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Evaluation of Agricultural Inputs for Cultivation Organic Asparagus in the Field

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Abstract Result showed that the total yield or fresh weight of organic treatment was significantly different when compared to the natural control. It is proved that application of the tested bio-products as organic fertilizer, liquid bio fertilizer, Chaetomium, Bot-F, Nano-elicitor, Bio insect, Ya-Ra-Gua, Nano-chitosan, and Nutrient food as agricultureal inputs which research derived from Bio-control Research Unit, KMITL, Bangkok, Thailand for organic asparagus cultivation has continuously increased in yield of asparagus when compared to the natural control. Percent increase in total fresh weight yield (Grade A, B, C) per week in organic treatment was increasing with 128.04%, 191.87%, 239.07, 197.56%, 211.68% and 201.03%, accordingly. It was in third week with 239.07% increase that gained the highest percent increase while second week was the lowest with 191.89%. The results clearly show that fresh weight yield in organic treatment was increased compared to natural control as shown in table 11. Result showed that total yield in all grade (A,B,C) for six weeks in organic treatment was significantly different at P=0.01 when compared with the natural control. Asparagus yield for six weeks in organic treatment was 6202.5 g and the natural control was 2066.5 g. With this, it is increased of 200.18 % in yield for organic treatment when compared to natural control.

Introduction

Asparagus is a well known vegetable that provides the amounts of vitamins A and C, riboflavin, niacin, and thiamin and the minerals iron, phosphorus and potassium (Barnes, G. L. 1986, David W. 1914). The cultivation of vegetable crop has been applied agrochemicals that affects the living life and nature, hazardous to human being. Only 0.1 percent of pesticides are used to hit the target pest, while 99.99 percent of pesticides are contamination the environment especially in soil, air, and water, which affect the ecology and food chain. So, it is campaigned for growing organic vegetables (Wikipedia, 2017). Organic asparagus production requires the use of

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certified agricultural inputs that must not been applied synthetic agrochemicals (Cheryl and Matt, 2012).

Organic agriculture are included all agricultural systems that promote environmentally, socially and economic production. These systems rely on soil fertility as a key to successful production and define as a holistic product management system to promote and enhance agro-system and biodiversity, biological cycles and soil biological activity (James *et al.* 2000).

Cheryl and Matt (2012) stated that the interesting in organic foods, along with farmer's interest in seeking safer farming method has promoted. It has been learned about the risked in association with conventional agriculture (James *et.al*., 2000). Increasing consumer demand for organic products has made organic crop production for the fastest growing. Organic agriculture is concerned about natural and maintaining natural balance to build up agro-ecosystem which aims to stop the use of chemical pesticide and chemical fertilizer. Organic products are safe for consumers and have more demand in the market. There are many techniques that has been used for organic crop production.

Asparagus officinalis var *altilis* L. is a perennial vegetable native to the seacoasts of Europe and eastern Asia, where it has been cultivated for over 2,000 years (Brands, S.J., 1989).Growing asparagus organically adds further value to this already high-value vegetable crop. A rule of thumb for conventional asparagus is that it takes a market size of 10,000 people to successfully market every acre produced (Cheryl and Matt, 2012).

The organic agriculture has begun with work of Englishman Sir Albiert Haward, who developed "organic growing method" in India in the early 1900s. Rudolf Steiner and Ehrinfried Pfieffert were developing "biodynamic" methods based on concept that the earth is the living substances that needs to be replenished and revitalized through organic mean (James, *et al.*, 2000). Soytong (2001) stated that in Thailand is the one of research leader on biological products for organic crop production. The aim is to stop the application of toxic agrochemicals. Research and development in organic agriculture has performed with the several known outstanding scientist in this field of microbial biotechnology in agriculture. Soytong *et al.* (2001) reported that the research for agricultural inputs for organic crop production are released to the organic growers as follows:- biofertilizer, Chaetomium, Microbial elicitor, Bio-insecticide etc. George *et al.* (2001) stated that organic crop production disallows the application of synthetic pesticides or conventional commercial fertilizers. The organic growers must rely on biodiversity, cultural practices, alternative, environmentally friendly inputs. As a commercial crop, asparagus can be somewhat challenged to produce organically.

