Selection of Potato Trial Varieties in Northern Thailand

S. Chucheep[1], T. Duangyam[2], K. Faiupara[3] and O. Wongmetha[4*]

[1] Chiang Mai Agricultural Research and Development Center, Department of Agriculture, Fang, Chiang Mai 50110

[2] Chiang Rai Horticultural Research Center, Horticultural Research Institute, Department of Agriculture, Muang, Chiang Rai 57000

[3] Tak Agricultural Research and Development Center, Department of Agriculture, Mueang Tak, Tak 63000

[4] Chiang Mai Royal Agricultural Research Center, Horticultural Research Institute, Department of Agriculture, Hangdong, Chiang Mai 50230

* Corresponding author: agriculture_24@hotmail.com

Abstract

The selection of potato trial varieties in Northern Thailand was conducted at Chiang Mai Agricultural Research and Development Center (CMARDC), Chiang Rai Horticultural Research Center (CRHRC) and Tak Agricultural Research and Development Center (TARDC) in 2017 - 2018. All experiments were laid out using a randomized completely block design RCBD with 3 replications and 9 treatments (YS 202, 203, 301, 304, 401, 506, 603 and Atlantic and Spunta). Variables reflecting the performance, quality and resistance to disease were recorded. Findings show that YS203 at CMARDC, CRHRC and TARDC yielded a greater number of tubers per plant (15, 14 and 10 tubers per plants, respectively), tuber weight per plant (688, 362.7, 268.7 g, respectively), and total yield (5,198, 2,739 and 2,030 kg/rai, respectively) than Spunta and other varieties but lower than Atlantic at CMARDC and TARDC. In terms of quality attributes, total solid content of YS202 at CMARDC, CRHRC and TARDC was 22.7, 21.2, 18.6 %, respectively. However, YS203 at TARDC and CRHRC was found to be consistently firmer (0.87, 0.85 N, respectively) than those of Spunta and other varieties. Findings also showed that total tuber weights per plant were positively correlated with total solid and total solution solid content. Overall the findings suggest that out of all of the varieties grown included in the trials, varieties YS203 and YS202

were the best for processing. Further investigation on the selection of potato trial varieties for late blight resistance, nutritional quality, satisfaction of farmers and consumers, and marketing acceptance should be conducted in the future.

Keywords: Trial varieties, yield, quality, potato

Introduction

Potato (*Solanum tuberosum*) is the important economic crop in the northern part of Thailand because the farmers' income from planting potato per crop per hectare is approximately 2,679 - 4,464 USD (15,000 - 25,000 Baht/rai) (Wongmetha, 2017). In 2016, the total potato planting area showed more than 7,011 hectares (43,818 rai). The total production was 142,303 tons with the average yield of 19,712.6 tons/ha (3,154 kg/rai) (Office of Agricultural Economics, 2016). Normally, potato is grown after harvesting rice in paddy fields in the cool season. The main planting period is in November-December which will be harvested in February-March. In the rainy season, potato cultivation is in highland areas with two different plantings periods, in April-May and July-August which will be harvested in August-September and October-November, respectively (Kittipadakul *et al*., 2016; Office of Agricultural Economics, 2016).

There are two main varieties in Thailand, Spunta for fresh consumption and Atlantic for processing (Wongmetha, 2017). Thai farmers used to plant Bintje, Kennebec, Donata, Baraka and Mirka varieties but most varieties were not suitable for planting in the northern part of Thailand (Kittipadakul *et al*., 2016). At present, the farmers and companies look for different potato varieties which give high yield, high quality, and disease resistance to late blight, viruses, bacteria and scab, for fresh consumption and processing (Wongmetha, 2017). Then, CMARDC imported new potato varieties from Yunnan Academy of Agricultural Sciences (YAAS) in 2015 to select of potato varieties in northern part of Thailand. These varieties give high yield, high total solid content, creamy-white fresh pulp and late blight resistance.

The objective of this study was to identify new potato varieties for processing and fresh consumption with high yield and high quality in the northern part of Thailand.

Materials and Methods

Plant material

Seven potato varieties including YS202, YS203, YS301, YS304, YS401, YS506 and YS603, and two check varieties (Atlantic and

Spunta) were used in the trial. The tubers were harvested about 90 days after planting (DAP) or when the plant's foliage or vines died back. The tubers were graded for uniformity, size and shape. Yield components, quality attributes and disease evaluation were recorded. Ten tubers from each variety were selected for quality attribute evaluation.

