Introduction

1. The importance of the project

Rice (*Oryza sativa* L.) is one of the most important food crops globally. The harvested area of rice, which is mainly concentrated in Asian countries [Faostat, 2020], accounts for approximately 10% of that of other crops. In Vietnam, rice is the main food crop, plays an important role in national food security, and is the food crop with the largest cultivation area and output in the country [Hoang Kim, 2016]. Rice production is considered the most important sector of Vietnam's agriculture. In 2020 alone, rice export output is 6.15 million tons withexport value being up to 3.07 billion USD [Faostat, 2020].

Thanh Hoa province is located in the North Central Delta region,and is one of the largest rice-producing regions in the country. In 2017, the province had 250.5 thousand hectares of rice cultivation area, decreasing 1.39% from 2016; the average rice yield reached 58.4 quintals/hectares, lower than the average yield of the provinces in the Red River Delta (60.60 quintals/hectares) [People's Committee of Thanh Hoa province, 2017]. In recent years, the application of scientific and technological advances to the production and the changing of rice cultivar structure has created breakthroughs in intensive rice production. However, the rice production industry in Thanh Hoa province has not fully exploited its inherent potential.

In order to improve the efficiency of rice production, Thanh Hoa province has decided to build a specialized high-quality rice production area with a scale of more than 60,000 hectares, concentrated in the districts of Trieu Son, Quang Xuong, Hoang Hoa, Nong Cong, Yen Dinh, Thieu Hoa, Tho Xuan, Dong Son [People's Committee of Thanh Hoa province, 2007]. Survey results show that currently, rice produced in the province are from either hybrid rice with high yield and good quality such as Thai Xuyen 111, VT404, Huong uu 98; high-yield and medium-quality hybrid rice such as Nhi Uu 986, GS9, Nhi Uu 838; high-yielding pure rice cultivars such as Thien Uu 8, Q5, TBR1, TBR45; or high-quality purebred rice such as Bac Thinh, TBR225, BT7, Lam Son 8, Bac Huong 9. However, high-yield and high-quality purebred rice cultivars that can be planted in the spring crop are of few numbers and are not updated regularly [Department of Agriculture and Rural Development 2019].

Therefore, the research and selection of high-quality purebred rice cultivars in order to increase the number of high-yield and high-quality rice cultivars planted in the spring crop in the province and at the

same time the determination of appropriate farming techniques are of great importance to the sustainable development of the specialized high-quality rice production area of Thanh Hoa province. This aligns with the decision approving the "Project on restructuring the rice industry of Vietnam until 2025 and 2030" of the Ministry of Agriculture and Rural Development (2021), and with the Project "Restructuring the agricultural sector in Thanh Hoa province towards increasing added value and sustainable development until 2020 and orientation until 2025" of the Thanh Hoa Department of Agriculture and Rural Development (2012). Thus, this thesis, "Research on the selection of rice cultivars and the identification of some technical measures to improve the efficiency of high-quality purebred rice production in the delta of Thanh Hoa province" was carried out.

2. Project objectives

2.1. General objective

Selecting rice cultivars and identifying appropriate farming techniques to improve the efficiency of high-quality purebred rice production in the delta region of Thanh Hoa province.

2.2. Detailed objectives

- Assessing the climate, soil, production situation and high-quality rice intensification techniques in the delta of Thanh Hoa province.

- Selecting high-yield and high-quality purebred rice cultivars suitable for production conditions in spring crops in the delta of Thanh Hoa province.

- Identifying some cultivation techniques for the selected rice cultivars such as: transplanting density and nitrogen fertilizer dosage, amount of microbial organic fertilizer for growth, yield, quality and efficiency of rice production in the delta region of Thanh Hoa province.

- Building a production model for high-quality purebred rice cultivars selected based on applying integrated technical measures in the delta region of Thanh Hoa province.

3. Scientific and practical significance of the project

3.1. Scientific significance

Contributing scientific data on identifying high-quality purebred rice cultivars, including the specialty cultivar Japonica, some technical measures for rice intensification, and at the same time confirming and clarifying the role, the importance of using microbial organic fertilizers in increasing the yield, quality and efficiency of rice production in the delta of Thanh Hoa province in the context of increasingly complex climate change.

delta of Thanh Hoa province:

- The treatment containing the density of 45 hills/m^2, the nitrogen dose of 90 kg N/ha, 8 tons of manure (or 2.0 tons/ha of Song Gianh microbial organic fertilizer) +100 kg of P_2O_5 + 80 kg of K_2O/ha was the most suitable for rice cultivar VAAS16. The actual yield of this cultivar was highest in the spring crop in Thanh Hoa delta (6.63 tons/ha in Dong Son and 6.47 tons/ha in Hoang Hoa). At this density, the technical maximum amount of nitrogen fertilizer was 99.9 kg/ha in Dong Son, 105.4 kg in Hoang Hoa, and the economic optimum was 92.8 kg/ha in Dong Son; 97.1 kg/ha in Hoang Hoa.

- Song Gianh microbial organic fertilizer had a good effect on the growth and development of rice cultivar VAAS16 in Thanh Hoa province; increased leaf area and dry matter weight in all growth stages. On the base of inorganic fertilizer 90 kg N + 100 kg P_2O_5 + 80 kg K_2O/ha, applying 2.0 tons of microbial organic fertilizer Song Gianh/ha gave the highest rice yield in Dong Son and Hoang Hoa districts, reaching 6.72 tons/ha and 6.57 tons/ha respectively; higher than that of no organic fertilizer and equivalent to 8 tons of manure/ha. Therefore, in the situation of scarcity of manure for rice production, it is possible to use Song Gianh microbial organic fertilizer instead.

1.4. The application of model of new rice cultivar VAAS16 and some technical measures of rice intensification in 4 locations in the delta region of Thanh Hoa province increased the average rice yield from 5.19 tons/ha (check model, cultivar BT7) to 6.43 tons/ha (experimental model, cultivar VAAS16), net profit increased from 13.363 million VND/ha to 23.603 million VND/ha, the difference between natural and organic farming is 10.240 million VND/ha; marginal cost and profit ratio (MBCR) was from 2.60 to 2.71 times, the average was 2.68 times. This model is recommended for expansion in production.

2. Recommendations

2.1. Adding pure rice cultivar VAAS16 to the rice cultivar set in rice-intensive areas of Thanh Hoa province. Gradually expand the area of high quality commercial rice production for Dong Son and Hoang Hoa districts and other high-efficiency, productive rice-growing areas of Thanh Hoa province.