Application of chemical has been recognized to cause environmental pollution and leave chemical residue in the soil, water and agriculture products, it is known that continuous use of chemical fungicide leads to the environment of resistance of pathogen(Soytong, 1996). Biological control of plant pathogen has successful provided a relative recent strategy for integrating with other agro-system and maintain natural balance (Soytong *et al.*, 1999). There are several reports on the potential use of biological control agent against plant pathogen. *Caetomium* spp. is one of the strictly saprophytic antagonists several plant pathogen, e.g. *Venturia ingualis* (Heye and Andrews, 1983).

Soytong (2004) stated the research and development of microbial products for bio agriculture have been now successfully to apply for organic agriculture (microbial products which belongs to Dr. Kasem Soytong are now used to reduce damage several economical plant in Thailand, Vietnam and P.R china, and to decrease toxic chemical in agriculture products and surrounding environment for sustainable develop. The microbial products use for bio-agriculture biological organic fertilizers (microbial fertilizer), biological humus, liquid organic microbial fertilizer to improve soil fertility and promote plant growth, biological fungicide (Ketomium) and biologically active substances (Bot-f) for disease control.

Dr. Kasem's Organic Farm Model is one of the demonstration organic farm that do organic crop cultivation, mainly citrus and other crops like asparagus, green okra etc.

The objective of the research finding was to evaluate how to grow organic asparagus by using bio-products as agricultural inputs and determine its effect on the yield.

Materials and methods

The experiment was performed by using Randomized Complete Block Design (RCBD) with 4 replications and two treatments. There were eight experimental plots and each plot had 40 plants. Treatments were as follows:- Treatment 1 was application of bio-products as agricultural inputs for organic production such as organic fertilizer at the rate 6 kg per plot, liquid bio fertilizer 20-40 cc, ketomium 20g, Bot-F 30-50cc, Nano-elicitor 5-10 cc, Bio insect 50cc, Ya-Ra-Gua 30-50cc, Nano-chitosan 30cc, Nutrient food 50 g and sulfur 5 g per 20 liters of water (All bio-products are research products which offered by Dr. Kasem Soytong, Bio-control Research Unit, Faculty of Agricutural Technology, Knig Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok, Thailad. These bio products were applied every two weeks. Treatment 2 was non-treated control (only watering and removed weed). Plant

spacing was 100 X 50 cm. Grading system of asparagus shoots was done by following the standard as follows:

Grade A: perfect spout, length from basal stem to top not over 25cm, green in color at least 20 cm and diameter in about 1.1-1.5cm, the harvested shoots do not have sign or symptom of insects and disease, look good performance, straight, not stunt, do not wash with other vegetable or mix with other grade and transportation with carefully in cool cabinet.

Grade B: perfect spout, length from basal stem to top not over 25cm, green in color at least 20 cm and diameter in about 0.6-1cm, the harvested shoots do not have sign or symptom of insects and disease, look good performance, straight, not stunt, do not wash with other vegetable or mix with other grade and transportation with carefully in cool cabinet,

Grade C: perfect spout, length from basal stem to top not over 25 cm, green in color at least 20 cm and diameter lower than 0.6 cm, the spears of harvest do not have sign or symptom of insects and disease, look good performance, straight, not stunt, do not wash with other vegetable or mix with other grade and transportation with carefully in cool cabinet.

Data were collected as number of shhots or spears (yield) and freash weightin each asparagus grade. Data were computed statistical analysis (ANOVA) and treatment means were compared with Duncan's Multiple Range Test at P =0.05 and P=0.01.

