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Seed and Crop Production of Yardlong Bean Under Organic Farming System

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1. Introduction

Yardlong beans (Vigna sesquipedalis (L.) Fruw) is an economic crop in the leguminosae. It has potential for export both fresh and frozen and can be grown all year round and in every part of Thailand. However, the problem of pests occurs all through its growing life, prompting farmers to use chemicals to control it. The use of chemicals without considerations of their impacts and safety have induced various problems such as dangers to farmers themselves, ecological balance disturbance and effects on environment through food chain and then to the consumers. The deposit in soil, water contamination and residues in plants are all dangerous to living things and human health.

Yardlong bean production using reduced amount of chemicals or organic farming system, hence, has become important and increasingly wanted. Organic farming system is the production system which avoids the use of synthetic fertilizers, insecticides and plant growth regulators. The standard requirement of organic plant production is that the seeds used for growing must be from organic farming production that has been approved. This is especially true for the Common European Market Council which requires farmers operating under the organic farming system to use the seeds produced via organic farming system since January 1, 2004. Thailand has also adopted that approach.

However, there are many factors involving the production of seeds under the organic farming system, making the yield low. Hence, in producing organic seeds, suitable varieties should be selected to suit each area and they should be the open-pollinated varieties with regular quality high yield. It should be able to grow in low fertile soil, resist pests and diseases, and compete with weeds. The suitable season should be selected for the production of seeds and the planting areas should not be repeated. Rotation corps such as the bean family should be emphasized. Compost, farm manure, green manure, wastes from other materials, organic and inorganic matters from nature should be used as nutrients.

The use of bio-extract solution and gypsum mixture is an alternative in the organic farming system because bio-extract solution is made from nature and can be used instead of chemical fertilizers as plant growth regulators and can be used for disease and pest

prevention and elimination. It is easy to produce and safe for the users, consumers and environment. It can be used in producing various kinds of vegetable for consumption such as cabbage, broccoli, lettuce, Chinese cabbage, Chinese turnip, carrot, chili, egg plant, cucumber, kale, yardlong bean crops and seeds. As for Gypsum, likewise, is a natural mineral, a source for calcium and sulfur which can help boost the ability of the bean family plants to create more root nodule, improve soil physical structure and increase seed yields of Chinese turnip, wheat, bean family plant and peanut. Hence, the study about the use of bio-extract solution and gypsum mixture in the production of yardlong bean under the organic farming system which will help perfect the process and reduce the negative effects and dangers in using chemicals

The aim to study the yield, seed quality and the selected PSU yardlong bean produced under the organic farming system in comparison with those produced using chemicals.

2. Materials and methods

The first trial studied types and quantity of bio-extract solution in producing yardlong bean seeds using 3 formulas: 1) Water Convolvulous bio-extract solution, made from 3 kilograms of Water Convolvulous, 1 kilogram of molasses, 100 grams of microorganism/1 liter of water, 2) fruit bio-extract solution, from 3 kilograms of papaya, 3 kilograms of pumpkins, 3 kilograms of bananas, 3 kilogram of molasses, 300 grams of microorganism/1 liter of water, and 3) sea fish bio-extract solution, from 6 kilograms of ground sea fish, 3 kilograms of molasses, 200 grams of microorganism/1 liter of water. These were kept in covered bins for 45 days. The 3 formulas of bio-extract solutions at 1:500 and 1:1000 were used to water the Yearlong beans in the trial beds. Tobacco extract solution was used for the first three treatments while chemical insecticides. In comparison, the use of chemicals were done by bedding each planting hole with 1 gram of Carbofuran, applying 15-15-15 formula fertilizer at the rate of 20 kilograms/rai at the age of 2, 5 and 7 weeks after planting. Phriphonil solution at 20 cc./1 liter was sprayed to prevent and eliminate pests every 7 days.

