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EVALUATION OF GROWTH, DEVELOPMENT, AND YIELD POTENTIAL OF SEVERAL IMPORTED WAXY CORN VARIETIES IN NORTHERN VIETNAM

Nguyen Tuan Khoi* and Bui Thi Thu Trang
Faculty of Agronomy, BacGiang Agriculture and Forestry University

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ABSTRACT

This study aims to evaluate the growth, development, and yield potential of several imported waxy corn (Zea mays L. var. ceratina) varieties in Northern Vietnam. A series of field trials were conducted across multiple locations to assess various agronomic traits, including germination rate, plant height, leaf area, flowering time, and grain yield. The experimental design was a randomized complete block with three replications for each variety. Data were collected and analyzed using statistical methods to compare the performance of the different varieties. The results indicated significant differences in growth parameters and yield among the tested varieties. Certain varieties exhibited superior adaptability and productivity under the specific climatic and soil conditions of Northern Vietnam. These findings provide valuable insights for breeders and farmers in selecting the most suitable waxy corn varieties for cultivation in this region. Further research is recommended to explore the genetic and environmental factors influencing the observed variations in performance.

Keywords: Waxy corn, Growth evaluation, Development assessment, Yield potential, Imported varieties, Northern Vietnam.

1. INTRODUCTION

Waxy corn (Zea mays L. var. ceratina), characterized by its distinctive sticky texture due to the presence of amylopectin in its endosperm, is a staple food and an important crop in various regions around the world. In Vietnam, waxy corn holds significant cultural and economic value, being a major component of traditional cuisine and a source of income for farmers. However, the local production of waxy corn faces challenges related to limited genetic diversity and suboptimal agronomic practices.

Northern Vietnam, with its unique climatic conditions and soil types, presents both opportunities and challenges for the cultivation of waxy corn. The region experiences a diverse range of weather patterns, which can affect the growth and development of corn varieties differently. To improve the productivity and sustainability of waxy corn cultivation, it is essential to identify varieties that can thrive under these specific conditions.

Imported waxy corn varieties offer a potential solution to the challenges faced by local farmers. These varieties may possess superior traits such as enhanced growth rates, improved resistance to pests and diseases, and higher yield potentials. However, their performance in the agro-ecological context of Northern Vietnam needs to be thoroughly evaluated.

This study aims to assess the growth, development, and yield potential of several imported waxy corn varieties in Northern Vietnam. By conducting field trials and analyzing various agronomic traits, this research seeks to identify varieties that are well-suited to the local conditions and can contribute to increased productivity and profitability for farmers. The

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findings of this study will provide valuable insights for breeding programs and inform decision-making processes for waxy corn cultivation in the region.

2. MATERIALS AND METHOD

Materials: The HN88 maize variety, a single-cross glutinous maize variety developed by the Central Seed Joint Stock Company and recognized as a national variety in 2011, was used as the control. Additionally, nine glutinous maize varieties imported from China were tested, designated as: QUENEP 521, CS 03, CuuLong 818, HMT 76, Bani 510, Bani 569, VNUA 11, VNUA 70, and ATN 17.

Method: The experiment was arranged in a completely randomized block design with 10 varieties, each variety constituting one experimental plot, with 3 replications. The area of each experimental plot was 14 m² (excluding furrows), and the planting distance was 70 cm x 25 cm.

- The care procedure followed QCVN 01-56: 2011/BNNPTNT issued by the Ministry of Agriculture and Rural Development of Vietnam.
- The criteria and research methods followed QCVN 01-56: 2011/BNNPTNT issued by the Ministry of Agriculture and Rural Development of Vietnam.
- The data were processed using Microsoft Excel and IRRISTAT 4.0 software.

