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EVALUATION OF YIELD, YIELD COMPONENTS AND CONSUMERS' SATISFACTION TOWARDS YARDLONG BEAN AND COWPEA IN AGRICULTURAL ORGANIC SYSTEM

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Abstract

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Yield evaluation, yield components and consumers' satisfaction surveys on yardlong bean and cowpea in agricultural organic system were carried out by planting 20 lines of yardlong bean and cowpea in the experimental plots at the Faculty of Technology and Community Development, Thaksin University, Phatthalung campus, between September and November 2009. The experimental design was Randomized Complete Block Design (RCBD) with four replications. It was found that IT84D-666 had the fastest flowering to 50 % at 32.33 days. The next long rate were Khao – hinson, SR_{01} – 0402 and SR_{00} – 863 which had flowering up to 50 % in 34.33, 35.67 and 36.33 days respectively. Sudsakhorn took the longest time for flowering at 50 % about 43 days. As for the yields/plant, it was found that IT82E – 16 gave the highest yield about 104.96 g/plant. The next lower rate included IT84D – 666, SR_{00} – 863 and Khao – hinson, yielding about 98.22, 96.34 and 75.86 g/plant respectively. Violet 696, yielding the least, gave 19.35 g/plant. As for consumers' satisfaction towards yardlong bean and cowpea in agricultural organic system, it was found that customers were satisfied with Nicro line the most at 4.11 points, while IT84D – 666 was the line with which customers were least satisfied at only 2.32 points.

Key words: yardlong bean, cowpea, yield components, consumers' satisfaction

Introduction

Yardlong bean is one of the important economic products of Thailand. The planting areas are 18,560 – 20160 hectares (Sarutayophat et al., 2007), yielding products for 124,002.73 tons. Most of yardlong beans are eaten in the country and exported to overseas such as Hong-Kong, Singapore, Malaysia, Germany, France, Japan, the Netherlands, the United States and some countries in South Asia (Tindall, 1987). Furthermore, yardlong bean is full of various kinds of important vitamins, fiber and minerals (Rubatzky and Yamaguchi, 1997). Fiber in particular eases the digestive system and gives a sense of long – lasting satiety. It can be used as medicine to help kidney's and, spleen's function, and to reduce cholesterol in the blood (Rubatzky and Yamaguchi, 1997).

Cowpea was classified as belonging to the same

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group of yardlong bean (Li et al., 2001; Phansak et al., 2005; Tantasawat et al., 2010). There are various kinds of essential nutrients in cowpea (Deseran, 2001). Moreover, it is the kind of plant that has been used as a protein source at a cheap price (Knott and Deanon, 1967; Ehlers and Hall, 1997; Ofuya, 1997). Yardlong bean and cowpea are required by the world market, especially from developed countries (Earth Net Foundation, 2006; Benchasri, 2009). Because of its economical importance, agriculturalists try to increase the production so as to meet consumers' high demand. Therefore, farmers use fertilizers and chemical substances to reduce the spread of diseases and gain more productivity (Earth Net Foundation, 2006). However, as fertilizers and chemical substances are being used for this reason, some chemicals are left over in the product and environment. The use of such substances also increases the cost of production, making it not economically viable. Consequently, agriculturalists have to look for new methods for planting vegetables which is safe for consumers and the environment. Growing plants organically seems to offer an alternative to the use of pesticides. Besides, it ensures that consumers will get a healthy product without endangering the environment. Furthermore, the organic method reduces cost production (Yussefi and Willer, 2003; Guerena and Adam, 2008).

Hence, the purpose of this experiment is to study the yield, yield components and consumers' satisfaction towards yardlong bean and cowpea in agricultural organic system in order to search for the varieties of yardlong bean and cowpea which are able to