Results

Organic treatment and natural control wre compared by counting the number of spears, fresh weight and classified as Grade A, B and C, and total yield for six weeks of cultivation. The result showed that number of spears in organic treatment was significantly different at P=0.05 when compared with natural control in every week for six weeks as shown in Table 1. The natural control gave the highest number of spears was in sixth week, (50 spares) and the lowest number of spears was in second week (21.75 spears) while in the organic treatment gave significantly highest in number of spears at the fifth week harvesting (121.75 spears) and the lowest number of spears was in sixth week, (115 spears). The continuous use of bio-products in organic treatment enhanced the production of asparagus spears. The organic treatment give significantly increased in the number of harvested spears at six week when compared to the natural control that no significant difference in the number of harvested spears in each week (Fig 1). As the result, organic treatment was significantly increased in the number of spears in the first week, second week,

third week, fourth week, fifth week and sixth week after as 98.1, 150.5, 129.1, 143.3, 178.2 and 128.7 %, respectively (Table 2).

Table 1. Number of asparagus spears in each week

Methods	week1	week2	week3	week4	week5	week6
control	26.75[b]	21.75[b]	33.5[b]	45.00[b]	43.75[b]	50.50[b]
Organic	53.00[a]	54.50[a]	76.75[a]	109.50[a]	121.75[a]	115.50[a]
CV%	4.43%	36.48 %	28.86 %	13.25 %	9.69 %	15.87 %

Average of four replications, Means followed by a common letter in the each column are significantly differed at P=0.05.

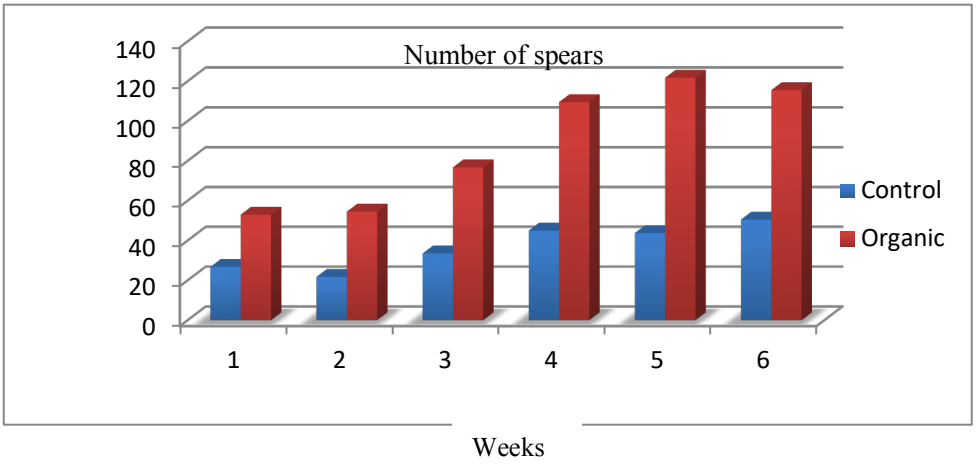

Figure1. Number of asparagus spears for six weeks

Table 2. Percentage of increasing in the number of spears in each week

Method	week1	week2	week3	week4	week5	week6
Control (%)	0.00	0.00	0.00	0.00	0.00	0.00
Organic (%)	98.13	150.57	129.10	143.33	178.28	128.71

Percentage increase in number of spears were calculated as follow: organic treatment –control treatment/control treatment x100.