3. RESEARCH RESULTS AND DISCUSSION

Table 1: The growth period of the experimental sticky corn varieties

Unit: days

Variety	From sowing to emergence	From sowing to tasseling	From sowing to silking	From sowing to fresh corn harvest
HN88 (Control)	4	57	60	83
QUENEP 521	4	56	59	81
CS 03	4	56	59	81
CuuLong 818	4	58	61	83
HMT 76	4	57	60	82
Bani 510	4	56	59	81
Bani 569	4	58	61	83
VNUA 11	4	58	61	83
VNUA 70	4	55	58	80
ATN 17	4	57	61	83

The growth stages of maize plants, whether long or short, depend on the variety and external conditions. The variation in growth stages is the scientific basis for determining planting seasons. The results in Table 1 show that, at the initial planting stage, the warm weather resulted in all maize varieties emerging at the same time, four days after planting. The time from sowing to tasseling varied among the maize varieties, ranging from 55 to 58 days. Specifically, the glutinous maize varieties QUENEP 521, CS 03, Bani 510, and VNUA 70 tasseled 1-2 days

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earlier than the control variety, while the remaining varieties tasseled either simultaneously with or one day after the control.

The time from sowing to silking ranged from 58 to 61 days, with the maize varieties QUENEP 521, CS 03, Bani 510, and VNUA 70 silking 1-2 days earlier than the control.

The duration from sowing to ear harvest, which influences the timing of subsequent planting seasons, showed that the glutinous maize varieties under study had similar harvest times, differing by only 1-3 days. The VNUA 70 variety had the earliest harvest, at 80 days after planting.

Table 2. Plant height, ear height, plant condition, and ear coverage of the sticky corn varieties

Variety	**Plant height** *(cm)*	**Ear height** (*cm*)	**Plant condition** *(point)*	**Ear coverage** *(point)*
HN88 (Control)	176.8^{abc}	80.4^{bc}	1	1
QUENEP 521	171^{c}	80.5^{ab}	1	1
CS 03	145.4^{de}	50.6^{h}	2	1
CuuLong 818	176.5^{bc}	76.7^{cd}	2	1
HMT 76	140.6^{ef}	60.2^{fg}	2	1
Bani 510	170.2^{c}	76.5^{d}	1	1
Bani 569	184.0^{a}	86.4^{a}	1	1
VNUA 11	140.0^{ef}	70.8^{e}	1	1
VNUA 70	135.6^{f}	56.5^{g}	1	1
ATN 17	170.2^{c}	75.6^{de}	1	1
CV%	***6.6***	***8.3***		
$\boldsymbol{LSD_{0,05}}$	***9.99***	***5.58***		

The results in Table 2 show that the experimental varieties had lower plant heights compared to the HN88 variety (control), with statistically significant differences at the 95% confidence level. Among the varieties, Bani 569 had the highest plant height at 184 cm, while the other varieties were all shorter than the control.

Ear height: The experimental glutinous maize varieties all had lower ear heights compared to the control, except for the Bani 569 variety, which had a higher ear height at 86.4 cm.

Plant condition: Three glutinous maize varieties, CS 03, CuuLong 818, and HMT 76, exhibited a fair condition (score 2), while the remaining varieties and the control exhibited good plant condition (score 1).

Ear coverage: All the glutinous maize varieties studied had very tight ear coverage (score 1).

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Table 3. Pest and disease incidence and resistance of some experimental corn varieties

Variety	Pets (point)			Diseases (point,%)			Resistance capability (point)		
	The stem borer	Corn earworm	Corn leafhopper	Small leaf spot disease	Large leaf spot disease	Leaf blight disease	Root lodging resistance	Stalk lodging resistance	"Cold resistance
	(1 – 5)	(1 – 5)	(1 – 5)	(0 – 5)	(0 – 5)	(%)	(1-5)	(1-5)	(1-5)
HN88 (Control)	1	1	1	1	1	5.5	0	1	1
QUENEP 521	1	1	1	1	1	3.2	0	1	1
CS 03	1	1	1	1	1	4.6	0	1	1
CuuLong 818	1	1	1	1	1	5	0	1	1
HMT 76	1	1	1	1	1	7.8	0	1	1
Bani 510	1	2	1	1	1	8.2	0	1	1
Bani 569	1	2	1	1	1	2.4	0	1	1
VNUA 11	1	1	2	1	1	3.6	0	1	1
VNUA 70	1	1	2	1	1	3.5	0	1	1
ATN 17	1	1	1	1	1	2	0	1	1

Vietnam is located in a tropical climate region with high humidity and heavy rainfall, where pests develop and cause damage in all maize growing seasons. Breeding maize varieties resistant to pests is one of the most economical measures, reducing pest damage while ensuring a clean environment and human health. Monitoring the appearance and severity of pest damage provides a scientific basis for evaluating pest resistance of varieties and determining timely and effective pest control measures. The data in Table 3 show that because the experimental crop was grown in winter, when temperatures are lower, pest damage was minimal.