2.2. Applying the technical process of intensive cultivation for the proposed VAAS16 rice cultivar in the next crops and building demonstration models on a large scale to replicate the research results in the province.

3.4. Building an integrated technical model to increase yield and efficiency for high-quality purebred rice cultivars in the delta region of Thanh Hoa province

The application of new cultivars and some technical measures in intensive rice cultivation in the delta region of Thanh Hoa province increased the average rice yield from 5.19 tons/ha (using the BT7 cultivar) to 6.43 tons/ha (using VAAS16 cultivar). Net profit increased from VND 13,363 million/ha to VND 23,603 million/ha (the difference between the check model and the experimental model was 10,240 million VND/ha). Marginal cost and profit ratio (MBCR) wasfrom 2.60 to 2.71 times, especially the average MBCR value of the empirical model at 4 locations was2.68 times. This model is recommended for expansion in production.

CONCLUSIONS AND RECOMMENDATIONS

1. Conclusion

1.1. Climatic and soil conditions of the delta region of Thanh Hoa province are favorable for the growth and development of rice. However, the productivity and efficiency of rice production are still not commensurate with the potentials of the region. The results of secondary and primary data collection showed that the following groups of rice cultivars exist in the area: groups of high-yielding, good-quality hybrid rice such as Thai Xuyen 111, VT404, Huong uu 98; groups of high-yield and medium-quality hybrid rice such as Nhi Uu 986, GS9, Nhi Uu 838; groups of high-yielding pure rice cultivars such as Thien uu 8, Q5, TBR1, TBR45 and high-quality pure rice groups such as Bac Thinh, TBR225, BT7, Lam Son 8, Bac Huong 9. However, high yielding rice cultivars, good quality that can be planted in the spring crop is not much available and has not been updated regularly. Besides, it is really necessary to study to identify appropriate intensive farming techniques to promote the yield potential of the cultivar.

1.2. Selected a quality rice cultivar VAAS16 belonging to the Japonica group with many outstanding characteristics: good growth and development, the average growth time of about 133 days in the spring crop, the yield of 6.8 tons/ha. Mild infection with major pests and diseases, good rice quality, brown rice rate 82.2%, white rice rate 70.1%, head rice rate 84.6%, amylose content 11.92%, protein content 8.29%; rice is delicious and fragrant, suitable for consumer and export tastes, suitable for spring crop in the delta, Thanh Hoa province.

1.3. Identified a number of suitable cultivation techniques for the purebred high quality rice cultivar VAAS16 in the spring crop in the

3.2. Practical significance

The high-quality purebred rice cultivar Japonica, VAAS16, suitable for spring crop in the delta region of Thanh Hoa province, and appropriate farming techniques that contribute to improving the yield and quality of rice, that increase the income for local people and that help develop sustainable agriculture in the region has been selected.

4. New contributions of the thesis

The high-quality purebred rice cultivar VAAS16 belonging to the Japonica group has been selected, with many outstanding properties: excellent growth and development, average growth time being 133 days in the spring crop, yield of 6.8 tons/hectares, mild infection with major pests and diseases, good quality rice; some suitable technical measures for the rice cultivar VAAS16 in the spring crop in the delta of Thanh Hoa province, including transplanting density of 45 hills/m^2 and nitrogen fertilizer amount of 90 kg N/ha; and Song Gianh microbial organic fertilizer amount of 2.0 tons/ha have been identified; The model for application of the rice cultivar VAAS16 and some suitable intensive farming techniques in 4 locations in the delta of Thanh Hoa province increases the average rice yield from 5.19 tons/hectares (MHĐC, cultivar BT7) to 6.43 tons/hectares (MHTN, cultivar VAAS16); marginal benefit-cost ratio (MBCR) ranges from 2.60 to 2.71, with the average of 2.68; expansion and development in production has been recommended.

5. Thesis structure

The thesis is presented in 141 pages, with 42 data tables, 09 figures. Introduction is comprised of 4 pages, chapter 1: Overview of research papers spans 36 pages, chapter 2: Materials and methods spans 17 pages, chapter 3: Results and discussion spans 80 pages; Conclusions and recommendations spans 2 pages. There are also appendices. The thesis uses 104 references, with 60 being in Vietnamese, 43 being in English and 1 being an Internet resource.

Chapter 1. OVERVIEW OF RESEARCHES AND SCIENTIFIC BASES OF THE PROJECT

1.1. Taxonomic origin of rice

1.2. Status of rice production in the world and Vietnam

1.2.1. Status of rice production in the world

1.2.2. Status of rice production in Vietnam

1.3. Studies on agro-biological properties of rice

1.3.1. Studies on growth time

1.3.2. Studies on tree height

1.3.3. Studies on rice ear length

Rice is a short-duration food crop that has an important and irreplaceable role in the agricultural production of Vietnam in general and of Thanh Hoa province in particular. Reviewing domestic and foreign references has shown the results and research on issues related to the contents of the topic: Taxonomical origin of rice; rice production in the world and in Vietnam; Agro-biological properties and quality parameters of rice. Besides, the overview of the thesis has synthesized and evaluated the research results on the breeding and selection of high-quality rice cultivars and the influence of technical measures on the growth, development and yield of rice.

Chapter 2. MATERIALS AND METHODS

2.1. Materials

2.1.1. Rice cultivars

Table 3.36. Effect of Song Gianh microbial organic fertilizer on actual yield of rice cultivar VAAS16 at 2 experimental sites, spring crop 2017 and 2018

CT	Actual Yield (tons/ha)					
	Dong Son			Hoang Hoa		
	2017	2018	Average	2017	2018	Average
M1 (Base – ĐC 1)	5.88	5.80	5.84	5.72	5.90	5.81
M2 (Base+ 8 tons PC- ĐC 2)	6.71	6.85	6.78	6.68	6.76	6.72
M3 (Base + 0.5 tons HCVS)	5.86	5.98	5.92	5.77	5.99	5.88
M4 (Base + 1.0 ton HCVS)	6.06	6.20	6.13	6.06	6.12	6.09
M5 (Base + 1.5 tons HCVS)	6.48	6.36	6.42	6.42	6.30	6.36
M6 (Base + 2.0 tons HCVS)	6.68	6.76	6.72	6.62	6.52	6.57
M7 (Base + 2.5 tons HCVS)	6.72	6.78	6.75	6.72	6.46	6.59
$LSD_{0.05}$	0.174		*0.18*	0.97		*0.30*
CV (%)	*6.6*			*6.9*		

The application rate of 2.0 tons/ha of Song Gianh microbial organic fertilizer (M6) was suitable for the rice cultivar VAAS16. With this level of fertilizer, the rice yield in the 2 districts of Dong Son and Hoang Hoa reached values of 6.72 tons/ha and 6.57 tons/ha, respectively, which were higher than those without organic fertilizer and equivalent when the application of 8 tons of manure/ha.

