Technology Dissemination of Virus-free Seed Potato Production using Hydroponic Production systems in Thailand

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ABSTRACT

Technology dissemination of virus-free seed potato production using hydroponic production systems in Thailand was conducted in Chiangmai Royal Agricultural Research Centre (CMRARC) at Maehea and Khungwang, Chiangmai, Thailand during 2017-2018. The purpose of this study to improve the quality and quantity of potato including stabilize the potato industry by assisting the technologies for virus-free seed potato. Technical support for propagation of potato plantlets cv. Chiangmai 1 by tissue culture technique in solid media, microtuber production, pre-basic seed production under hydroponic (aeroponic) system and virus detection will be done. Repairing tissue culture room, cutting room and rebuilding of mother plant net house and aeroponic net house were constructed at CMRARC (Maehea). Tissue plantlets production in laboratory at Maehea produced amount 40,000 plantlets per year. At Khungwang station, Mother plant production in aeroponic system produced over 40,000 plants per year. More than 20,000 shoots cutting from mother plant net house transferred to aeroponic system for 19,248 tubers/net house (240 m^2) of pre-basic seed (G0) production. Moreover, handbook of seed potato production, good agricultural practice (GAP) and postharvest technology of potato for Thai researcher, smart farmers and agricultural extension agent of entrepreneurs including leaflets and poster were published more than 500 copies. CMRARC transferred knowledge by training course of seed potato production technology to researchers, students farmers and entrepreneurs no less than 224 persons. Furthermore, to represent PR performance e.g. online news, field day, exhibition and welcome visiting delegations from Japan, Bhutan, Netherland, Malaysia, AFACI (Seed-extension) more than 1,125 persons.

Keywords :Aeroponic, system, virus-free, seed potato, production.

INTRODUCTION

Potato (*Solanum tuberosum*) is the third most important food crop in the world after rice and wheat. More than a billion people worldwide eat potato, and global total crop production exceeds 300 million metric tons. Potato is the important economic crop and an important in the north and northern part of Thailand because

potato chip consumption is an increasing rapidly. The potato farmer income is 2,679-4,464 $US/hec (15,000-25,000 baht/rai). In 2017, total potato planting area is showed more than 6,057.3 hectare (37,858 rai) divided to 380.2 hec (2,376 rai) for consumption and 5,677.12 hec (35,482 rai) for processing. The total production is showed 107,103 tones divided to 6,023 tones for consumption and 101,080 tones for processing. The total yield is show 15,843.75 tones/hec (2,535 kg/rai) for consumption and 17,806.3 tones/hec (2,849 kg/rai) for processing. Only twice potato varieties are Spunta for consumption and Atlantic including Chiangmai 60-1 for processing. The potato cultivation divides to two groups. In cool and dry season, lowland area, the most potato is planted in November-December and harvested in February-March. For rainy season in highland area, potato cultivation is separated two stages such as planting in April-May, harvesting in July-August, and Planting in August-September, harvesting in October- November. The farmer can be defined as an agreement of the production and supply of agricultural products under contract farming with entrepreneur.

In the present, the consumer prefers potato chips for snack food. Two biggest companies such as Pepsi-Cola (Thai) Trading Co.,Ltd. (Frito Lays bands) and Berli Jucker Foods Limited (Testo brand) are produce potato processing (Chips) about 80% and 20% of whole market, respectively. The both entrepreneurs required more Atlantic potato for processing and farmer also required basic seed production (G1) and certified seed production (G2-G3) to support them. Chiangmai Royal Agricultural Research Center (CMRARC), Horticulture Research Institute (HRI), Department of Agriculture (DOA), produced pre-basic seed (G0) and basic seed for farmer but it not adequate. Then, the entrepreneur of potato chip is imported certified seed for seed production and fresh potato seed for processing. However, the imported certified seeds are high unit cost and difficult for a management system. Farmers are stored low quality certified seed potato and the seed penetrated diseases such as virus, bacteria, late blight, scab etc. for planting. The local seeds that selected from farmer are stored low quality for planting in next season. Moreover, seed-borne virus is effect to the quantity and quality of potato, by reduce the total yield and also reduce the marketable quality. To reduce the infection rate of virus and diseases in seed potato by using tissue culture and bioreactor in potato plantlets, mother plant production in soil media and hydroponic, and minituber production under hydroponic (aeroponic) system, soil media and field. However, bioreactor culture, hydroponic (aeroponic) technique should be developed and widely used for high yield production, more easy, rapid, flexible, more security for the phytosanitary quality and at lesser cost through research and development. And, CMRARC transfer knowledge of technology to government officials, potato farmers/farmer association, students, and the public and private sectors through training demonstrations and supporting them on developing commercial scale.