The total number of spears for six weeks in organic treatment was significantly different from the natural control. Results revealed that natural control yielded 221.25 asparagus spears, while organic treatment gave a total of

531.00 spears which shown 140 % increasing the total yield in organic treatment when compared to natural control (Table 3). The harvested asparagus spears were grading and resulted that fresh weight of grade A for six weeks in organic Treatment was significantly different at P=0.05 compared to natural control (Table4). The natural control, the highest fresh weight of grade A was in the fourth week (130 g) and the lowest fresh weight was first week (35g). On the other hand, organic treatment gave the highest fresh weight in sixth week (653.75 g) and the lowest fresh weight was in first week, (139.50 g) as seen in Table 4. It is proved that all tested bio-products in organic treatment enhanced yield (asparagus spares). The organic treatment gave significantly increased in fresh weight of spears (yield) in the six week when compared to the natural control (Figure 2). This illustrated that organic crop production gave the highest response to increased in yield of asparagus when compared to natural control.

Table 3. Percentage of increasing number of spears in six weeks

Methods	Total weeks	Percentage of increasing (%)
Control	221.25[b]	0.00
Organic	531.00[a]	140
CV%	13.94	

Average of all replication Mean follow by a common letter in the same column are significantly different at P=0.01;
Percentage increase in total number of spears also was calculated as follow: organic treatment – control treatment/control treatment x100.

Table 4. Fresh weight (g) of grade A of asparagus in each week

Methods	1week	2weeks	3weeks	4weeks	5weeks	6weeks
control	35.75[b]	61.50[b]	61.25[b]	130.00[b]	121.00[b]	111.00[b]
Organic	139.50[a]	300.25[a]	364.75[a]	643.50[a]	570.75[a]	653.75[a]
CV%	43.11	37.71	19.55	13.23	6.09	9.13

Average of four replication Mean follow by a common letter in the same column are significantly different at P=0.05.

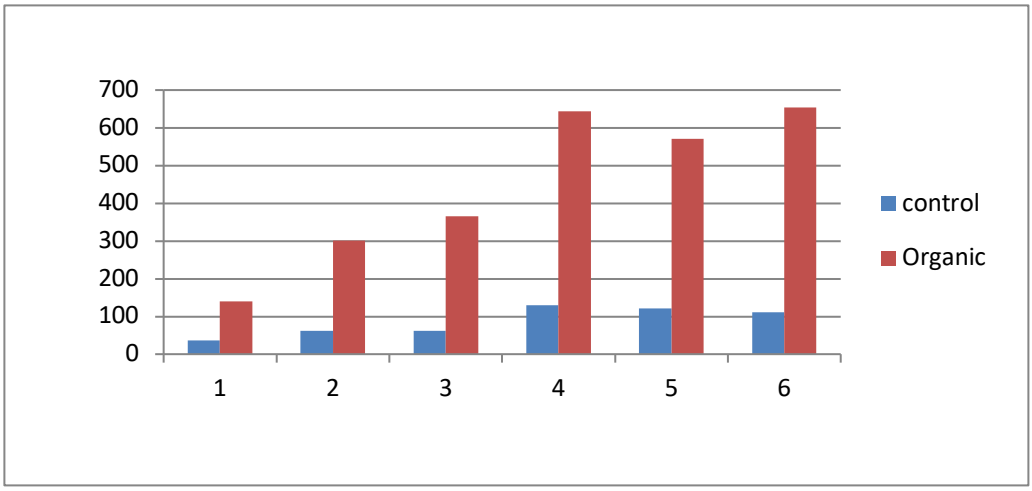

Figure 2. Fresh weight yield in Grade A in each week for six weeks

The result clearly showed that increased yield in organic treatment at every week which was 290.20, 388.21, 495.51, 395.00, 371.69 and 488.96 %, respectively, when compared to the natural control (Table 5). Result indicated for grade B that organic treatment which applied bio-products gave the highest yield of asparagus when compared to the natural control. The highest yield in organic treatment was third week (644.50) and the lowest was second week (232.75g), while in natural control showed the highest yield in the fifth week (240.50g) and the lowest was the first week (97.00g). It is shown that organic treatment provided better yield than the natural control (Table 6 and Figure 3). Grade B was increased in organic treatment at every week when compared to the natural control. The highest percentage of increased yield was third week (210.60%) and the lowest was the second week (100.86%) as seen in Table 7.