3.3.2.4. Effects of Song Gianh microbial organic fertilizer on some chemical properties of experimental soil

Agrochemical parameters include: Acidity (pH KCl), total nitrogen (N%), total phosphorus (P_2O_5%), total potassium (K_2O %), available phosphorus (P_2O_5 mg/100g soil), available potassium (K_2O mg/100g soil), cation exchange capacity (CEC ldl/100g soil) after the experiment in Song Gianh microbial organic fertilizer were all improved compared to before the experiment as well as compared with the control when using only inorganic fertilizers.

and y = -0.0738x2 + 15,557x + 5505.1 with coefficient of determination R^2 = 0.8865 (in Hoang Hoa). However, these correlations are non-linear, which means that if the amount of nitrogen fertilizer is too high, the rice yield tends not to increase but will stop and decrease.

In Dong Son district, with a transplanting density of 45hills/m^2, the maximum nitrogen fertilizer dose was 99.9 kg N/ha and the economically optimal fertilizer application rate was 92.8 kg N/ha. In Hoang Hoa district, the maximum level of nitrogen fertilizer was 105.4 kg N/ha and the optimal economic level of fertilizer was 97.1 kg N/ha; fertilizer-based treatments (for 1 hectare) 8.0 tons of manure + 100 kg of P_2O_5 + 80 kg of K_2O.

3.3.2. Effect of microbial organic fertilizer dosage on growth, development and yield of rice cultivar VAAS16 in spring crop in the delta of Thanh Hoa province

3.3.2.1. Effect of microbial organic fertilizer dosage on growth and development of rice cultivar VAAS16 in spring crop in the delta of Thanh Hoa province

The research results showed that Song Gianh microbial organic fertilizer application had a positive effect on the growth and development of the rice cultivar VAAS16. Song Gianh microbial organic fertilizer application also increased leaf area and dry matter weight in all growth and development stages of rice, thereby significantly affecting growth, development, and yield of rice cultivar VAAS16.

3.3.2.2. Effect of microbial organic fertilizer dosage on leaf area index and dry matter accumulation capacity of rice cultivar VAAS16 in spring crop in the delta of Thanh Hoa province

The leaf area index increased rapidly through the period from tillering to flowering and gradually decreased in the ripening period. Manure and Song Gianh fertilizer supported the increase of dry matter weight in all growth stages of rice cultivar VAAS16 compared with control 1 that only applied inorganic fertilizers.

3.3.2.3. Effect of microbial organic fertilizer dosage on pest and disease infection of rice cultivar VAAS16 in spring crop in the delta of Thanh Hoa province

In general, the degree of mild damage was assessed to be less harmful to the yield and efficiency of the rice cultivar VAAS16, however, through two monitoring seasons, it had been shown that rice fertilized with Song Gianh micro-organic fertilizer treatments and substrate were able to better resistance to pests and diseases.

3.3.2.4. Effect of microbial organic fertilizer dosage on yield of rice cultivar VAAS16 in spring crop in the delta of Thanh Hoa province

10 high-quality purebred rice cultivars with a short growing time from domestic and foreign sources have been collected for evaluation and selection in the delta of Thanh Hoa province (Table 2.1 and Appendix 1).

Table 2.1. List of quality pure rice cultivars and their main properties

No	Name	Source	Main properties
1	Bac Thinh (BT)	Center for Research and Application of Science and Technology for agricultural plant cultivars in Thanh Hoa	Growth period: 135 - 140 days (Spring crop); 105 - 110 days (Summer crop). Average yield: 6.5 - 7.0 tons/hectare (Spring crop); 6.0 - 6.5 tons/hectares (Summer crop). Plant height: 95 - 105 cm.
2	Bac Xuyen (BX)		Growth period: 135 - 140 days (Spring crop); 105 - 110 days (Summer crop). Average yield: 6.0 - 7.0 tons/hectare (spring crop); 6.0 - 6.5 tons/hectares (Summer crop). Plant height: 100 - 105 cm.
3	Huong Com 3 (HC3)	Vietnam National University of Agriculture	Growth period: 135 - 145 days (Spring crop); 115 - 120 days (Summer crop). Average yield: 6.0 - 7.0 tons/hectare (spring crop); 5.0 - 6.0 tons/hectares (Summer crop). Plant height: 110 - 105 cm.
4	Huong Com 4 (HC4)		Growth period: 130 - 135 days (spring crop); 105 - 110 days (Summer crop). Average yield: 6.0 - 7.0 tons/hectare (spring crop); 5.5 - 6.0 tons/hectares (Summer crop). Plant height: 90 - 105 cm.
5	LH12	Plant Resources Center	Growth period: 130 - 135 days (spring crop); 105 - 110 days (Summer crop). Average yield: 6.5 - 7.0 tons/hectare (spring crop); 6.0 - 6.5 tons/hectares (Summer crop).
6	LH13		
7	ĐA1	Thai Binh Seed Joint Stock Corporation	Growth period: 130 - 135 days (spring crop); 105 - 110 days (Summer crop). Average yield: 6.5 - 7.0 tons/hectare (spring crop); 6.0 - 6.5 tons/hectares (Summer crop). Plant height: 110 - 115 cm.
8	ĐS1	Agricultural Genetics Institute	Growth period (in the provinces of the Red River Delta and the Northern Midlands): 135 - 145 days (spring crop); 110 - 115 days (Summer crop). Average yield: 60 - 65 quintals/hectares, with intensive farming: 75 - 80 quintals/hectares.
9	VAAS16	Vietnam Academy of Agriculture Sciences	Growth period: 130 - 140 days (spring crop), 105 - 110 days (Summer crop) (more suitable for spring crop than the Summer crop), average yield: 60 - 65hectares).
10	BT 7 (Đ/C)	Thanh Hoa Seeds Joint Company	Growth period: 130 -135 days (spring crop), 105 - 110 days (Summer crop). Height: 105 - 115 cm; Average yield: 5.5- 6.0 tons/hectares.

2.1.2. Soil, fertilizers and pesticides

- Experimental soil: Alluvial soil that is not accreted annually.

- Fertilizers: Common fertilizers on the market are used: Urea (46% N); Lam Thao superphosphate (16.5% P_2O_5); potassium chloride (KCl) 60% K_2O; Song Gianh microbial organic fertilizer (components: Organic ≥15%, P_2O_5 ≥1.5%, Ca ≥1%, Mg ≥0.5%, S≥0.2%, microbial strains: Aspergillus sp. 1,106 CFU/g, Azotobacter and Bacillus (1,106 CFU/g); agricultural materials and pesticides commonly used in local rice intensification.