The second trial was to study the effect of bio-extract solution and gypsum mixture on yields and quality of yardlong bean seeds. The water convolvulus bio-extract solution at 1:1.000 to water the plant every 4 days gained from the first trail was used in the preparation of the trial beds with 50 kilograms of gypsum/rai, and a bio-extract solution from water convolvulus rated 1:1.000 + gypsum rated 50 kilograms/rai., compared with a conventional method (chemicals application) for control. Tobacco extract solution was used for the first three treatments while chemical insecticides were used with the fourth treatment to control major insect pests when necessary.

The third trial studied the effects of methods in increasing the amount of bio-extract solution to produce seeds under the organic farming method. The water convolvulus bio-extract solution at 1:1.000 was used to bio-extract solution watering once for 4 days, bio-extract solution watering once for 7 days alternated with spraying once for 4 days, bio-extract solution spraying once for 3 days were compared with conventional method (chemical application).

The fourth trial studied the production of fresh crop production from organically produced seeds and the use of chemicals. The seeds from the 2nd and 3rd trials were planted to produce crop. The trial was done at the Department of Plant Science, Faculty of Natural Resources, Prince of Songkla University, Hat Yai, Songkhla, Thailand.

3. Results and discussion

The first trial studied types and quantity of bio-extract solution in growing yardlong bean seeds (Table 1, 2 and 3). It was found that the suitable bio-extract solution for producing yardlong bean seeds was the water convolvulus bio-extract solution at 1:1.000. The seed yield was 49.81 kilograms/rai which were higher than the production using other types and ratios of bio-extract solution but lower than growing by using chemicals with the yield of 52.17 kilogram/rai. The germination rate of the seeds produced by any method was higher than 89% whereas the use of water convolvulus bio-extract solution yielded seeds stronger than any other methods. Hence, water convolvulus bio-extract solution at 1:1.000 was used in the second trial.

Treatment	Days to flowering 50% (days)	Days to harvested seed (days)	No. of harvested plants (%)	Seed yield (kg/rai)
Chemical method	40	53	88	52.17a
Water convolvulus bio-extract solution at 1:500.	40	53	86	37.55ab
Water convolvulus bio-extract solution at 1:1.000.	40	54	91	49.81a
Fruit (namva, pumpkin, papaya) bio-extract solution at 1:500.	41	54	85	42.39ab
Fruit (namva, pumpkin, papaya) bio-extract solution at 1: 1.000.	41	54	88	33.55b
Sea fish bio-extract solution at 1:500.	40	53	88	40.48ab
Sea fish bio-extract solution at 1: 1.000.	41	54	90	37.59ab
F-test	ns	ns	ns	*
C.V. (%)	3.59	2.41	5.96	21.47

ns = non-significant * = significant different at $P \leq 0.05$
Within each column, means not followed by the same letter are significantly different at the 5% level of probability as determined by DMRT

Table 1. Days to flowering 50%, days to harvested seed, no. of harvested plants and yield of yardlong bean seed by application of bio-extract solution compared with chemical method

The second trial studied the effects of bio-extract solution and gypsum on yields and quality of yardlong bean seeds (Table 4, 5 and 6). It was found that the use of water convolvulus bio-extract solution at 1:1,000 yielded 40 kilograms of yardlong bean seeds /rai which was higher than the production using gypsum and bio-extract solution + gypsum but lower than the production using chemicals (90 kilograms/rai). As for quality, the seeds produced using bio-extract solution had more seed size and seed dry weight than seeds produced by any other methods. However, standard germination and seeds vigor were not different no matter what method was used (97-98%).