Table 5. Percentage increased fresh weight of grade A in each week

Methods	**week1**	**week2**	**week3**	**week4**	**week5**	**week6**
Control (%)	0.00	0.00	0.00	0.00	0.00	0.00
Treatment (%)	290.20	388.21	495.51	395.00	371.69	488.96

Percentage increased yield in each week was calculated as follows: organic treatment –control treatment/control treatment x100

Table 6. Fresh weight (g) of grade B of asparagus in each week for 6 weeks

Method	week1	week2	week3	week4	week5	week6
Control	97.00[b]	115.75[b]	207.50[b]	235.75[b]	240.50[b]	209.00[b]
Treatment	253.75[a]	232.50[a]	644.50[a]	596.75[a]	599.25[a]	510.25[a]
CV%	43.11	41.73	21.33	10.29	16.20	30.71

Table 7. Grade B increased in each week

Method	week1	week2	week3	week4	week5	week6
Control (%)	0.00	0.00	0.00	0.00	0.00	0.00
Treatment (%)	161.59	100.86	210.60	153.12	149.16	144.13

Calculation percentage of increased yield in grade B as follows: organic treatment –control treatment /organic treatment x100

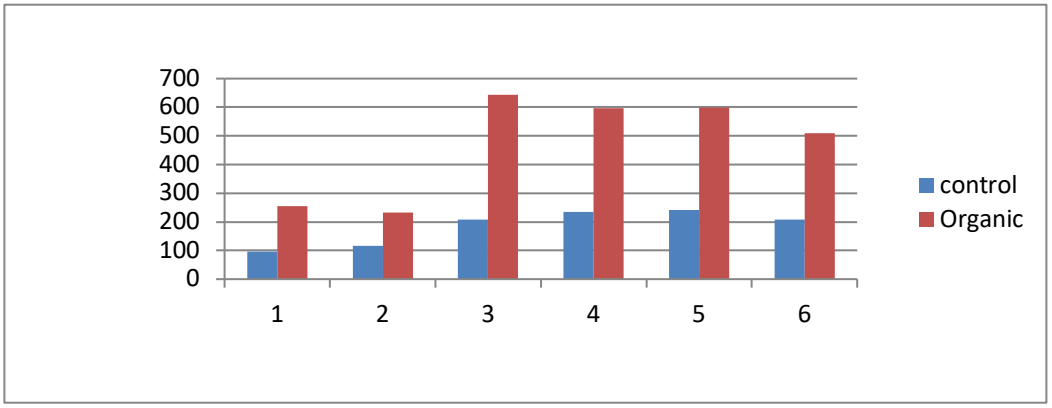

Figure 3. Fresh weight yield in grade B in each week for six weeks

The result showed that yield in grade C in the first four weeks was not significantly different (at P=0.05). The first, second, third, and the fourth weeks yielded grade C in organic treatment was 74.25, 39.75, 53.75, 104.00 and the natural control was 72.25, 22.75, 44.75, 86.00, respectively (Table 8). It revealed that there are an increasing percentage of fresh weight yields in organic treatment in every week as 2.75%, 74.72%, 20.11%, and 20.93% 155.66% and 54.82% respectively. The highest increase 155.66% and lowest increase 2.76%. The result showed that organic treatment was increase compared to natural control (Table 9 and Figure 4).

Table 8. Yield of grade C

Method	1week	2weeks	3weeks	4weeks	5weeks	6weeks
control	72.25[a]	22.75[a]	44.75[a]	86.00[a]	77.25[a]	137.25[a]
Organic	74.25[a]	39.75[a]	53.75[a]	104.00[a]	197.50[b]	212.50[b]
CV%	29.60	16.60	13.72	28.23	16.90[a]	28.87[a]

Averages of four replications, Means folloed by a common letter in each column are not significantly different at P=0.05.

