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ADAPTABILITY OF KOREAN CHINESE CABBAGE VARIETIES IN THE RED RIVER DELTA OF VIETNAM

Pham Thi Thu Huong*[1], Cho Won Dae[2] Lee Dong Jin[2]

Abstract

The objectives of the study were to test adaptability and identify the best performance varieties of Korean Chinese cabbage in the Red River Delta, Vietnam. Adaptability of 12 Korean varieties was tested in winter - spring 2012 -2013 and winter - spring 2013 -2014 at the Field Crops Research Institute, (20° 54' N, 106° 17' E), in Hai Duong province... The crop was transplanted at the distance of 60 cm x 40 cm. Fertilizer application was 170 N - 100 P_2O_5 - 150 K_2O and 10 ton of manure per ha. Most of the tested varieties were well adapted to the Red River Delta conditions. Asia yellow Mini and Jeongsang varieties with high yield (number) and high quality product were the most promising varieties, which can be grown in winter-spring season in the Red River Delta of Vietnam.

Key words: Adaptability Chinese cabbage, Korean varieties, Red River Delta

INTRODUCTION

In Vietnam, agricultural potential and market access affect the economic development of rural areas. The poverty rate in remote areas is closely associated with low agricultural development potential and lack of access to markets (Minot *et al*., 2006). Crop production contributes 77% of the profit from agricultural production (1990-2008) (General Statistic Office (GSO), 2009) and plays an important role in the economy of rural areas in Vietnam.

Vegetables are important crops in the Red River Delta (RRD) in Northern part of Vietnam (Huong *et al*., 2013). In 2012, the rural population of the RRD was 14 million, constituting 70% of the total population of this region and earning a living mainly from agricultural production (General Statistic

[1] Field Crops Research Institute (FCRI), Hai Duong, Vietnam
[2] Dankook University, Chungnam, Korea
* Corresponding author: thithuhuong.pham@gmail.com

Office (GSO), 2013). Vegetables are cash crops in the RRD (Ha, 2008; Linh, 2001). Income from vegetable production contributed 83% and 89% of the total income from crop production in peri-urban areas of the capital Hanoi and in rural areas of the RRD, respectively (Ha, 2008).

The insecure market has been considered the most important constraint on vegetable production in the RRD (Huong *et al*., 2013; Anh *et al.*, 2004). Most of vegetables in the RRD are produced under farmers' decision without contracts between producers and traders, except for the small amount of safe vegetables traded through co-operatives and distribution companies. Therefore, producers depend on fluctuating free market prices. In the main season of vegetable production in the RRD from November to March, vegetable supply can be over the demand. Then, vegetable products can be sold at low price or cannot be sold (Huong *et al*., 2013; An *et al*., 2003). Exporting vegetables is one option to improve farmers's income.

Chinese cabbage (*Brassica rapa*var. *Pekinensis)* has been originated from China. It has been grown all over the world. Although traditionally favored for pickling, soups and stir-fry medleys, it can be substituted adequately for cabbage in many western dishes. Chinese cabbage prefers a cool period of the growing season. Although optimum temperature for Chinese cabbage growth is 16 - 20°C, some varieties tolerate higher temperatures. Other varieties can withstand light frosts, although alternate freezing and thawing may damage leaf tissue. Soils with good structure, fertility and water-holding capacity usually produce a satisfactory crop of Chinese cabbage. Chinese cabbage can grow in soils with pH from 5.5 to 7.6, although the ideal pH for growth is near neutral (7.0) (Shattuck and Shelp, 1986).

Project "Establishing Demonstration Model for Vegetable Production" has been implemented under the cooperation between Korea Rural Community Corporation and Vietnam Academy of Agricultural Sciences. The objectives of the project are: 1) To share advance technologies for increasing vegetable productivity; 2) To generate income and alleviate poverty in the rural areas through improving vegetable production and distribution systems; 3) To build capacity of technical staff and farmers on vegetable farming. The project focusing on the most five important vegetable crops in Korea: Chinese cabbage, red pepper, radish, Welsh onion and potato. The project comprise on two steps: As the first step Korean varieties of the five vegetable crops were tested for their adaptability in northern Vietnam. As the second step, the best performing varieties of the crops will be produced in large scale in farmers' fields under contracts between them and Korean companies. The study in this paper is a part of the first step.

Objectives of the study were to test adaptability of Korean Chinese cabbage varieties and to identify the best performance varieties of Korean Chinese cabbage in the Red River Delta, Vietnam.