Treatment	Seed size (cm)		Seed dry weight (mg/seed)	Standard germination (%)	Field emergence (%)
	width	Length			
Chemical method	0.52	1.07b	127.50	91.50	92.50
Water convolvulus bio-extract solution at 1:500.	0.55	1.12a	127.50	91.50	93.50
Water convolvulus bio-extract solution at 1:1.000.	0.53	1.08b	125.00	92.00	95.50
Fruit (namva, pumpkin, papaya) bio-extract solution at 1:500.	0.53	1.07b	130.00	89.50	87.00
Fruit (namva, pumpkin, papaya) bio-extract solution at 1: 1.000.	0.54	1.06b	120.00	90.00	89.50
Sea fish bio-extract solution at 1:500.	0.53	1.07b	130.00	89.00	93.50
Sea fish bio-extract solution at 1: 1.000.	0.53	1.05b	130.00	90.00	93.00
F-test	ns	*	ns	ns	ns
C.V. (%)	2.60	2.41	3.21	3.87	4.78

ns = non-significant * = significant different at $P \leq 0.05$
Within each column, means not followed by the same letter are significantly different at the 5% level of probability as determined by DMRT

Table 2. Seed size, seed dry weight, standard germination and field emergence of yardlong bean seed by application of bio-extract solution compared with chemical method

When the seeds age were accelerated to study their ability storage, it was found that seeds produced using bio-extract solution + gypsum had the highest germination rate of 98% whereas the production using bio-extract solution and gypsum had the germination rates of 92.50% and 90.50%, respectively. On the other hand the production using chemicals had the germination rate after the age acceleration of 93.50%. This meant that the seeds produced using bio-extract solution + gypsum could be storage longer than the seeds produced by other methods. However, the production of seeds using convolvulus bio-extract solution at 1:1,000 to water the plants every 7 days might not give them enough nutrients for growth and seed production because they took a long time—20 days after the flowers started to bloom, or the pods had to become brown—before they could be harvested. It could be seen that the leaves turned yellow during the flowering and yielding, on the fifth day after the application of bio-extract solution. Some of the plants yielded at least 10 pods each. The calculation of the amount of bio-extract solution used to water the plants all through the season revealed that there were 192.00, 19.55 and 640.44 gram of N, P, and K respectively/rai only. Yardlong beans usually needed 1.6-3.2 kilogram of Nitrogen/rai and 8.0-9.6 of Phosphorus and Potassium/rai to be sufficient for growth and yield. Hence, more bio-extract solution was needed in the seed production.

Treatments	Speed of germination index	Seedling dry weight (mg/seedling)	Conductivity (μmho/cm/gm)	AA germination (%)
Chemical method	14.01ab	67.50	13.57	84.00
Water convolvulus bio-extract solution at 1:500.	14.43a	61.50	14.82	82.50
Water convolvulus bio-extract solution at 1:1.000.	14.47a	69.50	14.98	83.00
Fruit (namva, pumpkin, papaya) bio-extract solution at 1:500.	12.18c	63.75	15.77	87.00
Fruit (namva, pumpkin, papaya) bio-extract solution at 1: 1.000.	13.23b	63.00	15.40	83.00
Sea fish bio-extract solution at 1:500.	14.05ab	68.00	15.99	80.00
Sea fish bio-extract solution at 1: 1.000.	13.69ab	66.50	14.71	73.00
F-test	*	ns	ns	ns
C.V. (%)	5.03	5.03	13.30	6.79

ns = non-significant * = significant different at $P \leq 0.05$
Within each column, means not followed by the same letter are significantly different at the 5% level of probability as determined by DMRT

Table 3. Speed of germination index, seedling dry weight, conductivity and AA germination of yardlong bean seed by application of bio-extract solution compared with chemical method

Treatment	Days to flowering 50% (days)	Days to harvested seed (days)	No. of harvested plants (%)	Seed yield (kg/rai)
Chemical method	41.25	52.83	71.46	89.78 a
Bio-extract	40.50	52.75	75.83	40.06 b
Gypsum	41.41	52.99	73.96	31.41 b
Bio-extract + Gypsum	40.99	53.17	70.21	29.55 b
F-test	ns	ns	ns	*
C.V. (%)	1.79	1.03	18.18	29.66

ns = non-significant * = significant different at $P \leq 0.05$
Within each column, means not followed by the same letter are significantly different at the 5% level of probability as determined by DMRT