Varietal treatments

The pre-basic seed (G0) potato of nine varieties (treatments) with uniform size was planted during the cool and dry seasons (November, 2017). The plot size was 2 × 6 m for each replication. The pre-basic seeds were planted using a spacing of 90 × 20 cm. Compost and dolomite were incorporated to the soil before planting G0 with 200 kg/rai and 200 kg/rai, respectively.

NPK fertilizers (15-15-15) and NPK (13-13-21) were applied at the rate of 100 kg/rai for basal dressing. After that, urea (46-0-0) at the rate of 12.5 kg/rai was applied twice at 30 and 45 days after planting. The cultural and management practices i.e. hoeing, weeding, irrigation and spraying for insect pest and disease control were carried out uniformly for all treatments.

Yield performance

Total yield (kg per rai), the number of tubers per plant were recorded for each variety. Tuber weight per tuber and tuber weight per plant were recorded.

Quality attributes

Total solid content (TSC) was measured using a specific gravity method using samples of 3.63 kg each (Vakis, 1978). The percentages of solid content was calculated from the specific gravity (Murphy and Goven 1959) as follows:

Solid content (%) = -2.86 + 47.1 U

U = (5G-5)/G

G = specific gravity (SG)

SG = weight of tuber in air/ (weight of tuber in air – weight of tuber in water)

Total soluble solids (TSS) were measured using a digital hand refractometer (Atago Pocket refractometer PAL-1) with results expressed in °Brix. Measurements were taken from three pieces of the ventral shoulder, middle and beak of tuber slices.

Firmness was measured using a fruits hardness tester (Nippon Optical Works FHR-5) and a 5 mm-base diameter cylinder type. Firmness of the tubules were measured in three different areas. The readings were averaged and recorded in newton (N).

Statistical analysis

The experiment was laid out using a randomized completely block design (RCBD). Nine treatments with three replications were evaluated for yield

performance and quality attributes. Mean comparisons were made using the Duncan's multiple range tests (DMRT) at $p \leq 0.05$. Statistical analysis was carried out using the SAS program

Results and Discussion

Yield performance

The total number of tubers per plant from Atlantic variety in CMARDC, CRHRC and TARDC research stations (16, 11 and 12 tuber per plant) was not significantly different from YS203 variety (15, 14 and 10 tuber per plant) and YS603 in CMARDC and TARDC research sites (15 and 10 tuber per plant), but was significantly different from YS401, YS506, Spunta and YS304, respectively (Table 1).

In CMARDC and CRHRC, the means of tuber weight per tuber of YS401 (95.1 and 50.83 g, respectively) and Spunta (90.2 and 45.7 43.8 g, respectively) were not significantly different from these of the tuber weight found YS202, YS203, YS301 and YS501, but were significantly different from YS603. However in the CRHRC and TARDC research sites, the means of weight per tuber of Atlantic (45.8 and 45.3 g, respectively) were higher than those from Spunta, YS301, YS202, YS301, YS203, YS506 and YS603, respectively (Table 1).

Mean of tuber weight per plant of Atlantic was not significantly different from YS301 in CMARDC research site, but significantly different from CRHRC and TARDC (184.7 and 114.7 g, respectively). In addition, YS203 was found to have the high tuber weight per plant (688 g) in CMARDC research station (Table 1).

Mean of tuber weight per 12 sq. m^2 of Atlantic in CMARDC, CRHRC and TARDC (50, 20 and 27 kg, respectively) were not significantly different from YS301 in CMARDC (50 g) but significantly different in CRHRC and TARDC (10 and 8 g, respectively) including other varieties (Table 1).

Mean of total yield of Atlantic in CMARDC and TARDC (6,624 and 3,549 kg per rai, respectively) were not significantly different from YS301 in CMARDC (5,198 kg per rai) and YS203 in CMARDC and CRHRC (5,198 and 2,739 kg per rai, respectively) but was significantly different from Spunta and other varieties (Table 1).

