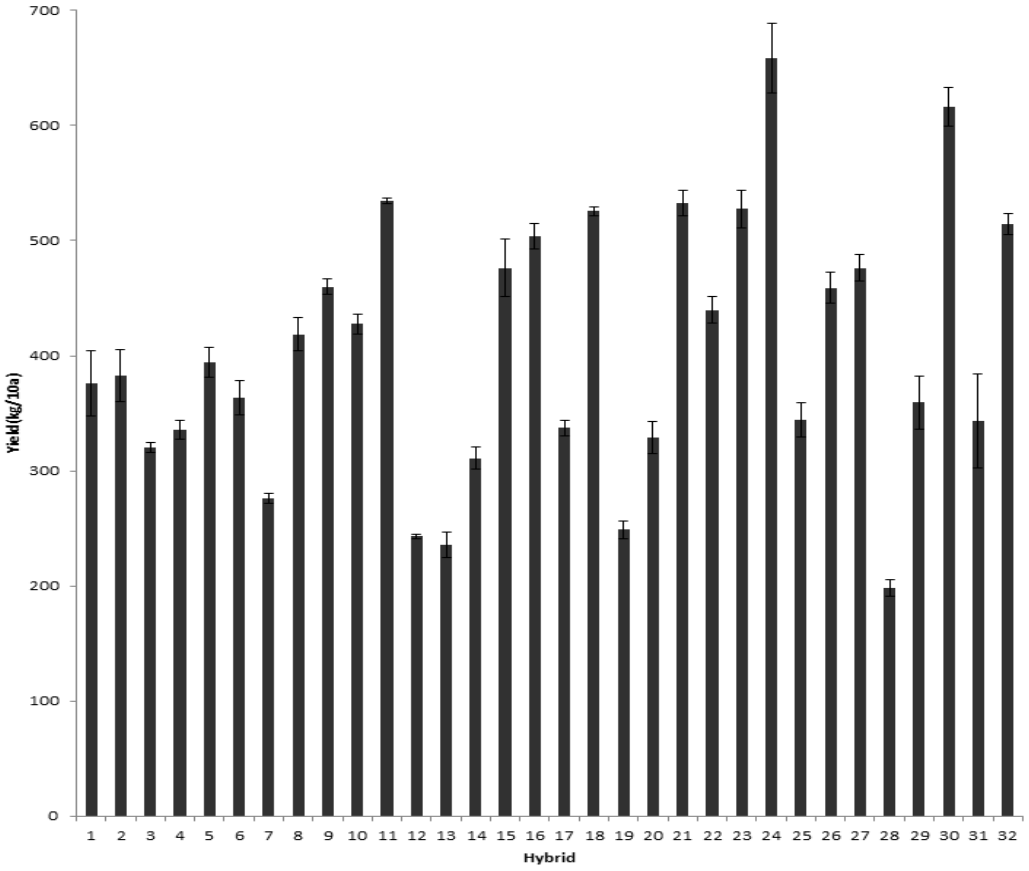

Fig. 1. Comparison of the first attached fresh ear yield per 10a of CNU waxy corn hybrids(9, 24 and 32 were control hybrids).

CNU13H-3	2. CNU13H-9	3.CNU13H-16	4. CNU13H-23	5. CNU13H-24
6. CNU13H-26	7. CNU13H-27	8. CNU13H-73	9. Mibak 2	10. Yeonnong
11. CNU13H-29	12. CNU13H-34	13. CNU13H-35	14. CNU13H-36	15. CNU13H-39
16. CNU13H-40	17. CNU13H-44	18. CNU13H-69	19. CNU13H-70	20. CNU13H-71
21. CNU13H-96	22. CNU13H-97	23. CNU13H-98	24. Daehackchal Gold 1	25. CNU13H-46
26. CNU13H-55	27. CNU13H-74	28. CNU13H-75	29. CNU13H-77	30. CNU13H-79
31. CNU13H-80	32. Miheuckchal			

Table quality-related characteristics

The sugar content and pericarp thickness were known as a evaluated standard of table qualities were analyzed in the 28 hybrids including control hybrids (Table 4). The sugar content of the CNU13H-73 among hybrid was 19.3 brix%, which was the highest. Next, CNU13H-55 and Mibak 2 followed with sugar contents of 19.1 brix% and 17.8 brix%, respectively.