Then, DOA was collaborated to stabilize the potato industry in Thailand by assisting the technologies for virus-free seed potato under AFACI project during 2017-2018.

The goals of this project are represent to improve the quality and quantity of potato and stabilize the potato industry by assisting the technologies for virus-free seed potato. The purpose of this study to propagate potato plantlets cv. Atlantic by tissue culture technique in solid media, microtubers production and pre-basic seed production under hydroponic (aeroponic) system. Technical support for tissue culture, aeroponic culture and virus detection will be done.

MATERIALS AND METHODS

This project conducted in Chiangmai Royal Agricultural Research Centre (CMRARC) at Maehea and Khungwang, Chiangmai, Thailand during 2017-2018. Potato (*S. tuberosum*) plantlets cv. Chiangmai 1 variety was suitable variety for planting in the northern and northeastern part of Thailand. The characteristics of this selected cultivar showed Late blight (*Phytophthora infestans*) resistant, early late maturity (90-120 days after planting), round shape, shallow eye, white flesh, light tan skin, consistently 4 to 9 cm diameter, the yield 21.43 tones/hec (3,429 kg/rai) and high solid gross >17.5%.

Protocol of virus-free seed potato production in Thailand (Fig 1) :

1. Rebuilding of aeroponic nethouse, repairing tissue culture room, cutting room and mother plant nethouse (Aug 16 - Nov 17)

2. Induction and multiplication of shoots in vitro (May-Aug 17)

- Prepare material for micropropagation plantlets.

- To find out the suitable medium for multiplication of potato shoots and roots for produce potato plantlet production form in vitro micropropagation technique. Including monitoring virus infection of plantlet.

3. Mother plant production in net house (Sep-Dec 17)

- Tissue plantlets are transplant to a tray, soil media in net-house. The Stem cutting of mother plant is transplant in aeroponic system in 30-45 days after planting. To find out the suitable fertilizer for produce mother plant in soil media. Including monitoring virus infection of mother plant.

4. Microtubers production in vitro (Jan-Apr 18)

- Potato plantlets are induce microtubers by using tissue culture method in solid media or bioreactor system in liquid media under aseptic condition in laboratory. In additional, to find out the suitable medium for microtuber production in both media.

5. Pre-basic seed production (G0)

5.1 G0 from stem cutting in Aero-ponic system (Jan-Apr 18)

- Stem cutting of tissue plantlet are inserted to a spongy in holes of form plastic sheets and connected with aeroponic system in net-house. To find out the suitable fertilizer or technique for minituber production in aeroponic system. Including monitoring virus infection of G0 production.

5.2 G0 from microtuber in vitro in soil media (Nov 18-Feb 19)

- Microtubers from in vitro are transplant to a tray, soil media in net house. To find out the suitable fertilizer or technique for G0 production. Including monitoring virus infection.

6. Publication paper or leaflet or book etc. (Jan17 - Dec 20)

- Publication potato production and poster publication by CMRARC for Thai DOA Researcher, farmers and enterprise.

7. Training course for enterprise, student, farmer. (Jan17 - Dec 20)

- Attend training course, transfer knowledge to researcher, students farmers and enterprise.