2.2.4. Building an intensive farming model of high-quality rice cultivar VAAS16 based on the comprehensive application of optimal technical measures in the spring crop in the delta region of Thanh Hoa province

2.3. Research period and location

- Research period: From 2015 to 2020.

- Research location: Dong Son and Hoang Hoa, Thanh Hoa Province.

2.4. Research Methods

2.4.1. Investigating and evaluating climate, soil, production status and high-quality rice intensification techniques in the delta region of Thanh Hoa province.

2.4.1.1. Secondary data collection method

All documents, statistics, maps, technical processes, scientific reports, production reports, etc. related to climate, soil, production status and technical measures for high-quality rice intensification in the delta region of Thanh Hoa province were collected.

2.4.1.2. Primary data collection methods

- Investigating and collecting information related to the production status and rice intensification techniques of farmers through the household survey method.

- Selecting locations, and households for the survey: In the delta area of Thanh Hoa province, selecting 2 districts with large rice-growing areas (Hoang Hoa, Dong Son), selecting from each district 5 communes, selecting from each commune 10 rice-growing households for the survey.

The total number of surveyed households: 2 districts x 5 communes/districts x 10 households/commune = 100 households.

- Survey method: Investigating and collecting information according to a questionnaire with printed questions, which include both closed and open questions (Appendix 8).

M3N2 treatment (55 hills/m^2 and 60 kg N/ha) gave the second-highest number of rice panicles, reaching 277.2 rice panicles/m^2. The treatment M1N0 (35 hills/m^2 and 0 kg N/ha) gave the lowest number of rice panicles, reaching 188.0 rice panicles/m^2.

Theoretical yield (NSLT): ranges from 5.70 - 8.13 tons/ha. The highest yield was obtained when using M2N4 (45 hills/m^2 and 120 kg N/ha) was 8.13 tons/ha), which was not much different from the M2N3 treatment (45 hills/m^2 and 90 kg N/ha) with 7.93 tons/ha. The treatment M1N0gave the lowest yield (35 hills/m^2 and 0 kg N/ha), reaching 5.70 tons/ha (Table 3.30).

Actual yield (NTTT): ranged from 4.87 to 6.47 tons/ha. The treatment M2N3 (45 hills/m^2 and 90 kg N/ha) gave the highest yield, reaching 6.47 tons/ha. The lowest yield was obtained when using the treatment M1N0 (35 hills/m2 and 0 kg N/ha) with only 4. 87 tons/ha (Table 3.30).

Thus, in order to achieve the highest yield of the rice cultivar VAAS16 in Hoang Hoa district, it is recommended to transplant at a density of 45 hills/m^2 and apply nitrogen at a dose of 90 kg N/ha on the basis of general fertilizers.

c. Correlation between nitrogen dosage and yield of rice cultivar VAAS16

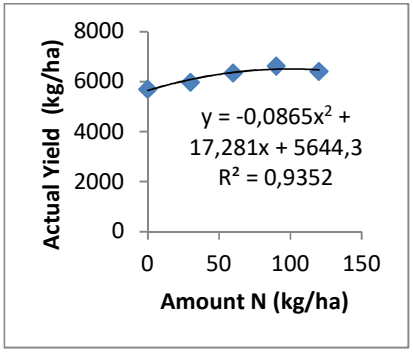

Figure 3.5. Correlation between nitrogen fertilizer and yield of rice cultivar VAAS16 in Dong Son district

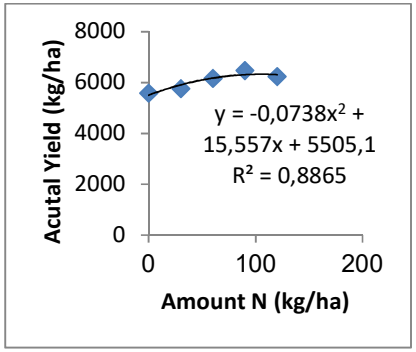

Figure 3.6. Correlation between nitrogen fertilizer and yield of rice cultivar VAAS16 in Hoang Hoa district

The results showed that the correlation between the amount of nitrogen fertilizer application and the actual yield of the rice cultivar VAAS16 is strongly correlated with the regression equation: y = -0.0865x2 + 17,281x + 5644.3; coefficient of determination R^2 = 0.9352 (in Dong Son)

yield (5.75 tons/ha) (Table 3.27).

Actual yield: Actual yield ranged from 4.91 to 6.63 tons/ha. The highest yield was obtained with the M2N3 treatment (45 hills/m^2 and 90 kg N/ha) at 6.63 tons/ha, the M1N0 treatment (35 hills/m^2 and 0 kg N/ha) only gave the lowest yieldat 4.91 tons/ha (Table 3.27).

Thus, in order to achieve the highest yield of rice cultivar VAAS16, we should transplant with a density of 45 hills/m^2 and apply 90 kg of N/ha on a general fertilizer base.

b. Results in Hoang Hoa district

Table 3.30. Interaction effects between inoculation density and nitrogen dosage on yield and yield components of VAAS16 cultivar in spring crop in Hoang Hoa district, Thanh Hoa province

Treatment		Panicles /m^2	Total number of seeds/ rice panicle (seed)	Percentage of full grain (%)	1000 seeds weight (gam)	Theoretical yield (ton/ha)	Actual yield (ton/ha)
M1	N0	188.0	143.3	88.6	23.9	5.70	4.87
	N1	191.5	145.0	90.9	24.0	6.06	5.02
	N2	198.5	143.6	91.1	24.2	6.28	5.26
	N3	211.8	145.4	92.4	24.6	7.00	5.73
	N4	213.9	143.6	94.9	24.7	7.20	5.91
M2	N0	231.8	142.4	85.8	23.3	6.60	5.58
	N1	235.8	141.9	87.2	23.4	6.83	5.76
	N2	248.0	137.5	88.2	23.6	7.09	6.16
	N3	264.6	138.2	88.9	24.4	7.93	6.47
	N4	265.1	138.0	91.1	24.4	8.13	6.23
M3	N0	266.8	125.4	80.3	23.2	6.23	5.18
	N1	273.9	127.2	81.3	23.3	6.60	5.26
	N2	277.2	125.5	82.2	23.6	6.75	5.54
	N3	282.7	125.7	82.8	23.9	7.03	5.71
	N4	273.9	127.6	79.2	23.5	6.50	5.58
$LSD_{0,05}$ (M&N)		*13.7*	*6.21*	-	-	-	*0.61*
CV(%)		*7.4*	*6.7*	-	-	-	*7.5*

(Average Data from 2 Spring Crop: 2017 and 2018)

Number rice panicles/m^2:ranged from 188.0 - 282.7 rice panicles/m^2, the treatment M3N3 (55 hills/m^2 and 90 kg N/ha) gave the highest number of rice panicles, reaching 282.7 rice panicles/m^2. The

2.4.2. Research on selecting high-quality and high-yield purebred rice cultivars suitable for spring crop conditions in the delta of Thanh Hoa province

Experiment 1: Selection of high-quality and high-yield rice cultivars with high yield suitable for spring crop conditions in the delta of Thanh Hoa province

- The experiment consists of 10 cultivars, check cultivar: Bac Thom 7.