Table 1
Sources of yardlong bean and cowpea lines

Lines	Sources	Original Sources	
Chaophya 697	Local market	Bangkok	Thailand
Evergreen	Local market	Bangkok	Thailand
Lumnumchee	Local market	Bangkok	Thailand
Nicro	Local market	Phatthalung	Thailand
Samson	Local market	Trang	Thailand
Saythip	Local market	Nakhon Srithummarat	Thailand
Sudsakhorn	Local market	Bangkok	Thailand
Violet 696	Local market	Songkhla	Thailand
KU20	KU	KU, Bangkok	Thailand
Selected – PSU(control)	PSU	PSU, Songkhla	Thailand
Suranaree 1*	SUT	SUT, Nakhon Ratchasima	Thailand
IT84D – 666*	Field Crops R.C.	Ubon Ratchathani	Thailand
IT82E – 16*	Field Crops R.C.	Ubon Ratchathani	Thailand
Khao-hinson*	Field Crops R.C.	Ubon Ratchathani	Thailand
SR_{00} – 863	TVRC	Nakhon Pathom	Srilangka
SR_{01}-0402	TVRC	Nakhon Pathom	Srilangka
VU 012	TVRC	Nakhon Pathom	Thailand
VU 124	TVRC	Nakhon Pathom	Thailand
VU171	TVRC	Narathiwat	Thailand
VU176*	TVRC	Nakhon Pathom	Srilangka

Remark * cowpea lines

yield more than selected – PSU (local line, control) before supporting agriculturalists for further commercial planting.

Materials and Methods

Plant material

Twenty lines of yardlong bean and cowpea were collected from someplace in Thailand (Table 1). Experiments were conducted in the field condition between September and November 2009 at the Department of Agricultural Technology, Faculty of Technology and Community Development, Thaksin University, Phatthalung province Thailand

Preparation for planting

The preparation of plots and the planting of yardlong bean and cowpea were carried out in the regulation of Organic Agriculture Certification Thailand (Yussefi and Willer, 2003) and International Federation Organic Movement, IFOAM (International Federation Organic Movement, 2009) between September and November 2009 at the Department of Agricultural Technology, Faculty of Technology and Community Development, Thaksin University. Prior work before planting was carried out by thoroughly ploughing the soil in a new open area and left it to rest for one week. Afterwards, the plot was size 4 x 1 m. Four seeds of yardlong bean or cowpea were dropped in each hole. The distance between each row was 50 cm and 50 cm between each plant with four replications. The rows were planted in pair with 16 holes in each replication. Randomized Complete Block Design was planned. 7 days after young plants began to germinate, they were separated and only one plant was left in the hole. The manure was laid as foundation at the rate of 1000 kg/rai and it was done 2 times. The first time, the manure would be put in the bottom of the hole after the soil had already been prepared. The second time, the manure would be filled around the hole again, about 28 days after planting. Weed control was done by pulling out and using a hoe to plough them out which could be carried out throughout the planting season. Yield and yield components would be recorded by collecting fresh plant aged 7 – 10 days after booming to compare with Selected – PSU (control) line.

Consumers' satisfaction towards yardlong bean and cowpea in agricultural organic system

Studying consumers' satisfaction towards yardlong bean and cowpea in agricultural organic system was done by 100 students from Thaksin University (50 males and 50 females). Points were given by observing, tasting and recording their satisfaction. Four essential characteristics were length, size, color and taste of the pods. Five levels of points are as follows:

Level 5 means highly satisfied
Level 4 means satisfied
Level 3 means averagely satisfied
Level 2 means less satisfied
Level 1 means not satisfied

Results

Evaluation of yield and yield components of yardlong bean and cowpea in agricultural organic system

As for yield evaluation and components of yardlong bean and cowpea in agricultural organic system, in order to compare with Selected – PSU (local market variety), the length of pods, the number of pods/plant, the number of seeds/plant and the weight of 100 seeds, it was found that all types were statistically significant. IT84D – 666 line spent 32.33 days to flower which was the fastest. The next longer rate, included lines Khao – hinson, SR_{01} – 0402 and SR_{00} – 863 which spent 34.33, 35.67 and 36.33 days respectively (Table 2). The line which took longer for flowering (43 days) was Sudsakhorn. As for the production/plant, it was found that line IT82E – 16 yielded the highest production/plant which was 104.96 g/plant. The next lower rate included line IT84D-666, SR_{00} – 863 and Khao – hinson which produced 98.22, 96.34 and 75.86 grams/plant respectively. As for Violet 696, it produced the least which was 19.35 grams/plant. As for the length of the pod, it was found that Selected –