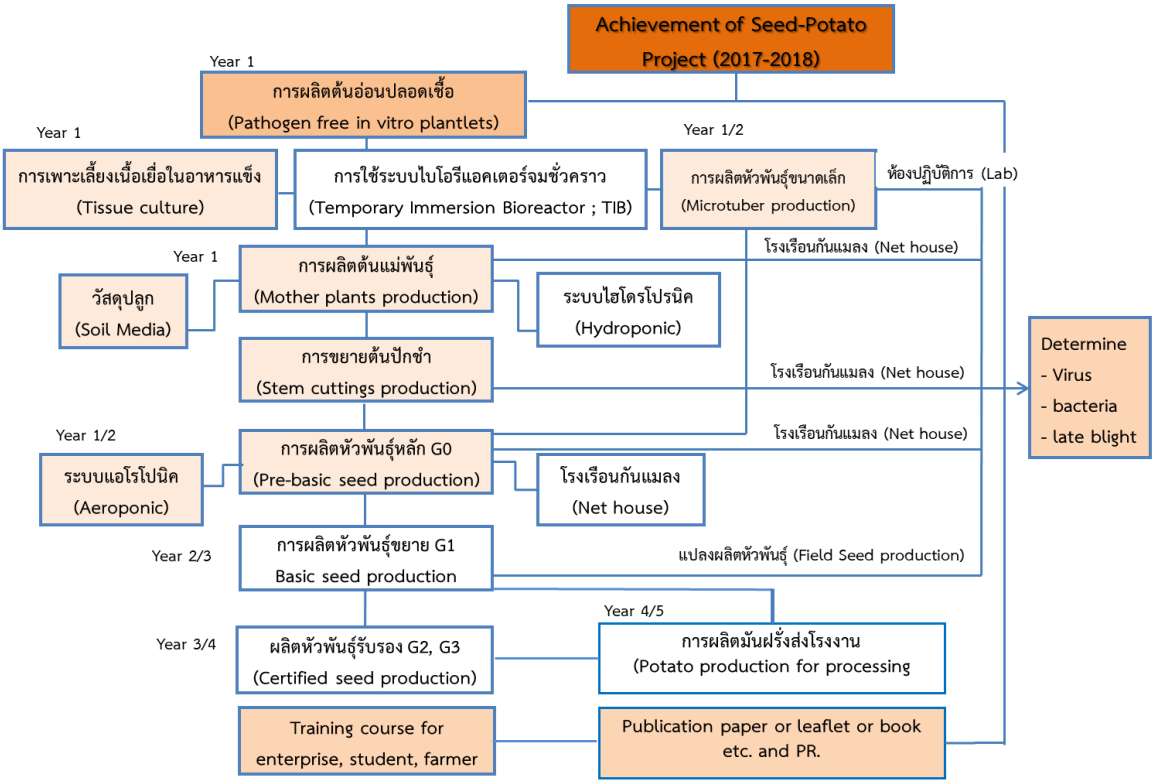


Fig 1. Achievement and protocol of virus-free seed potato production in Thailand.

RESULTS AND DISCUSSION

1. Repairing tissue culture room, cutting room and rebuilding of aeroponic net house (Aug 16-Jul 18).

Repairing tissue culture room, cutting room and rebuilding of mother plant net house and aeroponic net house were constructed at CMRARC (Maehea) (Fig 2-6).

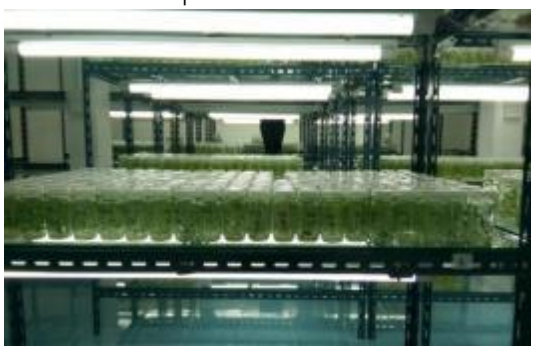
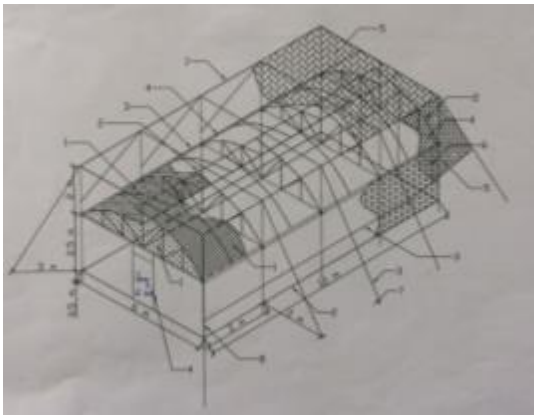
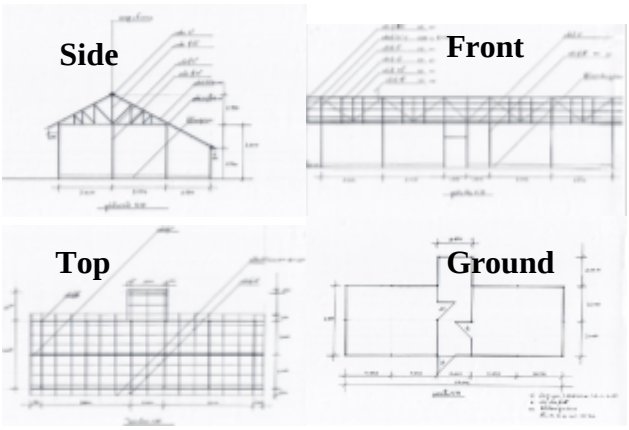


Fig 2. Repairing tissue culture room (Aug-Dec 16).