- The experiment consists of 10 rice cultivars, designed according to Randomized Complete Block (RCB), replicated 3 times according to the national technical regulation on testing the cultivation and use value of rice cultivars (QCVN 01) -55:2011/BNNPTNT) of the Ministry of Agriculture and Rural Development. The experimental plot area is 10 m^2 (2.5 m x 4 m). Total experimental area: 10 treatments (cultivars) x 10 m^2/CT x 3 replicates = 300 m^2 (excluding protection area).

2.4.3. Research on some suitable farming techniques for purebred rice cultivar VAAS16 in the spring crop in the delta of Thanh Hoa province

Experiment 2: Studying the effect of transplanting density and nitrogen fertilizer dosage on the growth and yield of rice cultivar VAAS16 in the spring crop in the delta of Thanh Hoa province

The two-factor experiment (density and nitrogen fertilizer dosage) was arranged in the style of large plots and small plots (Split plot); in which the nitrogen dosage factor is arranged in the small plot and the density factor is arranged in the large plot; 3 replicates; the area of each small plot is 10 m^2 (2.5 m x 4 m); the area of each large plot is 50 m^2; Between the experimental plots, there is a boundary embankment; the total experimental area is 50 m^2 x 3 cells/replicate x 3 replicates = 450 m^2 (excluding protection area).

- Density:

+ M1 density: 35 hills/m^2 (row spacing: 20 cm, hill spacing: 13 cm).

+ M2 density: 45 hills/m^2 (row spacing: 20 cm, hill spacing: 11 cm).

+ M3 density: 55 hills/m^2 (row spacing: 20 cm, hill spacing: 9 cm).

- Base fertilizer application: 8.0 tons of manure/hectares + 100 kg of P2O5 + 80 kg of K2O.

- Amount of nitrogen (calculated for 1 hectare):

+ 0 kg N (D/C): N0

+ 30 kg N/ha: N1

+ 60 kg N/ha: N2

+ 90 kg N/ha: N3

+ 120 kg N/ha: N4

Experiment 3: Studying the effect of microbial organic fertilizer dosage on growth and yield of rice cultivar VAAS16 in the spring crop in the delta of Thanh Hoa province

- The experiment consists of 7 treatments designed in a completely randomized block design (RCBD), 3 replicates according to the field experiment method [According to Nguyen Huy Hoang et al., 2014]. Experimental plot area is 10 m^2 (2.5 m x 4 m), total experimental area: 7 recipes x 10 m^2/CT x 3 replicates = 210 m^2 (excluding protection area); experimental base is 90 kg N + 100 kg P_2O_5 + 80 kg K_2O/ha.

- Experimental treatments (calculated for 1 hectare)

I: 90 kg N + 100 kg P_2O_5 + 80 kg K_2O) – Control treatment (Base)

II: Base + 8.0 tons of manure

III: Base + 0.5 tons of Song Gianh microbial organic fertilizer

IV: Base + 1.0 ton of Song Gianh microbial organic fertilizer

V: Base + 1.5 tons of Song Gianh microbial organic fertilizer

VI: Base + 2.0 tons of Song Gianh microbial organic fertilizer

VII: Base + 2.5 tons of Song Gianh microbial organic fertilizer

2.4.4. Building an intensive farming model of high-quality rice cultivar VAAS16 based on the comprehensive application of optimal technical measures in the spring crop in the delta region of Thanh Hoa province

- Model building method: Arranging according to the production trial method (large cells are not replicated), including 2 recipes. Time and location: Spring crop, 2019 at 4 locations in Thanh Hoa province:

+ Dong Ninh commune - Dong Son district.

+ Hoang Quy commune - Hoang Hoa district.

+ Dan Quyen commune - Trieu Son district.

+ Xuan Hoa commune - Tho Xuan district.

- Scale: 15,000 m^2/model

+ Check model: Using rice cultivar BT7; transplanted with a density of 50 hills/m^2; fertilizer 120 kg N + 100 kg P_2O_5 + 80 kg K_2O (for 1ha) + 5 tons of manure.

+ Experimental model: Using rice cultivar VAAS16 and applying some improved techniques, including: fertilizer 90 kg N + 100 kg P_2O_5 + 80 kg K_2O (calculated for 1ha); fertilizing 2.0 tons of Song Gianh microbial organic fertilizer to replace manure; transplanted at a density of 45 hills/m^2.

- Evaluating the economic efficiency of the models.

2.5. Methods for monitoring and analyzing data

2.5.1. Methods for monitoring crop indicators

- Th methods of assessment and data collection are applied

Table 3.27. Correlation effects between density and nitrogen dosage on yield and yield components of VAAS16 cultivar in spring crop in Dong Son district

Experimental Formula		Panicles /m^2	Total number of seeds/panicle (seed)	Percentage of full grain (%)	1000 seeds weight (gam)	Theoretical yield (ton/ha)	Actual yield (ton/ha)
M1	N0	190.4	146.1	86.8	23.8	5.75	4.91
	N1	193.9	147.8	88.2	24	6.06	5.14
	N2	200.9	147.8	90.4	24.2	6.47	5.42
	N3	214.2	148.4	91.1	24.4	7.07	5.93
	N4	216.3	144.9	92.8	24.3	7.07	6.01
M2	N0	234.9	143.6	85.5	23.5	6.78	5.7
	N1	236.0	144.0	86.1	23.6	6.90	5.98
	N2	250.1	145.4	88.2	23.8	7.63	6.35
	N3	267.3	145.1	92.1	24.2	8.64	6.63
	N4	266.2	140.2	92.2	24.1	8.29	6.41
M3	N0	270.6	128.9	80.4	23.2	6.50	5.48
	N1	275.8	130.4	81.2	23.5	6.86	5.66
	N2	280.1	132.2	82.1	23.6	7.17	5.94
	N3	283.6	133.2	83.2	23.9	7.51	6.21
	N4	277.8	130.1	80.1	23.8	6.89	5.86
$LSD_{0,05(M\&N)}$		*17.5*	*6.8*	-	-	-	*0.54*
CV(%)		*7.2*	*6.4*	-	-	-	*8.6*