During the tasseling stage, the temperature was not high, so the maize varieties in the experiment experienced minimal stem borer damage (score 1). However, ear borer damage was more prevalent in the Bani 510 and Bani 569 varieties (score 2), while the control and other varieties scored 1.

Aphid damage was more severe in the VNUA 11 and VNUA 70 varieties (score 2) compared to the control, while the other varieties experienced minimal damage (score 1).

Large leaf spot and small leaf spot diseases appeared frequently from the 7-9 leaf stage to maturity, but due to low temperatures and humidity during this period, the diseases were very mild (score 1).

Sheath blight ranged from 2% to 8.2%, with the control variety at 5.5% and the Bani 510 variety having the highest damage at 8.2%. All maize varieties showed good resistance to lodging and cold (score 1).

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Table 4. The factors contributing to the yield of the experimental corn varieties.

Variety	Corn ear length (cm)	Corn ear diameter (cm)	Number of kernel rows per ear (row)	Number of kernels per row (kernel)	Seed color
HN88 (Control)	18.2^{a}	4.6^{cd}	13^{bc}	35^{bc}	Opaque white
QUENEP 521	17.6^{ab}	4.9^{ab}	15^{a}	34^{cd}	Opaque white
CS 03	17^{b}	4.4^{d}	14^{ab}	31^{f}	Opaque white
CuuLong 818	18.6^{a}	4.8^{abc}	14^{ab}	36^{ab}	Opaque white
HMT 76	18.2^{a}	4.8^{abc}	14^{ab}	35^{bc}	Opaque white
Bani 510	18.6^{a}	4.9^{ab}	12^{c}	33^{de}	Purple-white
Bani 569	17.7^{ab}	4.9^{ab}	12^{c}	32^{ef}	Opaque white
VNUA 11	18.3^{a}	4.6^{cd}	12^{c}	35^{bc}	Opaque white
VNUA 70	18.5^{a}	4.7^{bc}	12^{c}	32^{ef}	Purple-white
ATN 17	18.5^{a}	5	14^{ab}	37^{a}	Opaque white
CV%	***6.6***	***5.5***	***9***	***5.7***	
$\boldsymbol{LSD_{0,05}}$	***1.12***	***0.24***	***1.83***	***1.09***	

The results in Table 4 show that the ear length of the glutinous maize varieties ranged from 17 to 18.6 cm. The ear lengths of the CuuLong 818, Bani 510, VNUA 11, and VNUA 70 varieties were higher than the control, but the differences were not statistically significant.

The ear diameter of the glutinous maize varieties QUENEP 521, CuuLong 818, HMT 76, Bani 510, Bani 569, and VNUA 70 was higher than the control, with statistically significant differences. The remaining varieties had smaller ear diameters compared to the control. The number of kernel rows per ear for the varieties ranged from 12 to 15 rows.

The number of kernels per row for the glutinous maize varieties ranged from 31 to 37 kernels per row, with the ATN 17 variety having the highest number at 37 kernels per row. This was higher than the control, with the difference being statistically significant at the 95% confidence level.