Table 9. Percentage of increased in grade C of asparagus

Method	week1	week2	week3	week4	week5	week6
Control (%)	0.00	0.00	0.00	0.00	0.00	0.00
Treatment (%)	2.76	74.72	20.11	20.93	155.66	54.82

Percentage of increased yield was calculated as follows: organic treatment –control treatment/control treatment x100

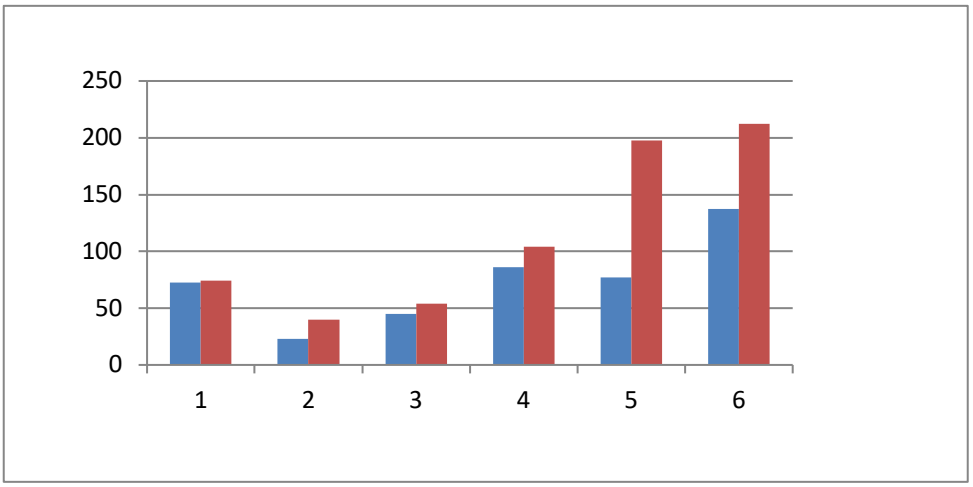

Figure 4. Fresh weight yields in grade C in each

Total yield (grade A, B, C) – The total yield (fresh weight) in each week of organic treatment was significantly different at P=0.05 when compared to natural control, which is shown in Table 10. The sixth week gave the highest yield of 1376.5 g, and the lowest yield in organic treatment was first week (467.50 g).

Table 10. Fresh weight yield for all replication in six weeks

Methods	Week1	Week2	Week	Week	Week	Week
Control	205.00	200	313.5	451.75	438.75	457.25
Treatment	467.50	583.75	1063	1344.25	1367.5	1376.5
CV%	21.79	31.24	17.72	11.43	8.3	11.29

Average of four replication Mean follow by a common letter in the same column are significantly different at P=0.05