(Average Data from 2 Spring Crop: 2017 and 2018)

Number rice panicle/m^2: ranged from 190.4 to 283.6 rice panicles/m^2, the formula M3N3 (55 hills/m^2 and 90 kg N/ha) gave the highest number of rice panicles at 283.6 rice panicles/m^2; M3N2 formula (55 hills/m2 and 60 kg N/ha) gave the second-highest number of rice panicles at 280.1 rice panicles/m^2. The treatment M1N0 (35 hills/m^2 and 0 kg N/ha) gave the lowest number of rice panicles at 190.4 rice panicles/m^2.

Theoretical yield (NSLT): The theoretical yield ranges from 5.75 - 8.64 tons/ha. The highest yield was obtained from the treatment of M2N3 (45 hills/m^2 and 90 kg N/ha), which was not a significant difference compared with the treatment M2N4 (45 hills/m^2 and 120 kg N/ha). The M1N0 treatment (35 hills/m^2 and 0 kg N/ha) gave the lowest

and development of rice cultivar VAAS16 in spring crop in the delta of Thanh Hoa province

The factors of nitrogen dosage and transplanting density affected the growth time and plant height of rice cultivar VAAS16. In general, the higher the level of fertilizer, the higher the plant height and growth time of the rice cultivar VAAS16 was obtained, but not too much difference.

3.3.1.2. Effect of transplanting density and nitrogen dosage on some physiological parameters of rice cultivar VAAS16 in spring crop in the delta of Thanh Hoa province

* *Leaf area index*: density and amount of nitrogen fertilizer significantly affected the leaf area index of rice cultivar VAAS16. Therefore, it is necessary to adjust the appropriate density to improve the photosynthetic efficiency, contributing to high yield and quality.

**Ability to accumulate dry matter*

The results showed that, when increasing the planting density and the amount of nitrogen fertilizer, the dry matter weight increased significantly. Rice fertilized with the treatment M2N3 (planting density of 45 hills/m^2 and the amount of nitrogen fertilizer 90 kg N/ha) and M2N4 (planting density of 45 hills/m^2 and the amount of nitrogen fertilizer 120 kg N/ha) had the highest cumulative dry matter weight, which was higher than that fertilized with the control and the rest of the treatments.

3.3.1.3. Effect of transplanting density and nitrogen dosage on pest and disease infection of rice cultivar VAAS16 in spring crop in the delta of Thanh Hoa province

Monitoring the effect of density and dose of nitrogen fertilizer on the level of infection with pests and diseases showed that the main pests and diseases of rice cultivar VAAS16 in the spring crop of 2017 and 2018 in the delta of Thanh Hoa province are rice leaf folder, brown-backed rice planthopper, yellow stem borer; brown spot, rice blast disease, sheath blight. The treatments with high nitrogen dosage and high-density transplanting suffered more severe damage than those with low nitrogen fertilization and sparse transplanting; The degree of damage was highest in the treament M3N3 (inoculation density 55 hills/m^2 and nitrogen dose 90 kg N/ha), M3N4 (plant density 55 hills/m^2 and nitrogen dose 120 kg N/ha) was the highest (score 3) (Table 3.24).

3.3.1.4. Effect of density and nitrogen doses on yield components and yield of rice cultivar VAAS16 in spring 2017 and 2018 in the delta of Thanh Hoa province

a. Results in Dong Son district

according to the National Technical Regulation on testing the cultivation and use value of rice cultivars (QCVN 01 - 55:2011/BNNPTNT)) (2011).

Quality indicators:

+ Methods for assessment of several quality parameters of products

Methods of evaluating some quality parameters of rice: Determination of the percentage of chalky rice, head rice and white rice; The size and shape of rice grains according to TCVN 8370 - 2010 (2010) (Appendix 4).

+ Methods for evaluating some nutritional quality indicators

The Center for Environmental Analysis and Technology Transfer evaluated these indicatoreaccording to regulations and standards of the Ministry of Agriculture and Rural Development.

- Method of evaluating some use value indicators of rice cultivars

+ Method to evaluate leaf fragrance: according to IRRI's International Standard System for Evaluation of Rice Genetic Resources, 1996 (Appendix 5).

+ Assessing the sensory quality of rice by scoring method with the following criteria: Fragrance, whiteness, hardness and deliciousness, assessed and classified according to TCVN 8373: 2010 of the Ministry of Science and Technology.

2.5.2. Methods and criteria for disease assessment in the field

Evaluation of the level of infection with pests and diseases in natural conditions on experiments (Appendix 6) according to QCVN 01 - 55:2011/BNNPTNT of the Ministry of Agriculture and Rural Development.

2.5.3. Methods for analyzing soil samples

Soil samples were analyzed for the parameters according to the method of FAO - ISRIC (1987, 1995) and of the Institute of Soil and Agrochemistry (1998).

2.5.4. Evaluation of economic efficiency method

Using the benefit-cost ratio analysis method by CIMMYT (1988) [cited by Nguyen Huy Hoang et al., 2017].

2.5.5. Data analysis

- Using Office Excel 2007 software, IRRISTAT 5.0 to process statistical data from the investigation of statuses and research experiments on farming techniques.

- Determining the technical maximum and economical optimized amount of fertilizer based on determining the (quadratic) regression equation between the amount of fertilizer and the crop yield according to the formula of Michel Lecompt (1985) [Vu Huu Yem, 1998].

- Method of determining the selectiion index:

Selecting high-quality rice cultivars in Thanh Hoa using the selection index program of Nguyen Dinh Hien (1996).

- Determining the equation and graphing the correlation with MS EXCEL 2010.

- Evaluating the stability of rice cultivars based on actual yield through the model of Eberhart and Russell (1966). In the thesis, Nguyen Dinh Hien's software ondinh.com was used to process data, analyze and evaluate the yield of experimenting rice cultivars and select stable cultivars for the ecological sub-regions where the experiments were carried out.