Fig 3. Repairing cutting room (Oct-Nov 16).





a. Aeroponic net house designed by Chiangmai Agricultural Engineering research center (Dec 16-Jan 17), and modified mother plant and aeroponic net house by CMRARC (Feb-Mar 17).

b. Rebuilding of aeroponic nethouse and Making of aeroponic tray (Mar 17-Mar 18).

c. Watering system.

d. Ozonizer and control timer.

Fig 4. Rebuilding of aeroponic net house of potato at Maehea (Mar 17- Mar 18) (a-d).

Fig 5. Rebuilding of mother plant net house of potato at Maehea (Dec 17-Jul 18).

a. Making of hydroponic tray (Jun-Jul 18).

b. Rebuilding of substrate tray (Jun-Jul 18).

Fig 6. Rebuilding of hydroponic and substrate net house at Maehea (Jun-Jul 18). (a-b)

2. Induction and multiplication of shoots in vitro (Oct 16- Jul 18).

Tissue plantlets production in laboratory at Maehea produced amount 40,000 plantlets per year (Fig 7).

a. Potato meristem cutting from potato's sprout (Oct 16-Apr 17).

b. Tissue culture in MS solid media (Apr-Aug 17).

c. Transplant or cutting tissue plantlets from perlite:vermiculite to media substrate after planting 3 weeks at 25°C, RH 40 % (Sep-Nov 17).

d. Microtubers production from MS solid media (Feb-Jul 18).

Fig 7. Pathogen-free plantlets production in laboratory at Maehea (Oct 16-Jul 18) (a-d).

3. Mother plant production in net house.

At Khungwang station, Mother plant production in aeroponic system produced over 40,000 plants per year. More than 120,000 shoots tip (stem cutting) from mother plant net house transferred to aeroponic system (Fig 8a, b).

3.1 Soil media.

a. Planting at Khungwang (Sep 17)

b. After planting 30 days (Nov 17).

c. Planting at Maehea (Jun 18).

d. After planting 30 days (Jul 18).

Fig 8. Tissue plantlets are transplant to soil media in net house at Khunwang and Maehea (Jun 17-Jul 18) (a-d).

3.2 Hydroponic system.

Fig 9. Planting mother plant from Tissue culture in hydroponic system at Maehea. (Jul 18)

4. Pre-basic seed production (G0) in net house.

The stem cutting from mother plant net house transferred to aeroponic system. The G0 production showed approximately 648,194 tubers/hectare (Fig 10). The other way, G0 production in soil media reached 605,903 tubers/hectare.

a. Stem cutting 2-3 nodes (Dec 17).

b. Soak chitosan+Trichoderma.

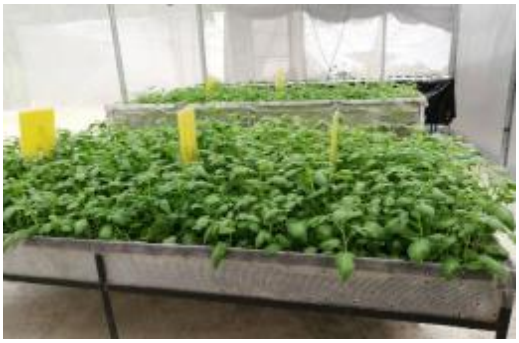
c. Transfer to aeroponic system.

d. After planting 50 days (Feb 18).

e. Open foam sheet (Mar 18).

f. After greening 9 days (Mar 18).

Fig 10. Shoot **c**utting from mother plant in soil media to aeroponic system for G0 production at Khungwang (Dec 17-Mar 18) (a-f).



a. Mother plant production (Jul 18).