Table 4. Days to flowering 50%, days to harvested seed, no. of harvested plants and yield of yardlong bean seed by application of bio-extract solution, gypsum and mixture of bio-extract solution and gypsum compared with chemical method

Treatment	Seed size (cm)		Seed dry weight (mg/seed)	Standard germination (%)	Field emergence (%)
	width	Length			
Chemical method	0.55	1.05	128.54	97.00	100.00
Bio-extract	0.56	1.08	131.90	97.50	100.00
Gypsum	0.53	1.06	130.41	98.00	99.50
Bio-extract + Gypsum	0.54	1.04	130.39	98.00	99.50
F-test	ns	ns	ns	ns	ns
C.V. (%)	3.08	10.77	1.69	2.03	0.71

ns = non-significant

Table 5. Seed size, seed dry weight, standard germination and field emergence of yardlong bean seed by application of bio-extract solution, gypsum and mixture of bio-extract solution and gypsum compared with chemical method

Treatments	Speed of germination index	Seedling dry weight (mg/seedling)	Conductivity (μmho/cm/gm)	AA germination (%)
Chemical method	33.33	73.21 a	28.21	93.50 ab
Bio-extract	33.33	76.00 a	28.31	92.50 b
Gypsum	33.16	67.98 b	27.92	90.50 b
Bio-extract + Gypsum	33.20	74.25 a	28.22	98.00 a
F-test	ns	*	ns	*
C.V. (%)	0.63	3.33	6.67	3.50

ns = non-significant * = significant different at $P \leq 0.05$
Within each column, means not followed by the same letter are significantly different at the 5% level of probability as determined by DMRT

Table 6. Speed of germination index, seedling dry weight, conductivity and AA germination of yardlong bean seed by application of bio-extract solution, gypsum and mixture of bio-extract solution and gypsum compared with chemical method

The third trial studied the effects of methods in increasing the amount of bio-extract solution in the production of seeds under the organic farming system (Table 7, 8, 9 and 10). It was found that the production using chemicals gave the highest yield of 160 kilograms/rai, not significantly different from watering bio-extract solution every 4 days, watering every 7 days together with spraying every 4 days, and spraying every 3 days, which gave the seeds yields at 146, 138 and 133 kilograms/rai respectively. Using bio-extract solution every 4 days was the most effective way.

The seeds produced by watering bio-extract solution every 4 days had more seed dry weight than seeds produced by other methods. However, their germination rate was not different from those of the seeds produced by other methods (95.50-97.25%). Seed age acceleration to find out their potential in storage time revealed that the seeds produced by watering bio-extract solution every 4 days had the highest germination rate (96%), which was different from the seeds produced using chemicals and watering bio-extract solution

every 7 days together with spraying at every 4 days, which had the germination rates after age acceleration of 90.00 and 94.00% respectively.

Treatment	Days to flowering 50%(days)	Days to harvested seed (days)	No. of harvested plants (%)
chemical method	45.00	61.00	87.81
bio-extract solution watering once for 4 days	45.00	61.00	85.94
bio-extract solution watering once for 7 days alternated with spraying once for 4 days	45.00	60.00	90.63
bio- bio-extract solution spraying once for 3 days	44.00	60.00	91.81
F-test	ns	ns	ns
C.V. (%)	3.22	0.87	13.81

ns = non-significant

Table 7. Days to flowering 50%, days to harvested seed and no. of harvested plants of yardlong bean seed by application of bio-extract solution compared with chemical method