Table 2
Yield and yield components of various yardlong bean and cowpea lines

Lines	Characteristics					
	Days to 50% flowering	Pod yield, g./plant	Pod length, cm	No. of pods/ plant	Seeds/ pod	100 seeds, g
Chaophya 697	39.67	67.55	47.17	5.43	16.33	14.56
Evergreen	40.67	35.83	51.48	2.89	15.44	15.98
Lumnumchee	38.67	46.7	44.17	5.46	13.78	14.78
Nicro	39.67	39.36	47.7	2.49	14.22	15.09
Samson	39.33	33.96	42.47	4.89	15.33	13.45
Saythip	41.67	36.25	40.72	2.53	15.33	12.85
Sudsakhorn	43	58.57	40.56	7.26	14.67	13.45
Violet 696	37.33	19.35	42.37	2.79	15.67	14.63
KU20	40.85	42.54	30.78	5.45	14.72	15.21
Selected – PSU (Control)	42.33	21.1	53.67	2.54	10.89	15.24
Suranaree 1	37.33	69.44	34.86	5.02	16.11	15.11
IT84D – 666	32.33	98.22	16.3	13.54	13.78	14.33
IT82E – 16	41.33	104.96	17.39	14.51	15.89	13.64
Khao – hinson	34.33	75.86	26.93	4.21	11.22	16.02
SR_{00} – 863	36.33	96.34	26.59	13.15	11.56	15.96
SR_{01}-0402	35.67	57.12	53.2	5.78	15.33	15.13
VU 012	37.01	58.31	22.86	8.46	12.46	13.4
VU 124	37.16	56.46	21.54	7.89	13.42	12.54
VU171	39.33	50.14	41.7	10.89	14.44	12.65
VU176	37.44	52.42	31.15	8.96	12.74	12.45
F-test	**	**	**	**	**	**
$LSD_{0.01}$	1.34	28.24	12.72	4.65	2.94	0.76
CV. (%)	9.08	7.19	9.46	10.84	8.3	4.15

* * Significant differences between lines by LSD test, p = 0.01

PSU, locally planted and controlled, produced the longest pod which was 53.67 cm.

The next shorter rate included SR_{01} – 0402, Evergreen and Nicro which produced pods of 53.20, 51.48 and 47.70 cm respectively. IT84D – 666 produced the shortest pods at 16.30 cm. As for the number of pods, it was found that IT82E – 16 had the most number of pods/plant which was 14.51 pods. Next was IT84D – 666, and Nicro having the least number of pods at 2.49 pods/plant? As for the number of seeds/pod, it was found that Chaophya 697 had 16.33 seeds, the biggest numbers of seeds. The lower rate included Suranaree 1, IT82E-16 and Violet 696, having the following number of seeds 16.11, 15.89 and 15.67 seeds respectively. The line which had the smallest number of seed/pod was Selected – PSU. As for the weight of 100 seeds, it was found that SR_{00} – 863 has the heaviest weight per 100 seeds and VU176 line had the lightest weight per 100 seeds which was 12.45 g.

The damage of yardlong bean and cowpea while planting in agricultural organic system

After planting yardlong bean and cowpea, it was found that the damage from insects was significantly higher than normal agricultural. Nicro line had 137.33±7.25 pods/plant, the biggest number of damaged pods. The next lower rate included Violet and Selected – PSU (control) having damaged pods/plant at 128.40±5.53 and 122.38±6.34 respectively. The line having the least damage included IT84D – 666 and IT82E – 16, having only 33.12±3.42 and 33.38±4.33 pods/plant. As from the study of the weight of damaged pods/plant, it was found that Nicro had the heaviest bulk of damaged pods that is 341.35±6.76 grams/plant. The next lower rate included Violet 696, Selected – PSU, KU20 and Chaophya 697, weighing 336.25±8.48, 333.74±5.75, 262.12±5.86 and 253.33±8.14 grams/plant respectively.

Contrary to that, line IT82E – 16 had the least weight of damaged pods, 72.33±3.42 grams/plant. The next higher rate, it was IT84D – 666 having a weight of damaged pod at 84.89±3.46 grams/plant (Table 3).