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Table 5. The fresh ear yield of the experimental glutinous maize varieties

Variety	Fresh corn yield (kg/plot of experiment)	Fresh corn yield (tons/ha)
HN88 (Control)	18.2^{a}	130.24^{a}
QUENEP 521	17.7^{abcd}	126.19^{abcd}
CS 03	14.2^{g}	101.67^{g}
CuuLong 818	16.9^{def}	120.95^{def}
HMT 76	17.3^{bcd}	123.57^{bcde}
Bani 510	16.6^{ef}	118.33^{ef}
Bani 569	16.1^{f}	114.76^{fg}
VNUA 11	17.1^{cde}	122.38^{cde}
VNUA 70	18^{ab}	128.33^{abc}
ATN 17	18.5^{a}	131.9^{a}
CV%	***5,0***	***6,5***
$\boldsymbol{LSD_{0,05}}$	***0.8***	***7.2***

Fresh ear yield is one of the most important criteria and the ultimate goal in maize breeding. Fresh ear yield reflects the genetic characteristics and adaptability of glutinous maize varieties under specific cultivation conditions.

The results in Table 5 show that the fresh ear weight of the glutinous maize varieties ranged from 14.2 to 18.5 kg per plot. The lowest weight was recorded for the CS 03 variety at 14.2 kg per plot, while the highest was for the ATN 17 variety at 18.5 kg per plot, higher than the control.

Glutinous maize is typically consumed fresh or processed in its fresh form. However, fresh ear yield varies depending on the variety. The yield of the ATN 17 variety reached 131.9 quintals per hectare, higher than the control, which yielded 130.24 quintals per hectare. All other varieties had lower yields compared to the control.

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Table 6: The taste test quality of the glutinous maize varieties

Variety	Stickiness (point 1 – 5)	Aroma (point 1 – 5)	Richness of flavor (point 1 – 5)	Sweetness (point 1 – 5)
HN88 (Control)	3	3	3	4
QUENEP 521	2	3	3	4
CS 03	2	3	3	3
CuuLong 818	3	3	4	4
HMT 76	3	3	4	4
Bani 510	3	3	3	3
Bani 569	3	3	3	4
VNUA 11	2	3	3	3
VNUA 70	3	3	3	4
ATN 17	2	3	3	4

The evaluation of glutinous maize quality through taste testing is crucial because its products are primarily consumed fresh. Evaluating the quality of various glutinous maize varieties reveals consistent chewiness (score 3), moderate aroma (score 3), and moderately rich flavor. Two varieties, CuuLong 818 and HMT 76, have slightly weaker flavors (score 4), while the remaining varieties and the control have a moderately rich flavor (score 3). In terms of sweetness, three varieties—CS 03, Bani 510, and VNUA 11—are moderately sweet (score 3), whereas the control and other varieties are moderately sweet (score 4).

4. CONCLUSION

The growth stages of maize, including tasseling and silking, vary by variety and are influenced by weather conditions. All varieties emerged simultaneously in warm weather, with variations in tasseling and silking times observed among different varieties.

Experimental varieties generally had shorter plant and ear heights compared to the control (HN88). The Bani 569 variety was an exception, having the highest plant height and higher ear height than the control.

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Minimal pest damage occurred during the experiment due to lower winter temperatures. However, certain varieties were more susceptible to specific pests like ear borers and aphids. Overall, the varieties showed good resistance to diseases and lodging.

The ear length and diameter of most experimental varieties were comparable or slightly higher than the control, with statistically significant differences in ear diameter for some varieties. The number of kernel rows and kernels per row varied, with the ATN 17 variety having the highest kernel count per row. Fresh ear yield varied, with the ATN 17 variety showing the highest yield, surpassing the control.

Taste testing revealed that the glutinous maize varieties had consistent chewiness, moderate aroma, and moderately rich flavor, with slight variations among varieties. The sweetness levels varied, with some varieties being moderately sweet and others slightly less sweet.

Author's declaration and contribution

All authors contributed equally to all stages of the preparation of this manuscript. The authors declare no conflicts of interest. Additionally, the final version of the manuscript was approved by all authors.

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Author info:

Nguyen Tuan Khoi. Faculty of Agronomy, BacGiang Agriculture and Forestry University. Email: khoint@bafu.edu.vn. https://orcid.org/0000-0002-5920-1486

Bui Thi Thu Trang. Faculty of Agronomy, BacGiang Agriculture and Forestry University. Email: thutrangdhnlbg@gmail.com