Treatment	Seed yield (kg/rai)	Seed size (cm)		Seed dry weight (mg/seed)
		width	Length	
chemical method	160	0.54	1.00	131.58
bio-extract solution watering once for 4 days	146	0.55	1.00	132.01
bio-extract solution watering once for 7 days alternated with spraying once for 4 days	138	0.55	1.16	131.35
bio- bio-extract solution spraying once for 3 days	133	0.55	1.16	131.40
F-test	ns	ns	ns	ns
C.V. (%)	13.31	1.53	1.30	0.77

ns = non-significant

Table 8. Seed yield , seed size and seed dry weight of yardlong bean seed by application of bio-extract solution compared with chemical method

Treatment	Standard germination (%)	Field emergence (%)	Speed of germination index
chemical method	96.50	98.50	32.70
bio-extract solution watering once for 4 days	97.25	99.50	33.24
bio-extract solution watering once for 7 days alternated with spraying once for 4 days	96.75	100.00	33.16
bio- bio-extract solution spraying once for 3 days	95.50	100.00	33.32
F-test	ns	ns	ns
C.V. (%)	1.32	1.58	1.25

ns = non-significant

Table 9. Standard germination, field emergence and speed of germination index, of yardlong bean seed by application of bio-extract solution compared with chemical method

Treatment	Seedling dry weight (mg/seedling)	Conductivity (μmho/cm/gm)	AA germination (%)
chemical method	65.00	25.32 ab	90.00 b
bio-extract solution watering once for 4 days	62.50	30.16 a	96.00 a
bio-extract solution watering once for 7 days alternated with spraying once for 4 days	67.50	20.77 b	94.00 b
bio- bio-extract solution spraying once for 3 days	65.00	24.53 ab	94.50 ab
F-test	ns	*	*
C.V. (%)	10.41	13.93	3.41

ns = non-significant * = significant different at $P \leq 0.05$
Within each column, means not followed by the same letter are significantly different at the 5% level of probability as determined by DMRT

Table 10. Seedling dry weight, conductivity and AA germination of yardlong bean seed by application of bio-extract solution compared with chemical method

However, the method of using bio-extract solution to water the plants every 4 days yielded only 14 kilograms of produce less than the yield produced using chemicals. This was probably because the plants received more nutrients as bio-extract solution was given more frequently (from every 7 days to every 4 days). The nutrients received were sufficient for growth and seed production as could be seen that the plants did not show the sign of nutrients lacking. The stems were healthy and the number of pods/plant was more than those produced using bio-extract solution to water every 7 days. The calculation of the amount of bio-extract solution used to water the plants every 4 days all through the planting

season revealed that there were 266.76, 33.35 and 964.00 grams of N, P, and K respectively/rai which was higher than applying it every 7 days. This was also because the bio-extract solution also had secondary nutrients which were Ca, Mg, and S at 1111.50, 166.72 and 144.49 grams/rai and also carbohydrate, protein, enzyme, organic acid and plant hormones which were important factors enhancing biochemical reaction leading to cell division and reproduction cell production, making the plants strong and finally yield flowers and seeds. Apart from that, bio-extract solution had micro-organism with the ability to decompose organic matters in the soil so that more nutrients were released into the soil for the plants to use.

Treatments	Days to indeterminate 50% (days)	Days to flowering 50% (days)	Days to harvested (days)	No. of harvested plants (%)
Chemical method	20.00	40.00	48.00	96.88
Bio-extract	20.00	40.00	48.00	94.06
Gypsum	20.00	40.00	48.00	94.06
Bio-extract + Gypsum	20.00	40.00	48.00	96.88
F-test	ns	ns	ns	ns
C.V. (%)	1.93	1.43	1.00	3.00

ns = non-significant.

Table 11. Days to indeterminate 50%, days to flowering 50%, days to harvested , and no. of harvested plants of yardlong bean seed by application of bio-extract solution, gypsum and mixture of bio-extract solution and gypsum compared with chemical method

Treatments	Wilted disease and death rate (%)	Marketable yield (kg/rai)	Non-marketable yield (kg/rai)
Chemical method	2.19	2,079	275
Bio-extract	5.31	2,171	255
Gypsum	5.00	1,894	281
Bio-extract + Gypsum	2.50	1,846	273
F-test	ns	ns	ns
C.V. (%)	89.58	12.82	19.33

ns = non-significant.