MATERIALS AND METHODS

Location, climate and soil conditions of the experimental site

The field experiments for testing the adaptability of Korean varieties of Chinese cabbage were carried out from December 2012 to February 2013 (2012-2013) and November 2013 to January 2014 (2013-2014) at Field Crops Research Institute (20° 54' N, 106° 17' E) in Hai Duong, province of the Red River Delta region.

Table 1. Monthly climate data for Hai Duong in the experiment period

Time	Temperature (°C)	Rainfall (mm/month)	Relative humidity (%)	Sunshine (hours/ month≥ 0.1 kW m^{-2})
	Mean	Total	Mean	Total
Nov. 2012	22.8	84.4	83	101
Dec. 2012	18.6	30.5	82	36.0
Jan. 2013	15.0	10.6	83	12.7
Feb. 2013	19.7	14.2	87	33.5
Oct. 2013	25.2	25.5	76	148.6
Nov. 2013	22.4	48.2	77	69.6
Dec. 2013	15.3	21.9	76	181
Jan. 2014	17.0	2.0	70	132.8

Sources: Hai Duong Meteo Station, 2012-2014.

The field had a history of potato, sweet potato or vegetables in rotation with a flooded rice crop per year for a long time.

Climate at the experimental site is a tropical monsoon with a hot and wet season from May to September, a cool and dry season from October to January and a cool and humid season February to April. The weather condition during the experiment conducting was recorded (Table 1). There was quite exceptional weather from December 2012 to February 2013 with more cloudyand rainy days than usual. Especially, there were 13 rainy days in December 2012.

The soil at the experimental sites was neutral pH and low organic carbon content (Table 2).

Experimental design, tested varieties and crop production

Ten Chinese cabbage varieties were tested, including nine Korean varieties and one control variety VL114 F1 (TAKII), which was commonly grown in the region (Table 3). The experiment was set up in a randomised complete block design, three replications for each crop season. The beds size was 1.1 m wide, 0.4 m furrow, 0.2 m height. The 20-days seedlings were planted with the distance of 60 cm × 40 cm in beds; two row per bed.

About crop management: fertilizers and manure were applied at the amount of 170 N - 100 P_2O_5 - 150 K_2O and 10 ton of manure per ha. The plants were mulched by agro-plastic. Pests and diseases were treated by using Korean pesticides as well as Vietnamese pesticides.

Table 2. Soil chemical properties of the experiment sites

Parameters	Field 1 (2012-2013)*	Field 2 (2013-2014)*
pH - H_2O	7.3	7.4
EC (dS/m)	0.60	0.67
OC (%)	1.11	-
OM (g/kg)		5
N total (%)	0.1	0.03
P_2O_5 total	0.25	-
K_2O total (%)	1.52	-
NO_3^- (mg/kg)	7.0	1.6
NH_4^+ (mg/kg)	4.2	11.4
P_2O_5 available (mg/kg)	114.6	350
K_2O available (mg/kg)	106	-
CEC (cmol/kg)	14.9	-
Ca^{++} (cmol/kg)	-	5.6
Mg^{++} (cmol/kg)	-	1.5
K^+ (cmol/kg)	-	0.11
Na^+ (cmol/kg)	-	0.39
B (mg/kg)	-	0.4

*Note: * at Field Crop Research Institute*

Table 3. Comparing yield among tested and control varieties in the two growing seasons (year, location)

Varieties	Crop duration in the field (Transplant – harvest)	Yield 2012-2013		Yield 2013-2014		Mean of the two season	
	(day)	ton/ha	kg/ha/day	ton/ha	kg/ha/day	ton/ha	kg/ha/day
Jeongsang	60	59.6	990^{c}	47.0	780^{b}	52.3	890^{b}
Norangkwandong	75	48.6	650^{a}	48.6	650^{b}	48.0	650^{ab}
Hwangwol 3	75	63.3	840^{c}	43.2	580^{ab}	53.4	710^{ab}
Norangchuseok	75	53.6	710^{ab}	40.0	530^{ab}	41.6	620^{a}
Asia Yellow Mini	60	50.8	850^{c}	42.4	710^{b}	45.7	780^{b}
Geumnorang	75	46.7	620^{a}				
Jangseang 3	75	56.1	750^{b}				
Huimori	75	63.7	850^{c}				
CR Seong Ha	75			42.6	570^{a}		
CR Summer Light	75			38.1	510^{a}		
Summer King	60			38.1	640^{b}		
VL-114 F1(TAKII) (control)	75	56.1	750^{b}	31.5	420^{a}	43.6	580^{a}
Significance			*P<0.01*		*P<0.05*		*P<0.01*
$LSD_{.05}$			*90*		*190*		*140*