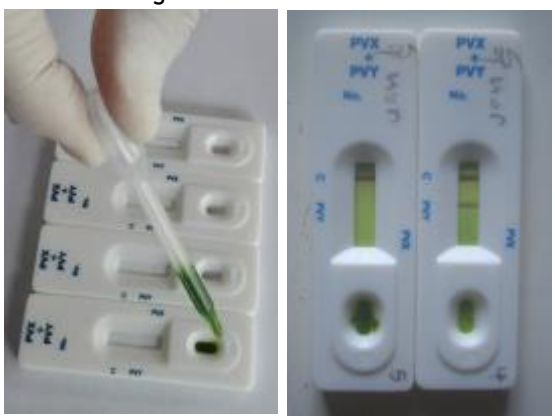
b. Stem cutting 2-3 nodes (Jul 18).

c. Transplant in aeroponic (Jul 18).

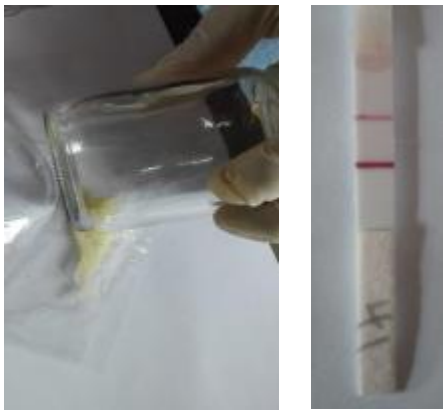
d. After transplanting 14 days (Jul 18).

Fig 11. Shoot cutting from mother plant in soil media to aeroponic system for G0 production at Maehea (Jul 18) (a-d).

5. Monitoring bacteria and virus infection of G0 production.



a. Check virus by using Glift kit after 20 days (Nov 17).



b. Check bacteria by using Glift kit in tuber after harvest (Mar 18).

Fig 12. Detection bacteria and virus infection of potato production (Nov 17-Mar 18) (a-b).

6. Attend training course, transfer knowledge to researcher, students and farmers.

CMRARC transferred knowledge by training course of seed potato production technology to researchers, students, farmers and entrepreneurs no less than 224 persons (Fig 13-16).

Fig 13. Researcher training course of meristem or growth point cutting

Transfer knowledge to students about tissue culture (May-Jul 17).

adapt from Korea (Aug 17).

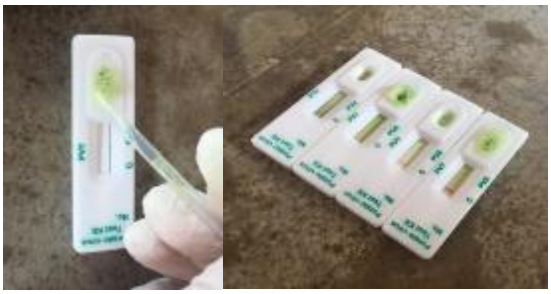
a. Stem cutting and transplant to new media adapt from Korea.

b. Transfer knowledge to 6 students.

Fig 14. Student training course (May-Jul 17) (a-b).

a. Cutting tissue plantlet and transfer to new media.

b. Planting plantlet in hydroponic system.



c. Virus test by using GLIFT kit.

d. Transfer knowledge to 5 students.

Fig 15. Student training course (May-Jul 18) (a-d).

a. GAP and postharvest of potato training course at CMRARC, Chiangmai (24 May 18).

b. GAP and postharvest of potato training course at CRHRC, Chiangrai (25 May 18).

Fig 16. Farmers and agricultural extension of entrepreneur training course: The good agriculture practice (GAP) and postharvest technology of potato at CMRARC, Chiangmai and CRHRC, Chiangrai (May 18) (a-b).

7. Publication paper or leaflet or book etc.

Moreover, handbook of seed potato production, good agricultural practice (GAP) and postharvest technology of potato for Thai researcher, smart farmers and agricultural extension agent of entrepreneurs including leaflets and poster were published more than 500 copies (Fig 17-19).

7.1 Manual

a. Seed potato production for Thai DOA Researcher publication by CMRARC (18 Jul 17).

b. The good agriculture practice (GAP) and postharvest technology of potato for Thai researcher, farmers and agricultural extension of entrepreneur publication by CMRARC (24 May 18).

Fig 17. Publication potato production book in 2017-2018 (a-b).

7.2 leaflets

a. Technology of Virus-free seed potato production.

b. Technology of seed potato postharvest handing.

Fig 18. Publication seed potato production and postharvest handing leaflets (a-b).




a. Publication poster technology dissemination of virus-free seed potato production using hydroponic production systems in Thailand.

b. Protocols of seed potato production in Thailand.

c. Training and transfer technology.