Table 12. Wilted disease and death rate, Marketable yield and Non-marketable yield of yardlong bean seed by application of bio-extract solution, gypsum and mixture of bio-extract solution and gypsum compared with chemical method

The fourth trial studied fresh crop production from organic seeds and the use of chemicals (Table 11, 12 and 13). The seeds gained from the 2nd and 3rd trials were planted for crops. To be specific, the seeds produced in the trial to study the effects of using bio-extract

solution and gypsum on yields and quality of seeds were used. All methods yielded non-significantly different amounts of fresh pods. The use of bio-extract solution yielded 2,171 kilograms/rai of marketable yields, higher than those produced by using chemicals, gypsum and bio-extract solution + gypsum which yielded 2,079, 1,894, and 1,846 kilograms/rai, respectively. Production using bio-extract solution to water the plants every 7 days could have given sufficient nutrients for growth and pod production since the plants did not reveal the symptoms of nutrients deficiency. The plants were healthy and yielded many pods/plant. In addition to that, the beans were creeping plants and their flowers bloomed in succession so the pods could be harvested everyday. The needs for nutrients to feed the plants and pods, hence, were less than those in producing seeds because the pods had to be left on the plants until the time to harvest the seeds.

Treatments	Pod length (cm)	Pod weight (g)	Pod color
Chemical method	63.08 a	24.46	143C
Bio-extract	63.49 a	22.71	143C
Gypsum	61.31 b	20.89	143C
Bio-extract + Gypsum	61.51 b	21.38	143C
F-test	*	ns	-
C.V. (%)	1.11	11.28	-

ns = non-significant * = significant different at $P \leq 0.05$
Within each column, means not followed by the same letter are significantly different at the 5% level of probability as determined by DMRT

Table 13. Pod length, pod weight and pod color of yardlong bean seed by application of bio-extract solution, gypsum and mixture of bio-extract solution and gypsum compared with chemical method

When the seeds from the study of the effects of the methods in increasing the amount of bio-extract solution in the production under organic farming method were used to produce fresh pods (Table 14, 15 and 16), it was found that the seeds produced by using organic farming method and using chemicals yielded no differences in fresh crop production. The crops were possible to harvest after the flowers had bloomed for 10 days and could be harvested for 25 days with marketable yields. The seeds produced using bio-extract solution to water every 4 days gave the highest yield of 1,606 kilograms/rai of marketable yields, higher than the yields from the production using bio-extract solution to water every 7 days together with spraying every 4 days, spraying every 3 days and using chemicals which gave the yields of 1,414, 1,285, and 1,587 kilograms/rai respectively. However, the yields in this production were smaller than the production using bio-extract solution to water every 7 days, probably because the environment during the planting time was different. In this planting time, during the time from stem growing to flowering to pod producing, there were continuous rains with high amount of water, a lot of clouds and hence little light, resulting in the significant growth in the stem but less flowering.

Treatment	Days to flowering 50%(days)	Days to harvested (days)	No. of harvested plants (%)
chemical method	40.00	48.00	93.75 a
bio-extract solution watering once for 4 days	40.00	47.00	84.69 ab
bio-extract solution watering once for 7 days alternated with spraying once for 4 days	40.00	48.00	82.19 ab
bio- bio-extract solution spraying once for 3 days	40.00	47.00	77.81 b
F-test	ns	ns	*
C.V. (%)	1.76	1.40	10.35

ns = non-significant * = significant different at P ≤ 0.05
Within each column, means not followed by the same letter are significantly different at the 5% level of probability as determined by DMRT

Table 14. Days to flowering 50%, days to harvested and no. of harvested plants of yardlong bean seed by application of bio-extract solution compared with chemical method