Note: Means with common letter are not significantly different at P≤0.05

Data measurement and analysis

The crop was harvested when it reached harvest maturity. Chinese cabbage was graded into marketable and non-marketable yield. The marketable products included well formed head and no disease infection. Non marketable products included deformed heads or disease infected heads. Because the varieties differed from each other in growth duration, their marketable yields were calculated per ha per day. By this method yields of the varieties were compared independently from growth duration in the field (Huong *et al.*, 2013b). Statistical analysis of differences in yield among the varieties was performed by analysis of variance using IRRISTAT 5.0. Rate of forming head was measured based on total plant number in each plot. Plant diameter, plant weight, head height, head diameter, head weight were measured based on the samples: five plant per plot (15 plant per varieties). The correlation coefficients between yield and the quantitative traits, an important yield component - head weight and other quantitative traits were analysed using Excel 2007.

RESULTS

Yield

In the crop season 2012-2013, yields of four tested varieties Jeongsang (990 kg/ha/day), Hwangwol 3 (840 kg/ha/day), Asia Yellow Mini (850 kg/ha/day), and Huimori (850 kg/ha/day) were higher than that of the control VL-114 F1 (TAKII) (750 kg/ha/day), ($P<0.05$, Table 3). Yield of two tested varieties Norangkwandong and Geumnorang was lower than that of the control variety. The two remaining tested varieties Norangchuseok and Jangseang 3 did not differ from the control variety in terms of yield.

In the season 2013-2014, yields of four tested varieties Jeongsang (780 kg/ha/day), Norangkwandong (650 kg/ha/day), Asia Yellow Mini (710 kg/ha/day) and Summer King (640 kg/ha/day) were higher than that of the control variety ($P<0.05$, Table 3). Yield of the four remain varieties: Hwangwol 3, Norangchuseok, CR Seong Ha and CR Summer Light were not different from the control variety. Yield of high quality product - class 1 of six tested varieties: Jeongsang, Norangkwandong, Hwangwol 3, Norangchuseok, Asia Yellow Mini and Summer King were higher than that of the control varieties as well ($P<0.05$, Table 4).

Over the two seasons, Jeongsang and Asia Yellow Mini had the highest yield among the tested varieties.

Table 4. Comparing yield of the high quality product - class 1 among the tested varieties in the season 2013-2014

Varieties	Market table yield	
	(ton/ha)	(kg/ha/day)
Jeongsang	47.0	780^{b}
Norangk-wandong	48.6	650^{b}
Hwangwol 3	34.8	460^{b}
Norang-chuseok	40.0	530^{b}
CR Summer Light	32.0	430^{ab}
CR Seong Ha	17.8	240^{ab}
Asia Yellow Mini	40.9	680^{b}
Summer King	32.4	540^{b}
VL-114 F1(TAKII) (control)	8.0	110^{a}
Significance		*P<0.05*
$LSD_{0.05}$		*340*

Note: Means with common letter are not significantly different at P≤0.05

Characteristics of tested varieties

Head characteristics of tested varieties in the season 2013-2014 are in Table 5. Head weight, rate of head forming directly impacted the yield. Rate of head forming of the tested varieties were high in the crop season 2013-2014, from 94% to 100%. Means of head weight of the tested varieties varied from 1.2 kg to 2.4 kg. Means of head diameter varied from 12.8 cm to 16.5 cm while means of head height varied from 21.4 cm - 24.8 cm. Jeongsang had the highest mean values of head weight and head diameter whereas CR Summer Light had the lowest mean values of head weight and head diameter.

Head weight positively correlated with other quantitative traits: head diameter, head height, plant weight excluded root, plant diameter ($P<0.01$, Table 6). However, head weight strongly correlated with head diameter (correlation coefficient $R = 0.7$) and plant weight excluded root ($R = 0.9$). The correlations between head weight and head height, plant diameter and plant height were not strong with $R \leq 0.5$.

Yield of the tested varieties positively correlated with quantitative traits: head weight, head diameter, plant weight excluded root and plant diameter ($P<0.01$, Table 6), except head height. Yield strongly correlated with head weight ($R = 0.8$), plant weight ($R = 0.8$) and head diameter ($R = 0.6$).