Potato yield vary among different potato cultivars; soil type and temperature; locations; cultural practices; maturity; post-harvest storage conditions and other factors (Sing and Kaur, 2009). Potato production in northern Thailand is highly correlated with climate and production constraints. The climate is quite warm (14 - 29 °C in January to 22 - 36 °C in April). Lowland (300 - 700 m above sea level) potato production is limited by temperature to one crop in the dry winter months (November-March) (Kittipadakul *et al.*, 2016).

Table 1 The average yield components; tubers number per plant, total weight per tuber, tuber weight per plant, production per 12 sq.m^2 and yield production of potato varieties in CMARDC, CRHRC and TARDC, Thailand in 2018.

Varieties	Tuber number/ plant			Tuber weight/ tuber (g)			Tuber weight/ plant (g)			Tuber weight/ 12 m^2 (kg)			Total yield (kg/rai)		
	CMARDC	CRHRC	TARDC	CMARDC	CRHRC	TARDC	CMARDC	CRHRC	TARDC	CMARDC	CRHRC	TARDC	CMARDC	CRHRC	TARDC
Atlantic (Control)	16 a	11 a	12 a	56.0 c	45.8 a	45.3 ab	876.7 a	351.7 ab	469.7 a	50 a	20 a	27 a	6,624 a	2,655 ab	3,549 a
Spunta (Control)	8 bc	4 b	4 c	90.2 ab	45.7 a	43.8 ab	554.7 bc	162.7 cd	112.0 c	31 bc	9 bc	6 c	4,191 bc	1,229 cd	846 c
YS202	11 ab	7 b	4 c	61.9 abc	36.7 ab	24.4 b	652.0 abc	207.3 bcd	68.3 c	37 abc	12 abc	4 c	4,926 abc	1,566 bcd	516 c
YS203	15 a	14 a	10 ab	61.3 abc	31.2 ab	56.5 a	688.0 ab	362.7 a	268.7 b	39 ab	20 a	15 b	5,198 ab	2,739 a	2,030 b
YS301	12 ab	7 b	7 bc	69.8 abc	38.3 ab	24.4 b	885.3 a	184.7 cd	114.7 c	50 a	10 bc	8 c	6,689 a	1,395 cd	866 c
YS304	10 bc	4 b	4 c	43.4 c	32.1 ab	37.5 ab	428.7 c	77.3 d	88.7 c	24 bc	4 c	5 c	3,239 bc	584 d	670 c
YS401	6 c	6 b	3 c	95.1 a	50.8 a	38.9 ab	436.7 bc	269.0 abc	129.3 c	25 bc	15 ab	7 c	3,299 bc	2,032 abc	977 c
YS506	8 c	4 b	3 c	74.6 abc	29.3 ab	43.8 ab	389.7 c	94.0 d	108.7 c	22 c	5 c	6 c	2,944 c	710 d	819 c
YS603	15 a	6 b	10 ab	43.2 c	19.3 b	45.7 ab	547.3 bc	77.7 d	279.3 b	31 bc	4 c	16 b	4,136bc	587 d	2,110 b
F-test	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
CV (%)	24.3	29.8	39.3	28.5	37.0	40.6	23.1	41.8	36.0	23.1	41.1	35.4	23.1	40.9	36.0

* = Significant difference at probability level 0.05

Quality attributes

Total solid content (TSC) of samples collected from YS202 in CMARDC, CRHRC and TARDC (22.7, 21.2 and 18.6 %, respectively) were significantly higher than those of the controls (Atlantic and Spunta) and other varieties (Table 2). Moreover, percentage of TSC in CMARDC was higher than those in CRHRC and TARDC because which could be that the weather in CMARDC was colder than the other research stations. Therefore, potato tuber accumulate starch and dry matter. Starch is the major component of the dry matter accounting for approximately 70 % of the total solids (Sing and Kaur, 2009). This is mainly determined genetically and thus depends on the variety (BeMiller and Whistler, 2009). Starch compositions (amylose and amylopectin) are affected by the cultivars and environmental factors (production area, soil, climate etc.) (Bhat, 2015). Climate, soil and addition of fertilizer all affect the growth and dry matter content of the tuber (BeMiller and Whistler, 2009).

Total soluble solids (TSS) of YS603 in CRHRC, CMARDC and TARDC (10.1, 8.2 and 4.9 ^{o}Brix, respectively) were significantly higher than those of Atlantic, Spunta and other varieties (Table 2). TSS and TSC were positively correlated, and highly depended on potato variety (Feltran *et al.*, 2004).