Chapter 3. RESULTS AND DISCUSSION

3.1. Basic conditions of the delta region of Thanh Hoa province in regarding rice production

3.1.1. Climate, weather and land conditions in the delta region of Thanh Hoa province

3.1.1.1. Climate and weather conditions

The delta region of Thanh Hoa province is influenced by the humid tropical monsoon climate with hot and rainy summer and hot dry West wind; winter is characterized by cold, dry with frost, hoarfrost and is effected by northeast monsoon which has a decreasing trend from north to south. Ocasionally, there are thunderstorms, fog, and hoarfrost that greatly affect agricultural crops.

3.1.1.2. Land conditions

Thanh Hoa has a total natural area of 11,134.73 km^2 [Statistical Yearbook of Thanh Hoa Province, 2019]. The total area of agricultural production land is 250,175 ha, distributed according to ecological regions: mountainous area 103,419 ha, plain area 98,910 ha, coastal area 47,846 ha [Statistical Yearbook of Thanh Hoa Province, 2019].

The rice cultivation area is mainly distributed in the delta with the cultivated area reaching 135,823 ha (in 2015) and 126,981 ha (in 2019). This is the key rice area of the province with many districts with large rice production areas such as Tho Xuan, Trieu Son, Yen Dinh, Dong Son, Hoang Hoa...

3.1.2. Analysis and evaluation of rice cultivar structure in the delta region of Thanh Hoa province

3.1.2.1. Rice cultivars that are commonly being grown in the delta of Thanh Hoa province

- High-yield hybrid rice cultivar with good quality: Nghi Huong 305; Nghi Huong 2308, Thai Xuyen 111, BTE1, GS9, VT404, PHB71…

LH13	6.26	6.22	6.24	6.15	6.09	6.12
ĐA1	6.08	6.00	6.04	5.98	5.92	5.95
ĐS1	6.58	6.46	6.52	6.53	6.49	6.51
VAAS16	6.85	6.79	6.82	6.85	6.77	6.81
BT7 (Đ/C)	5.21	5.11	5.16	5.24	5.2	5.22
$LSD_{0.05}$	*1.18*		*0.14*	*0.63*		*0.098*
CV(%)	*7.2*			*6.4*		

3.2.5. Assessing the adaptability and yield stability of high-quality purebred rice cultivars in spring crop in Thanh Hoa province

The results of the analysis of yield stability of the experimental rice cultivars in the spring crop showed that: all 10 tested rice cultivars had broad adaptability with a non-significant regression coefficient bi that was different to 1 (P ≥0.95, no asterisk in the corresponding column P). These cultivars are stable, with small deviations from the regression line that was different to 0(no significant difference, no asterisks in column P corresponding to the S^2_{di} value). In which, the highest yielding cultivar in both study sites in the spring crop was VAAS16 (average 6,815 tons/ha). Therefore, in the spring crop to study and identify intensive technical measures, the cultivar VAAS16 was selected.

3.2.6. Some quality indicators of quality purebred rice cultivars in Thanh Hoa

Compared with the regulations of quality rice, the purebred rice cultivars LH12, DS1, VAAS16, and HC4 equivalent to BT7 (Đ/C) all meet the standards. In which, VAAS16 cultivar has good quality of rice, round and clear rice; the rice is soft, strong in taste.

3.2.7. Selection of high-quality purebred rice cultivars in spring crop in Thanh Hoa according to selection index

Based on the selection objectives and the selection coefficient, rice cultivars were selected to participate in the experiment by using the selection index software, version 1.0 of Nguyen Dinh Hien (1996). The results showed that the selected cultivar, cultivar No. 9 (VAAS16), achieved the set goals, had many valuable characteristics: short duration, high yield, and met the requirements for rice production in the plains of the Thanh Hoa province.

3.3. Some technical measures to intensively cultivate rice cultivar VAAS16 in the delta region of Thanh Hoa province

3.3.1. Effect of transplanting density and nitrogen dosage on growth, development, and yield of rice cultivar VAAS16 in spring crop in the delta of Thanh Hoa province

3.3.1.1. Effect of transplanting density and nitrogen dosage on growth

with the longest growing time were HC4: 137 days (at 2 experimental sites), HC3 (137 days - Dong Son and 136 days - Hoang Hoa).

3.2.3. Levels of infection with major pests and diseases of high-quality pure rice cultivars in the spring crop in Thanh Hoa

Monitoring pests and diseases of rice cultivars at the experimental sites showed that: the level of infection with pests and diseases did not differ much between cultivars. Pests (thrips, stem borers, leaf rollers, and brown planthoppers) were introduced and caused mild damage, mostly at score 1. Some cultivars (LH13, DA1, BT7) had more severe infections (score 3). The diseases (blast, blight, powdery mildew, and bacterial streak spot) infection were mild, score 1 (HC, HC3, HC4, LH12, VAAS16) and score 3 (BT, LH13, DA1, BT7) (Table 3.11).

3.2.4. Factors constituting yield and yield of high-quality purebred rice cultivars in spring crop in Thanh Hoa

The number of rice panicles/m^2: In the experiment in Dong Son, the number of rice ear/m^2 was highest in cultivars VAAS16, DS1, DA1, and LH12, ranging from 249.3 to 257.4 rice panicles/m^2. With the experiment in Hoang Hoa district, the number of rice panicles/m^2 was not significantly different from the experiment in Dong Son district with the same rule.

The theoretical yield: ranges from 6.16 to 8.17 tons/ha (in Dong Son) and from 6.11 to 7.99 tons/ha (in Hoang Hoa). The DS1 and VAAS16 cultivars have the highest theoretical yield with 8.17 - 7.77 tons/ha (in Dong Son) and 7.99 - 7.76 tons/ha (in Hoang Hoa) (Table 3.12). The rest of the cultivars have theoretically higher yields than the control.

Actual yield: VAAS16 cultivar had the highest net yield (6.81 - 6.82 tons/ha). The difference in actual yield between the experimental rice cultivars was statistically significant.

Table 3.13. Actual yield of quality rice cultivars in Dong Son and Hoang Hoa, spring crop 2016 and 2017

(ĐVT: ton/ha)

Cultivar	Dong Son			Hoang Hoa		
	Spring crop 2016	Spring crop 2017	Average 2 crop	Spring crop 2016	Spring crop 2017	Average 2 crop
BT	5.63	5.73	5.68	5.64	5.60	5.62
BX	5.55	5.59	5.57	5.58	5.52	5.55
HC3	6.01	5.91	5.96	6.03	5.79	5.91
HC4	5.54	5.50	5.52	5.61	5.55	5.58
LH12	6.19	6.33	6.26	6.14	6.02	6.08

- High-yield and medium-quality hybrid rice cultivars: Nhi Uu 838, Nhi Uu 986, Nam Duong 99, ZZD001; HYT 108…

- High-quality purebred rice cultivars: Bac Thong No. 7, Lam Son 8, Huong Com 4, RVT, Bac Thinh, TBR225, Dong A1, Thien uu 8, Thuan Viet 1, J01, J02, T10...