Especially, CNU13H-40 hybrid had 17.6 brix%, which were higher than Daehackchal Gold 1 developed in 2009 (Lee *et al*). Additionally, that of CNU13H-55 as purple-colored hybrid was higher than control hybrids, Miheuckchal.

Lee *et al.* (2009) reported that pericarp thickness and sugar content in the development of new hybrids were the major factors determining taste quality, and also indicated that pericarp thickness was directly related to chewiness in edible corn. Among hybrids, CNUH13-46 was the thinnest as a 35.5 μm, followed by CNU13H-98 and CNU13H-36. Mean pericarp thickness in the used hybrids was 41.38 μm. The sugar content was the highest in CNUH13-73 and CNU13H-55, and their mean values was 14.95 brix%.

From this study, we found new hybrids for new variety development; CNU13H-79 of 28 hybrids was good in high yield, CNU13H-98 and CNU13H-73 were good in table quality such their pericarp thickness and high sugar contents than leading

Table 4. Sugar content and pericarp thickness in CNU waxy corn hybrids.

Characteristics / Hybrids	Sugar content (brix%)	Pericarp thickness (μm)
CNU13H- 3	14.5±0.8^{c}	46.0±1.0^{f-j}
CNU13H- 9	14.3±0.8^{c-d}	41.3±2.1^{f-k}
CNU13H-16	11.3±0.5^{g}	45.7±3.5^{d-i}
CNU13H-23	15.4±0.7^{c}	46.0±2.0^{f-j}
CNU13H-24	13.8±1.3^{e-f}	45.7±3.1^{c-e}
CNU13H-26	16.2±0.1^{b}	37.0±2.0^{h-k}
CNU13H-27	12.0±0.9^{f}	46.0±3.6^{m-n}
CNU13H-73	19.3±1.2^{a}	41.7±2.5^{d-g}
Mibak 2†	17.8±1.2^{a}	40.7±2.5^{j-l}
Yeonnong†	13.7±0.7^{d-e}	45.7±2.5^{b-d}
Mean / C.V (%)	14.8 / 16.6	43.6 /7.3
CNU13H-29	13.9±0.8^{e-g}	42.0±3.6^{b-d}
CNU13H-34	16.5±1.0^{a-b}	39.7±3.2^{m-n}
CNU13H-35	13.9±1.2^{e-g}	40.0±3.6^{f-j}
CNU13H-36	14.1±0.3^{d-f}	36.3±2.5^{g-k}
CNU13H-39	17.4±1.0^{a}	43.3±2.5^{b-c}
CNU13H-40	17.6±0.8^{a}	46.3±3.1^{d-f}
CNU13H-44	15.7±1.5^{b-c}	41.0±2.0^{c-e}
CNU13H-69	11.1±0.7^{h}	39.7±3.1^{o}
CNU13H-70	9.1±0.8^{i}	44.0±2.0^{n}
CNU13H-71	15.5±0.4^{b-d}	37.3±1.5^{f-j}
CNU13H-96	12.4±0.3^{g-h}	39.7±1.5^{d-g}
CNU13H-97	15.6±1.1^{b-d}	42.0±2.0^{e-j}
CNU13H-98	14.8±0.3^{c-e}	35.7±1.5^{b}
Daehackchal Gold1†	12.8±0.9^{f-g}	41.0±0.0^{c-e}
Mean / C.V (%)	14.3 / 16.6	39.9 / 10.4
CNU13H-46	15.6±0.6^{c-d}	35.5±0.6^{d-g}
CNU13H-55	19.1±0.9^{a}	39.1±0.9^{a}
CNU13H-74	17.5±0.4^{b}	40.3±1.2^{b-c}
CNU13H-75	15.4±0.9^{c-d}	42.7±2.5^{a}
CNU13H-77	13.6±0.3^{e}	37.7±1.5^{f-j}
CNU13H-79	17.2±0.2^{b}	42.7±2.5^{e-j}
CNU13H-80	14.9±0.6^{d}	40.0±1.7^{l-n}
Miheuckchal†	16.4±0.3^{b-c}	43.7±1.5^{k-m}
Mean / C.V (%)	16.2 / 10.5	35.2 / 32.0
Total mean	14.95	41.38
C.V (%)	15	9

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT
*Means ± Standard Error, †Control hybrids

hybrids, respectively. These results were similar with contents reported by Richardson (1966), Lee *et al.* (1993), Cha (2010), and Choe *et al.* (1993).

Accordingly, these selected hybrids were will use for regional adaptability traits and yield test.

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