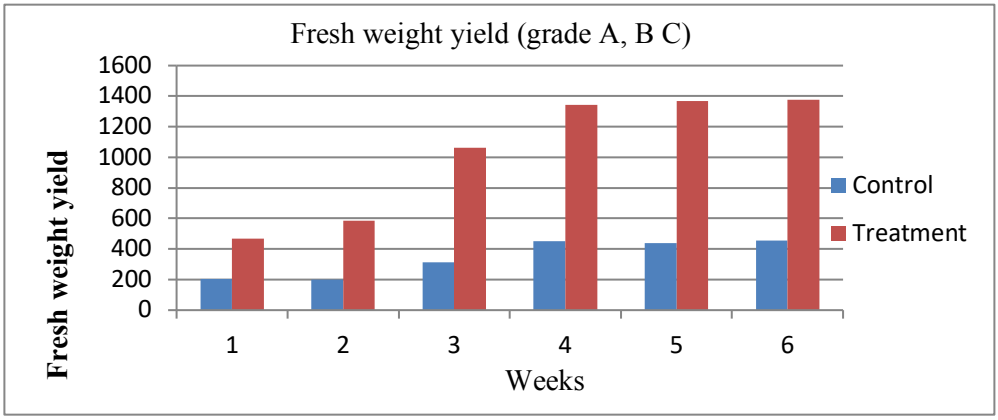

Figure 5. Total yield of asparagus

Applying bio-products of organic fertilizer at the rate 6 kg per plot, liquid bio fertilizer 20-40 cc, ketomium 20g, Bot-F 30-50cc, Nano-elicitor 5-10 cc, Bio insect 50cc, Ya-Ra-Gua 30-50cc, Nano-chitosan 30cc, Nutrient food 50 g and sulfur 5 g per 20 liters of water as agriculture inputs for asparagus production has continuously increased in yield of asparagus as shown in figure 5 when compared to the natural control (Fig 6). Percent increase in total fresh weight yield (Grade A, B, C) per week in organic treatment was increasing with 128.04%, 191.87%, 239.07, 197.56%, 211.68% and 201.03%, accordingly. It was in third week with 239.07% increase that gained the highest percent increase while second week was the lowest with 191.89%. The results clearly show that fresh weight yield in organic treatment was increased compared to natural control as shown in table 11. Result showed that total yield in all grade (A,B,C) for six weeks in organic treatment was significantly different at P=0.01 when compared with the natural control. Asparagus yield for six weeks in organic treatment was 6202.5 g and the natural control was 2066.5 g. With this, it is increased 200.18 % in yield for organic treatment when compared to natural control (Table12, Fig.6).

Table 11. Increasing fresh weight yield (grade A, B, C) by percent

Method	week1	week2	week3	week4	week5	week6
Control (%)	0.00	0.00	0.00	0.00	0.00	0.00
Treatment (%)	128.04	191.87	239.07	197.56	211.68	201.03

Increasing fresh weight yield by percent also calculated as follow: organic treatment –control treatment/control treatment x100

Table 12. Total fresh weight yield (grade A, B, C)

Method	Total	Percentage of increasing (%)
Control	2066.25[b]	0.00
Treatment	6202.50[a]	200.18
CV%	13.75	

Average of four replication Mean follow by a common letter in the same column are significantly different at P=0.01

Percentage of increasing total fresh weight or yield also calculated as follow: organic treatment –control treatment/control treatment x100

Figure 6. Yield of asparagus

Discussion

The results showed that organic treatment gave significantly higher number of spears (yields) than the natural control. It is proved that biological products which includes organic fertilizer, Nutrient crop(liquid bio-fertilizer) for plant growth, Bot-f and Ketomium for disease control, Nano elicitor for disease immunity, Bio Insect for insect protection, Ya-Ra-Gua for insect and disease control, Nutrient Food high potassium and Nano chitosan can be completely used for organic asparagus cultivation which rarely or no signs of diseases eg anthacnose disease etc. and also insct pests. The the natural control appared vmore anthacnose disease especially anthracnse caused by *Colletotrichum* spp. (Conway, Kenneth E. 1987; Johnson, D.A. 1990). These bio-products are proved to be used for organic crop production sucessfullty. This result are similar with Sibounnavong *et al* (2006) reported that organic treatment which, applied agricultural inputs as bio-products to produce organic Kangkong had increase in yields as 45.83% when compared to natural control. Sripai (2000) also stated that applied *Chaetomium and Trichoderma* could increase yields about 36.00% when compared to natural control. The reasons why the yield could be increased that can be explained by scientific reasons work by Suwan *et al.* (2000) who stated that *Trichoderma harzianum* stain Pc01 was elucidated to produce Trichotoxins promoting plant growth. As you see that T. *harzianum* Pc01was mixed to bio-fertilizer that used in the experiment, application rate comparison of bio-fertilizer to produce asparagus in organic method.