- High-yield purebred rice cultivars: Bac Xuyen, Thien uu 8, Diamond 111, Q5, TBR45, TBR36, mutant Khang Dan, BQ, NV1, Ha Phat 3.

- High-yield, medium-quality purebred rice cultivars (for processing): Q5, TBR1, mutant KD Glutinous rice: N87, N98.

3.1.2.2. Rice variety structure and cropping pattern on each type of the land

a) Region 1: Including the following districts: Nga Son, Hau Loc, Hoang Hoa, Ha Trung and Nong Cong. Spring crop: Sowing hybrid rice in 50 - 65% of the area and purebred quality rice and rice for processing 35 - 50% of the area. Summer crops: Mainly quality purebred rice is planted and a part of processed rice, and hybrid rice only accounts for a certain percentage.

b) Region 2: Including Quang Xuong and Dong Son districts. Spring crop: Sowing hybrid rice in 50 - 55% of the area and pure quality rice in 45 - 50% of the area. Summer crops: Mainly pure quality rice is planted and a part of the rice cultivation area is used for processing.

c) Region 3: Including Yen Dinh, Tho Xuan, Thieu Hoa, Trieu Son and Vinh Loc districts. Spring crop: Sowing hybrid rice in 65 - 70% of the area and rice for processing 30 - 35% of the area. Summer crop: Sowing hybrid rice in 35 - 40% of the area and rice for processing and quality rice in 60 - 65% of the area.

3.1.3. Intensive rice farming techniques that are currently being applied

3.1.3.1. The status of rice cultivar usage

- Growing time:

+ Spring crop: Cultivars with growing time >165 days are no longer used, cultivars with growth time from 145 - 165 days account for 28.7%, cultivars with growth time from 120 - 145 days account for 49.2%. The remaining cultivars have growing time from 110 - 120 days, occupying a smaller area (22.1%).

+ Summer crop: Rice cultivars with growth time from 120 - 145 days account for 14.3%, cultivars with a growing period from 100 - 110 days and 110 - 120 days account for most of the area (44.5%) and 41.2%).

- Types of rice varieties

In both spring and Summer crops, new short-duration, high-quality, high-yield rice cultivars only occupy a very small area (10% of the local rice production area). The level of using new cultivars for

production of the people is still very low, the farming practices of most farmers are still conservative, and they are hesitant to apply new cultivars due to fear of risks.

3.1.3.2. Survey on the methods for sowing/planting rice, the amount of seeds, the density of transplanting

- Method of sowing and transplanting: In both spring and summer crops, farmers use transplanting as the main method (90%), the rest (10%) apply the direct sowing method.

- Seed quantity and transplanting density: More than 50% of farmers use a large number of seeds, and over 40% of households plant thickly at a density of 50 hills/m^2 in both spring and summer crops, making investment costs more expensive, but the yield is low and the crops are infected with many pests and diseases.

3.1.3.3. Status of fertilizer use

The vast majority of farmers in the delta areas in Thanh Hoa province dont follow the fertilization recommended in the intensive farming techniques, applying unbalanced fertilization.There are more than 39% of farming households apply enough nitrogen fertilizer, a large part of households apply excess nitrogen (44.9%). For phosphate and potassium fertilizers, more than 59.9 - 62.3% of the farmer households apply them at average doses, and more than 20% of farmers provide not enough phosphorus and potassium in the spring crop. The survey results on the use of manure by farmers in the delta region of Thanh Hoa province show that: more than 39% of the rice area is not fertilized with manure due to lack of supply. The data also shows that the farmers do not have the habit of applying micro-organic fertilizers to rice plants.

3.1.3.4. Status of pesticide use by farmers

Farmers spray pesticides ≥ 3 times/crop season: 60.5% in spring crop, 31.4% in summer crop. Meanwhile, the percentage of proper use of spraying only ≤ 2 times/crop only accounts for 41.6%.

In summary, the delta region of Thanh Hoa province has a number of advantages and limitations in rice production, specifically as follows:

* Advantages:

- Climatic conditions (temperature, humidity, hours of light, rainfall) are suitable for rice plants to grow, develop well and promote yield potential in the growing seasons (spring and Summer).

- Rice is a key crop of the region with the rice cultivation area accounting for 76.1 - 78.8% of the agricultural land area, which is an advantage to promote rice production in the direction of commodity production.

- The level of intensive farming in rice production of farmers in the delta area of Thanh Hoa province is relatively good, especially in terms of investment in mineral fertilizers for rice.

- The government of Thanh Hoa province has been well aware of and has shown its determination, proposed many measures to support the development of the local rice production industry through specific schemes and projects in the whole province.

* Difficulties and limitations:

- Temperature and humidity are favorable for rice pests and diseases arising and developing, causing damage in the growing crops. Storms and floods often cause great damage to crops in general and rice in particular.

- Seed supply system has not been established, the quality of pure rice cultivars suitable for the delta region of Thanh Hoa province is still limited.

- Sources of organic fertilizers and manure for rice are increasingly limited; rice-growing households do not have the habit of using organic and microorganic fertilizers.

Stemming from advantages and limitations in rice production in the delta of Thanh Hoa province as well as inheriting published research results, within the framework of this topic, the following directions are focused on research:

1) Study and select high-quality pure rice cultivars with high yield suitable to the plain conditions of Thanh Hoa province.

2) Study on a number of farming techniques suitable for high-quality pure rice cultivars in the delta of Thanh Hoa province:

- Study on the effect of transplanting density and nitrogen fertilizer dosage on the growth and yield of high-quality pure rice cultivars.

- Study on the effect of the dose of microbial organic fertilizer on the growth and yield of high-quality pure rice cultivars

3.2. Selection of pure quality rice cultivars in spring crop in Thanh Hoa

3.2.1. Characteristics of growth and development of the seedling stage of high-quality pure rice cultivars in the spring crop in Thanh Hoa

The results of growth assessment at the seedling stage showed that: the number of seedling leaves after 20 days reached from 3.2 to 3.8 leaves in both experimental locations; seedling height varies from 11.5 - 14.6 cm. The seedling vigor of the experimental cultivars was classified into two groups.

3.2.2. Characteristics of growth and development through different stages of quality pure rice cultivars in spring crop in Thanh Hoa

In the spring crop, the pure quality rice cultivars had growth time ranging from 130 - 137 days in both experimental locations. The cultivars