Table 5. Characteristics of the tested varieties in the crop season 2013 - 2014, at Field Crops Research Institute, Hai Duong

Varieties	Head weight (kg) Mean±SE	Head diameter (cm) Mean±SE	Head height (cm) Mean±SE	Plant weight (kg) Mean±SE	Plant diameter (cm) Mean±SE	Plant height (cm) Mean±SE	Head formed (%)	Head inside colour
Jeongsang	2.4±0.2	15.6±0.4	24.8±0.6	2.8±0.2	68.0±1.8	32.7±0.9	98	white
Norangk-wandong	1.7±0.1	14.5±0.4	21.9±0.5	2.3±0.1	61.0±1.4	27.7±0.7	100	Light yellow
Hwangwol 3	1.5±0.1	14.5±0.4	23.3±0.3	2.5±0.1	63.6±2.3	32.1±0.7	96	Yellow
Norang-chuseok	1.5±0.1	14.7±0.3	24.8±0.5	2.0±0.2	58.0±3.3	26.4±1.4	94	Yellow
Asia Yellow Mini	1.6±0.1	14.7±0.5	23.1±0.6	2.3±0.2	57.4±2.5	27.5±1.4	98	Yellow
CR Seong Ha	1.5±0.2	15.1±0.4	21.4±0.5	2.3±0.2	59.0±1.5	24.4±0.5	99	Light yellow
CR Summer Light	1.2±0.2	12.8±0.6	21.9±0.5	1.9±0.2	54.4±3.0	26.0±1.3	96	Light yellow
Summer King	1.3±0.1	13.8±0.5	22.9±0.5	2.1±0.2	63.1±1.0	28.5±0.7	97	Light yellow
VL-114 F1(TAKII) (control)	1.2±0.1	13.8±0.3	22.0±0.3	1.8±0.2	57.2±2.2	25.2±0.7	96	Light yellow

Table 6. Correlation coefficients between head weight and other quantitative traits of the tested varieties in the season 2013-2014

Parameters	Head weight (kg)	Yield (ton/ha)
Head weight (kg)	-	0.8**
Head diameter (cm)	0.8**	0.6**
Head height (cm)	0.5**	0.3 ns
Plant weight excluded root (kg)	0.9**	0.8**
Plant diameter (cm)	0.4**	0.5**

*Note: ** The correlation is significant at P<0.01; ns = not significant at P = 0.05*

Most of the tested varieties had light yellow or yellow colour of the inside matured heads, except for the variety Jeongsang with white colour. The colour related to content of carotenoids in matured Chinese cabbage (Kalisz and Siwek, 2006). Asia Yellow Mini, Hwangwol 3 and Norangchuseok had the darkest yellow colour among the tested varieties.

Among the tested varieties, three varieties: Jeongsang, Asia Yellow Mini and Summer King had growth duration in the field of 60 days, while the others had growth duration in the field of 60 days (Table 3).

Pests and diseases

Flea beetle (*Phyllotretavittula)* was the most heavy infestation insect on all the tested Chinese cabbage varieties, especially in the young stage, before heading.

Soft rot *(Sclerotiniasclerotiorum)* infected two varieties Hwangwol3 and CR Summer Light with 13% and 7% of infected heads, respectively in the season 2013-2014.

DISCUSSION

Among six varieties grown in two seasons 2012-2013 and 2013-2014, the mean yield of season 2012-2013 was higher than that of season 2013-2014 ($P < 0.05$). It can be due to the high temperature in the seedling and early vegetative growth stage in the season 2013-2014. This explanation was supported by a study by Kalisz and Siwek (2006), which have shown that yield of Chinese cabbage varying from year to year.

Yield of some the varieties with means of plant diameter less than 60 cm, e.g.,Asia Yellow Mini, can be improved by increasing plant density. The distance between rows should be reduced to 45-50cm instead of 60 cm.

As mentioned in the results, head height was not strong related to head weight. It was because the variation in firmness of the varieties. Two heads with the same height, weight of a head wrapping loose was lower than that of the tight head wrapping. Firmness mainly determined marketable yield in Chinese cabbage.

The colour related to content of carotenoids in matured Chinese cabbage (Kalisz and Siwek, 2006).

Consumers prefer this qualitative trait. Therefore, the varieties with yellow head inside had greater advantage than the varieties with white head inside.

Varieties with shorter growth duration in the field had more advantage than the one with longer growth duration in the field. They not only can have high yield per hectare per day, but they also may yield higher benefit to farmers. With the same transplanting time, the short growth duration varieties are harvested earlier. The market price can be much higher than 15 days later.