Potato tubers from the Atlantic variety from all three sites were found to be firmer than those of Spunta and other varieties but not significantly firmer than those from YS603 (0.89 N) and YS203 in TARDC and CRHRC (0.87 and 0.85 N, respectively) (Table 2, Figure 1). Because different varieties have different enzymatically mediated degradation changes in the cell walls during maturity. The enzymes are pectin esterases and polygalacturonases which might be either synthesized, activated, or a combination of both (Kays, 1991).

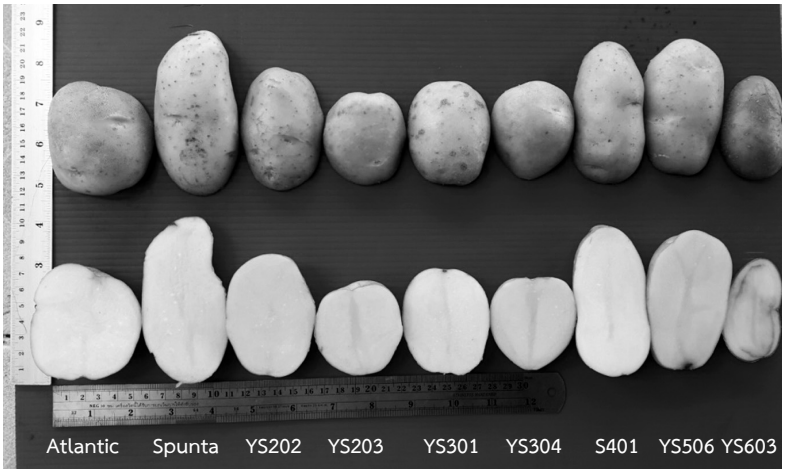

Figure 1 The tuber shapes of each variety after harvest in 2018

Table 2 The average quality attributes; total solid content (TSC), total soluble solid (TSS) and firmness of potato varieties in CMARDC, CRHRC and TARDC, Thailand in 2018.

Varieties	TSC (%)			TSS (°Brix)			Firmness (N)		
	CMARDC	CRHRC	TARDC	CMARDC	CRHRC	TARDC	CMARDC	CRHRC	TARDC
Atlantic (Control)	20.9 d	16.7 d	17.1 c	6.4 b	5.3 d	4.4 c	0.82 a	0.87 a	0.87 b
Spunta (Control)	18.8 f	16.5 d	16.5 d	4.3 g	3.9 f	3.5 f	0.78 bc	0.82 bc	0.84 b
YS202	22.7 a	21.2 a	18.6 a	5.9 de	5.4 cd	4.1 d	0.76 cd	0.83 bc	0.88 a
YS203	22.0 b	19.2 b	17.5 b	4.4 g	5.2 d	2.6 g	0.75 d	0.85 ab	0.87 a
YS301	21.4 c	16.0 e	15.8 e	5.3 f	4.8 e	4.7 b	0.79 b	0.84 b	0.83 bc
YS304	21.2 c	16.5 d	17.5 b	6.0 cd	5.6 c	2.6 g	0.81 a	0.80 cd	0.84 b
YS401	20.1 e	17.6 c	16.5 d	6.2 bc	6.2 b	3.8 e	0.77 bcd	0.78 d	0.81 c
YS506	17.5 g	15.8 e	16.0 e	5.7 e	5.2 d	2.6 g	0.82 a	0.83 bc	0.85 b
YS603	21.8 b	16.5 d	18.6 a	8.2 a	10.1 a	4.9 a	0.77 bcd	0.83 bc	0.89 a
F-test	*	*	*	*	*	*	*	*	*
CV (%)	0.9	0.8	1.1	2.7	2.6	3.5	1.4	2.0	1.6

* = Significant difference at probability level 0.05

Conclusion

Results from these experiment trials in Northern Thailand show that the variety YS203 had a better performance than Spunta but lower than Atlantic, followed by YS202 for processing. Moreover, quality attributes such as total solid content of YS202 and YS203 has a high percentage of starch and low TSS. Therefore, the findings suggested that YS203 and YS202 varieties were the most suitable processing variety for growing in Chiang Mai, Chiang Rai and Tak provinces.

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