Table 3

The number of damaged pods and the weight of damaged pods of yardlong bean and cowpea, testing plant in agricultural organic system

Lines	The number of total damaged pods, pod	The weight of damaged pods per plant, g
Chaophya 697	101.33 ± 8.24	253.33 ± 8.14
Evergreen	62.01 ± 6.34	128.78 ± 7.15
Lumnumchee	90.67 ± 6.61	226.67 ± 8.21
Nicro	137.33 ± 7.25	341.35 ± 6.76
Samson	38.67 ± 6.34	116.67 ± 7.35
Saythip	87.33 ± 5.78	103.39 ± 7.75
Sudsakhorn	57.33 ± 7.86	143.33 ± 4.89
Violet 696	128.40 ± 5.53	336.25 ± 8.48
KU20	86.86 ± 9.54	262.12 ± 5.86
Selected – PSU (control)	122.38 ± 6.34	333.74 ± 5.75
Suranaree 1	90.85 ± 3.55	101.15 ± 4.75
IT84D – 666	33.12 ± 3.42	84.89 ± 3.46
IT82E – 16	33.38 ± 4.33	72.33 ± 3.42
Khao – hinson	54.67 ± 5.45	96.67 ± 53
SR_{00} – 863	84 .00 ± 6.34	95.45 ± 5.23
SR_{01}-0402	90.67 ± 7.45	226.67 ± 5.53
VU 012	52.53 ± 5.54	101.12 ± 6.43
VU 124	62.32 ± 7.45	132.34 ± 4.24
VU171	68.00 ± 3.45	140.35 ± 5.41
VU176	48.52 ± 5.64	98.87 ± 6.45
F-test	**	**
$LSD_{0.01}$	21.45	28.45
CV. (%)	7.53	11.2

** Significant differences between accessions by LSD test, p = 0.01

Table 4
The satisfaction characteristics of yardlong bean and cowpea in agricultural organic system according to consumers

Lines	Pod length	Taste	Pod color	Pod size	Average $\bar{x}$
Chaophya 697	4.19	3.01	3.82	3	3.514
Evergreen	4.22	2.64	2.43	4.11	3.357
Lumnumchee	3.8	2.81	3.22	3.4	3.319
Nicro	4.2	3.41	4.61	4.2	4.111
Samson	3.79	2.6	3.84	2.81	3.2611
Saythip	3.52	2.81	4.2	2.62	3.291
Sudsakhorn	3.49	2.44	4.01	4.03	3.495
Violet 696	3.78	3.68	4.35	4.51	4.082
KU20	3.45	3.57	4.41	4.35	3.953
Selected – PSU (control)	4.52	2.8	3.4	3.14	3.476
Suranaree 1	3	3.02	3.81	3.48	3.338
IT84D – 666	2	1.4	3.02	2.84	2.322
IT82E – 16	2.2	1.56	2.84	2.84	2.3619
Khao – hinson	3	2.2	2.8	2.25	2.5615
SR_{00} – 863	2.8	2.19	3.2	2.45	2.6614
SR_{00} – 0402	4.51	2.78	3.21	1.87	3.0912
VU 012	2.84	2.59	2.98	2.45	2.7213
VU 124	2.83	2.13	2.79	2.48	2.5615
VU171	2.98	2.16	2.46	2.48	2.5218
VU176	2.93	2.16	2.46	2.61	2.5417

* Levels of consumers' satisfaction towards yardlong bean and cowpea

Consumers' satisfaction toward yardlong bean and cowpea in agricultural organic system

In the study of consumers' satisfaction toward yardlong bean and cowpea in agricultural organic system 5 levels of satisfaction were established; level 5 (most satisfied), level 4 (highly satisfied), level 3 (averagely satisfied), level 2 (less satisfied), level 1 (not satisfied). It was found that Selected – PSU was favored by local agriculturalists and as a controlled line it reached a level of satisfaction of 3.47 points. The most favorite line was Nicro with a level of satisfaction at 4.11 points (Table 4). The length of pod was at 4.20 points, the taste at 3.41, and the pod color at 4.61 and the size of pod at 4.20 points. The next 10 lines that were preferred by consumers were Violet 696, KU20, Chaophya 697, Sudsakhorn, Selected – PSU, Evergreen, Suranaree 1, Lumnumchee and Saythip with points of satisfaction at 4.08, 3.95, 3.51, 3.49, 3.47, 3.35, 3.33, 3.31 and 3.29 points respectively. The least favorite lines were IT84D – 666 and IT82E – 16 with 2.32 and 2.36 points respectively.