Treatments	Wilted disease and death rate (%)	Marketable yield (kg/rai)	Non-marketable yield (kg/rai)
chemical method	9.41	1,578	129 a
bio-extract solution watering once for 4 days	10.00	1,606	122 a
bio-extract solution watering once for 7 days alternated with spraying once for 4 days	15.69	1,414	90 b
bio- bio-extract solution spraying once for 3 days	13.13	1,285	87 b
F-test	ns	ns	*
C.V. (%)	61.92	16.29	10.47

ns = non-significant * = significant different at P ≤ 0.05
Within each column, means not followed by the same letter are significantly different at the 5% level of probability as determined by DMRT

Table 15. Wilted disease and death rate, Marketable yield and Non-marketable yield of yardlong bean seed by application of bio-extract solution compared with chemical method

It can be concluded from all the trials in producing yardlong bean seeds and fresh crops under the organic farming system that the production of seeds using the increased amount of convolvulus bio-extract solution at 1:1,000 to water the plants every 4 days, using 40 liters each time in the 1x5 meter beds was the method that gave the highest yield, as high as the production using chemicals both in terms of amount and quality. The production of fresh crops using the morning glory water convolvulus bio-extract solution at 1:1,000 to water the

plants every 7 days, using 40 liters each time in the 1x5 meter beds was the method that gave the highest yield, as high as the production using chemicals. Hence in the use of bio-extract solution in producing seeds and fresh pods under the organic farming method, the yardlong bean plants must be observed closely. If the leaves turn yellow and the plants are not healthy, it means that the nutrients are not sufficient. Hence, bio-extract solution should be added more frequently. Besides, the production of seeds and fresh crops under the organic farming method needs more meticulous care and attention in tending to the plants all through the planting season than the use of chemicals. Farmers need to have knowledge, experience and understanding about the production under the organic farming method.

Treatments	Pod length (cm)	Pod weight (g)	Pod color
chemical method	61.40 b	22.05 a	143C
bio-extract solution watering once for 4 days	62.47 a	22.09 a	143C
bio-extract solution watering once for 7 days alternated with spraying once for 4 days	61.63 b	21.31 b	143C
bio- bio-extract solution spraying once for 3 days	61.53 b	21.35 b	143C
F-test	*	*	-
C.V. (%)	0.69	1.28	-

* = significant different at $P \leq 0.05$
Within each column, means not followed by the same letter are significantly different at the 5% level of probability as determined by DMRT

Table 16. Pod length, pod weight and pod color of yardlong bean seed by application of bio-extract solution compared with chemical method

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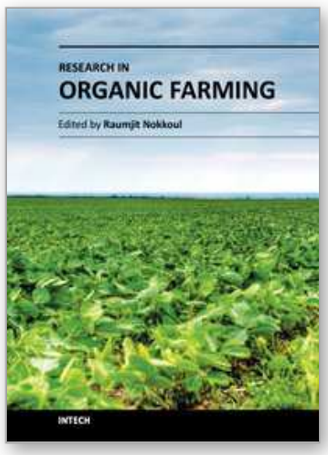

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This book has emerged as a consequence of the difficulties we experienced in finding information when we first started researching. The goal was to produce a book where as many existing studies as possible could be presented in a single volume, making it easy for the reader to compare methods, results and conclusions. As a result, studies from countries such as Thailand, Spain, Sweden, Lithuania, Czech, Mexico, etc. have been brought together as individual chapters, and references to studies from other countries have been included in the overview chapters where possible. We believe that this opportunity to compare results from different countries will open a new perspective on the subject, allowing the typical characteristics of Organic Agriculture and Organic Food to be seen more clearly. Finally, we would like to thank the contributing authors and the staff at InTech for their efforts and cooperation during the course of publication. I sincerely hope that this book will help researchers and students all over the world to reach new results in the field of Organic Agriculture and Organic Food.

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