Fig 19. Publication potato production poster (20 Jul 18) (a-c).

8. PR performance.

Furthermore, to represent PR performance e.g. online news, field day, exhibition and welcome visiting delegations from Bhutan, Malaysia, AFACI (Seed-extension) etc., more than 1,125 persons (Fig 20-29).

Fig 20. Transfer technology to private sector in 2017.

Fig 21. Online News : Invitation Potato Exhibitors

Fig 22. Exhibition Horti Asia 2017 at Bangkok, Thailand.

Fig 23. Field day of Potato is the future plant of farmer which takes a sustainable agriculture in Thailand at Farmer's field, Sansai,

Fig 24. Program workshop for visiting from Bhutan on 8-1(Oct 17 at Chiangmai, Thailand.

Fig 25. Welcome visiting HZPC from Neherland on 28 Nov 17 at Chiangmai, Thailand.

Chiangmai.

Fig 26. Welcome visiting MSPP from Malaysia on 2 Feb 18 at Chiangmai, Thailand.

Fig 27. Welcome visiting farmer from Netherlands on 20 Feb 18 at Chiangmai, Thailand.

Fig 28. Training course researchers from Bhutan on 27 Mar 18 at Chiangmai, Thailand.

Fig 29. Welcome visiting of Dr. Sueng oh Yoo and deligates that attend in meeting 2018 AFACI program workshop on seed-extension from 14 countries on 20 July 2018.

9. Project Outcomes

Categories		Performance
Outcome of Technology distribution	Education & Training	- Transfer knowledge to 8 researchers 16 students, and 100 farmers and entrepreneurs.
	Consultation for Farmer	- 5 persons and 1 Chiangmai Potato Grower Cooperative Limited.
	Publication on Farming Technology	- 2 books, 2 leaflets, 4 posters more than 500 copies
Presentation of project Outcomes	International	- 4 times (welcome and training course of Bhutan, Malaysia, AFACI)
	Domestic	- 2 times in Annual Evaluation Meeting on AFACI Project in Thailand on Jan 2017 and Feb 2018.
Introduction of Machinery or Establishment of Infrastructure		

Advertisement	TV	-
	Newspaper	-
	Internet	- Online News: Potato field day.
Publication of project outcomes		- Seed potato production for Thai DOA Researcher. - Good agricultural practice (GAP) and postharvest technology of potato for smart farmers and agricultural extension agent of entrepreneurs.
Etc.		- Transfer technology to private sector. - Exhibition Thailand Seed Hub at Bangkok, Thailand. - Exhibition Thailand Seed Hub at Chiangmai, Thailand. - Exhibition Horti Asia 2017 at Bangkok, Thailand. - Field day of Potato at Farmer's field, Sansai, Chiangmai.
Total		124 persons for training course, 100 persons for visiting, 1,117 persons for PR and 500 copies for publication.

CONCLUSIONS

Technology dissemination of pathogen-free seed potato production using hydroponic production systems in Thailand is a soilless method for producing pre-basic potato seed. These technology were propagated of potato plantlets cv. Chiangmai 1 by tissue culture technique in solid media, microtuber production, pre-basic seed production under hydroponic (aeroponic) system and determine virus detection in each steps. These techniques were increased high yields, quality processing, free-pathogen and resistant late blight disease. Moreover, the government officers, students, potato processing industry, farmers and farmer association were understood these techniques via field demonstration and transferred knowledge from DOA's researcher, and adapted in their own field. Then, aeroponic system is stabilizes and reach to sustainable seed potato production of the potato industry in Thailand.

IMPACT

This project helped to reduce potato diseases such as late blight, bacterial wilt and virus. These diseases are seed-borne that reduce quality and mass production of seed potato. Then, the techniques of *in vitro* micropropagation in potato cv. Chiangmai 1 and induce microtuber in solid media and the minituber production under aeroponic system in Thailand were developed from Korea techniques. They were improved and represented lower costs, and increase the farmers' income. Then, aeroponics is a soilless method for producing pre-basic potato seed. The method can produce higher yields, easier, rapid, flexible and more security for the phytosanitary quality.

ACKNOWLEDGMENTS

The authors wish to express their sincere gratitude to director of the CMRARC and administrative sector for facilitation. Asian Food and Agriculture Cooperation Initiative (AFACI) for supported funding. Our gratitude also goes to all staff of research centers for kindly assists and makes this research success.