Discussion

The evaluation of yield and damage of yardlong bean and cowpea in agricultural organic system

The experiment of yield evaluation and yield com-

ponents of yardlong bean and cowpea in agricultural organic system of 20 lines, found that yields/plant and yield components of yardlong bean and cowpea were statistically significant. However, when compared with the yields/plant which was the most important characteristic in producing yardlong bean and cowpea, it was found that plants tested under organic system had yielded less than those raised by using chemical substances. Line IT82E – 16, IT84D – 666, KU20, Selected – PSU, SR_{00} – 863 yielded 146.21, 143.83, 197.71, 123.83 and 282.17 g/plant respectively. Planting by using controlled chemical substances gave a production of only 104.96, 68.22, 42.54, 21.10 and 116.34 g/plant respectively (Benchasri, 2005) while planting under agricultural organic system yielded less at 28.21, 52.56, 78.48, 82.96 and 58.77 % respectively. By comparison with 37 lines of test yardlong beans and cowpeas in the plot using chemical substance, it was found that SR_{01} – 0402 and Selected – PSU yielded less at 90.93 and 70.75 % respectively (Sarutayophat et al., 2007). The reason was that in normal season, agriculturalists used chemical substance to control disease and pest throughout planting season (Benchasri, 2009). Whereas, when planting under agricultural organic system, they were not allowed to use chemical substances to control diseases and pests but were allowed to use only naturally-extracted substance instead (Department of Agriculture, 2000). As a result, organic agriculture was less efficient to control the outbreak of pests. Aphids in particular, were the pests which proved most destructive (Givovich et al., 1988). An outbreak of pests, can not only damage the pod and the weight of the pod, but it can also cause other kinds of diseases such as cowpea aphid-borne mosaic virus (CAMV) and black eye cowpea mosaic virus (BCMV) (Mali and KurTI-M, 1980; Huguenot et al., 1993) which produced only 30 – 40 % of yield (Jayappa and Lingappa, 1988). Therefore, those lines of yardlong beans and cowpeas which can withstand the attack of pests and grow successfully may be promoted to agriculturalists for commercial planting. When comparing with the production price of organic agriculture, it was found that planting under agricultural organic system was 50 – 100 % more expensive than chemical agriculture.

Consumers' satisfaction toward yardlong bean and cowpea under agricultural organic system

As for the study results of consumers' satisfaction toward yardlong bean and cowpea under agricultural organic system, it was found that Selected – PSU which was locally planted was being judged satisfactory at the range of 6. However, many agriculturalists were still getting used to planting this old line that they had planted for a long time, assuming that it was the only one available. In consideration of consumers' satisfaction, it was found that Nicro was the most satisfying level from consumers at 4.11 points because of the length, taste, color and size of the pod. It holds the highest demand from the market (Santipracha and Santipracha, 1992). When considering the whole line, it was found that as from the first 10 levels of satisfying point, 90 % was yardlong bean (except Suranaree 1 line). This is due to most Thai consumers preferring long pods to short pods (Santipracha and Santipracha, 1992). Consequently, the yardlong beans line IT84D-666 and IT82E-16 having a length of pod at 16.30 and 17.39 only had a satisfaction level at 1.40 and 1.56 points respectively. Apart from having unsuitable characteristics, yardlong bean lines IT84D-666 and IT82E-16 are not crispy and have high fiber which consumers do not like (Wuttiwong, 2007). When studying the skin of both lines, their tiny and sharp hairs were found at the skin of the pod which consumers do not like as they cause irritation during consumption (Wuttiwong, 2007). However, both lines are beneficial in the aspect of disease and pest resistance. Pests are barely able to destroy them owing to their hairs (Dixon, 1987; Benchasri, 2009).

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References

Benchasri, S., 2009. Inheritance of cowpea aphid (*Aphis craccivora* Koch) resistance and preliminary study of DNA markers associated with cowpea aphid resistant genes in yardlong bean and cowpea. PhD Thesis. Prince of Songkla Univ.(Tha)

Benchasri, S.,C. Nualsri, Q. Santipracha and A. Ngampongsai, 2005. Evaluation of aphid (*Aphis craccivora* Koch) resistance and yield in yardlong bean and cowpea. *Agricultural Science Journal*, **36**: 207 – 210.(Tha)

Department of Agriculture, 2000. *Standards of Organic Crop Production in Thailand*. Ministry of Agriculture and Cooperatives Bangkok.

Deseran, S., 2001. *Asian Vegetables from Long Bean to Lemongrass*. Chronicle Books, San Francisco.