CONCLUSION

Most of the Korean tested varieties of Chinese cabbage adapted well in the two growing seasons winter - spring in the Red River Delta of Vietnam. Asia Yellow Mini and Jeongsang varieties had high marketable yield, good quality, good disease resistance and short growth duration. They were considered as the most promising varieties, which can be grown in the winter-spring season of the Red River Delta of Vietnam.

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CURRENT STATUS OF AGRO-MICROBIAL GERMPLASM IN VIETNAM

Nguyen Thu Ha*[1], Tran Thi Thanh Thuy[1],
Cao Thi Thanh Tam[1], Doan Thi Kim Hanh[1],
Dam Thi Thanh Ha[1], Tran Quang Minh[1]

Abstract

The agro-microbial germplasm unit in Vietnam was established in 1994. The main activities are collecting, maintenance, isolation, evaluation, taxonomy, documentation and research on application ability of microorganisms in agriculture. 703 strains of bacteria, actinomyces, yeasts and filamentous fungi imported or isolated are collected and maintained by The agro-microbial germplasm unit. The different preservation methods has been used to maintain living ability and biological activity of microorganisms such as by slant agar, sterile distilled water, liquid paraffin, freeze-drying, methylcellulose, liquid nitrogen freezing. These strains has been collected from soils, root nodules or root samples and screened based on biological activities (nitrogen fixing, phosphorous solubilizing, silicate dissolving, cellulose degradation, plant growth promoting, tolerant to high temperature, salt tolerant, polysaccharide synthesis, anti-pathogenic bacteria, fungi and etc.). Bergey's taxonomy key, standard KIT, BIOLOG or sequence analysis of 16S/28S rRNA genes was used for taxonomy. The agro-microbial strains were documented, evaluated and utilized in agriculture. At present, 130 out of 703 strains have been introduced to research and production of microbial organic fertilizers and microbial inoculants.

Key words: Agriculture culture collection, maintenance, biological activity, microbial organic fertilizers, microbial inoculants.

INTRODUCTION

Microorganisms play an extremely important role in development strategies of biotechnology. They are basic materials for genetic engineering, microbial technology and fermentation technology. Maintenance of microorganisms has a great significance in any research Lab and microbial technology. The agro-microbial germplasm unit in Vietnam was established in 1994. This paper showed the current status of agro-microbial germplasm in Vietnam.

MATERIALS AND METHODS

Materials

- Microorganism strains: 703 trains including 622 bacteria, 48 actinomyces, 12 yeasts and 21 filamentous fungi.

- Media: YMA, Ashby, DAC, Gause, Pikovskaya, King B, SPA, PDA, czapech, Hansen, etc.

- Chemicals and equipment used in the research belonged to the Department of Microbiology, Soils and Fertilizers Research Institute.

Methods

- Maintenance of microorganisms: Preserving on slant agar, semi solid agar, methylcellulose, freezing (-20^{o}C), freeze-drying or liquid nitrogen based on TCVN 8741:2011; TCVN 9298:2012; TCVN 9299:2012.

- Isolation of microorganisms based on methods of Nguyen Lan Dung *et al.*, 1976.

- Evaluation of bioactivity of microorganisms followed by TCVN 6166:2002, TCVN 8564:2010, TCVN 6167:1996, TCVN 8565:2010, TCVN 10785:2015, TCVN 9300:2012, TCVN 8566:2010, TCVN 10784:2015, TCVN 6168:2002.

- Taxonomy of microorganisms: Bergey's taxonomy key based on Peter H.A. Sneath *et al*, 1989; standard KIT or BIOLOG; sequence analysis of 16S/18S rRNA genes and compared with sequenses of international gene bank EMBL by FASTA 33 method.

RESULTS AND DISCUSSION

Maintenance of microorganisms

703 strains including bacteria, yeasts and filamentous fungi were maintained in the agro-microbial germplasm unit belonging to the Soils and Fertilizers Research Institute. Among them, 604 strains were collected from Son La, Bac Can, Hoa Binh, Ha Noi, Hung Yen, Vinh Phuc, Thai Nguyen, Ninh Binh, Nam Dinh, Nghe An, Thanh Hoa, Quang Tri, Tay Nguyen etc., that have isolated from soil, nodule or root samples and 99 strains were imported from American, Australia, China, Germany, India, Russia, Scotland, Taipei, Thailand, etc.

Slant agar, semi solid agar, freezing (-20^{o}C), liquid nitrogen or freeze-drying were used to maintain different strains in short term, middle term or long term. The results was shown in table 1.

[1] Soils and Fertilizers Research Institute (SFRI)
* Corresponding author: thuhavasi@gmail.com