Dixon, A.F.G., 1987. Evaluation and adaptive significance of cyclical parthenogenesis in aphids. In: Minks AK and Harrewijn P (eds.) *Aphids: Their Biology, Natural Enemies and Control Volume 2A*. Elsevier Science Publishers, Amsterdam.

Earth Net Foundation, 2006. *Organic vegetable: eating safety*.TCG printing Lid, Bangkok, pp. 289 – 296.

Ehlers, J.D. and A.E. Hall, 1997. Cowpea (*Vigna unguiculata* L. Walp). *Field Crop Res*, **53**: 187 – 204.

Givovich, A., J. Weibull and J ettersson, 1988. Cowpea aphid performance and behaviour on two resistant cowpea lines. *Entomol exp appl*, **49**: 259 – 264.

Guerena, M. and K. Adam, 2008. Peanuts: Organic Production. ATTRA - National Sustainable Agriculture Information. Online available Service *www.attra.ncat.org/attra-pub/peanuts.html*

Huguenot, C., M.T. Furneaux, G. Thottappilly, H.W. Rossel and R. I. Hamilton, 1993. Evidence that cowpea aphid-borne mosaic and blackeye cowpea mosaic viruses are two different potyviruses. *Journal of General Virology*, **74**: 335-340.

International Federation Organic Movement, IFOAM., 2009. *Die Deutsche Bibliothek* : Bonn, Germany.

Jayappa, B.G. and S. Lingappa, 1988. Screening of cowpea germplasm for resistance to *Aphis craccivora* Koch in India. *Tropical Pest Management*, **34**: 62 – 64.

Knott, J.E. and J.R. Deanon, 1967. *Vegetable Production in Southeast Asia*. University of the Philippines, Laguna.

Li, C.D., C.A. Fatokun, U. Benjamin, B. B. Singh and G. J. Scoles, 2001. Determining genetic similarities and relationships among cowpea breeding lines and cultivars by microsatellite markers. *Crop Sci*, **41**: 189 – 197.

Mali, V.R. and K. S. KurTI-M, 1980. A seedborne potyvirus causing mosaic of cowpea in India. *Plant Dis*, **64**: 925 – 928.

Ofuya, T., 1997. Control of the cowpea aphid, *Aphis craccivora* Koch (Homoptera :Aphididae), in cowpea, *Vigna unguiculata* (L.) Walp. *Integrated Pest Management Reviews*, **2**: 199-207.

Phansak, P, P. W. J. Taylor and O. Mongkolporn, 2005. Genetic diversity in yardlong bean (*Vigna unguiculata* ssp. *sesquipedalis*) and related *Vigna* species using sequence tagged microsatellite site analysis. *Scientia Horticulturae*., **106**: 137– 146.

Rubatzky, V.E. and M. Yamaguchi, 1997. *World Vegetables: Principles, Production, and Nutritive Values*. Chapman and Hall, New York.

Santipracha, Q. and W. Santipracha, 1992. Yardlong bean trial in rainy season in Songkhla. *Songklanakarin J Sci Technol*, **14**: 373-378 (Tha).

Sarutayophat, T., C. Nualsri, Q. Santipracha and V. Saereeprasert, 2007. Characterization and genetic relatedness among 37 yardlong bean and cowpea accessions based on morphological characters and RAPD analysis. *Songklanakarin J. Sci. Technol.*, **29**: 591–600.

Tantasawat, P., J. Trongchuen, T. Prajongjai, W. Seehalak and Y. Jittayasothorn, 2010. Variety identification and comparative analysis of genetic diversity in yardlong bean (*Vigna unguiculata* spp. *sesquipedalis*) using morphological characters, SSR and ISSR analysis. *Scientia Horticulturae*, **124**: 204-216.

Tindall, H. D., 1983. *Vegetables in the Tropics*. Macmillan Education Limited, Hong Kong.

Wuttiwong, K., 2007. Antixenosis resistance to bean aphid (*Aphis craccivora* Koch) in yardlong bean and cowpea (*Vigna unguiculata*). Master thesis. Prince of Songkla Univ. (Tha)

Yussefi, M. and H. Willer, 2003. *Organic Agriculture Worldwide*: Statistics and Future Prespects, IFOAM, Tholey – Theley.

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