Kowapradit *et al.* (2007) reported that bio-ash treatment used in organic cultivation of rice was made out of 7 species of fungi that produces amylase, cellulose, protease and ligninase (*Aspergillus sparsus, Chaetomium lucknowense, Achaetomium theilaviopsis, Paecilomyces marquandii, Emericella nidulans, Eurotium herbariorum and Arthrobotrys oligospora*) and 4 species that produces amylase, *cellulose* and ligninase (*Trichoderma hamatum, T. hamatum*(T-12*),Mucor hiemalis and M. circinelloides)* Results showed that there was an increase in plant growth and number of grains per panicle . The rice growing in the experiment showed significantly different in total grain weight per panicle at 45 d after transplanting. It was clearly demonstrated that in control plot and ash treatment at 45 d, total number of grain weight per panicle were 152.44 and 111.32 g, respectively. But it was highly significant in total number of total grain weight per panicle at 45 day in bio-ash treatments at the rates of 25, 50 and 75 kg/rai which were 313.57, 299.25 and 351.18 g, respectively when compared to the ash treatment and non-treated one.

It is observed in this research finding that organic method was significantly higher fresh weight yields (grade A, B, C) than natural control. Kosom (1985) stated that grading Asparagus is good for maket demand. From the research work of Chaiwat (2004) stated that Kangkong's organic cultivation proved that organic treatment which applied liquid organic fertilizer, ketomium, Bot-f , Neem's, bio insecticide, and bio-humus can be provided fast growing and early harvest. It showed that all fresh weight yield were increased in organic method. Another study about organic farming is reported by Sibounnavong (2006) also showed that applying the above mentions agricultural inputs as bio-products to produce organic plant could increase in yields of kangkong compared to natural control method. These results are similar with the results of this research. This organic results also similar to Charee (2005), Sibounnavong *et al.* (2006) and Soytong *et al.* (2010) that organic crop production would be successfully performed, if it provided the effective agricultural inputs and must be meet the internation organic standard (James and Ford, 2000).

Conclusion

Biological products such as nutrient crop liquid biological fertilizer for plant growth, Bot-f and ketomium for disease control, Nano elicitor for disease immunity, bio insect for insect protection, Ya-Ra-Gua for insect and disease control, Nano elicitor for disease immunity, sulfur in powder for insect control, nutrient food high potassium, Nano chitosan helps plant ability to absorb nutrient and yields, especially organic fertilizer increase quantity and quality of asparagus yield. The agricultural inputs as bio products to produce organic asparagus gave higher response for number of spears and fresh weight of yield. It is recommended that these certified agricultural inputs could further promote to apply for other economic plants for food safety and protect environment for natural balance.

References

Barnes, G. L., Conway, K. E. and Mots, L. E. (1986). Diseases of asparagus in Oklahoma. OSU extension facts No. 7646, Oklahoma State University Cooperative Extension.

Brands, S. J. (1989). Systema Naturae 2000. In The Taxonomicon. Universal Taxonomic Services, Zwaag, The Netherlands. Retrieved from http://taxonomicon.taxonomy.nl/

Conway, K. E. (1987). Summer disease control on asparagus ferns can mean increased profit next year. Proceedings of the 1987 Oklahoma Horticulture Industries Show, Tulsa, OK. pp. 41-43.

Pumsing, C. (2005). Cultivation of *Brassica olreacea* var. *albograbra* in Good Agricultural Practices (GAP), Pesticide-FreeProduction (PFP) and Organic Agriculture (OA). (Special Problem). King Monkut's Institute Technology Lakrabang(KMITL).

Sirikarunwong, C. (2004). Cultivation of Pakchoi for GAP, PFP and OA. (Special problem). King Monkut's Institute Technology Lakrabang(KMITL).

Kaiser, C. and Ernst, M. (2012). Organic asparagus. Retrieved from https://www.uky.edu/Ag/CCD/introsheets/organicasparagus.pdf

David, W. (1914). Growing asparagus in home garden. The University of Tennessee: Agricultural Extension Service. Retrieved from https://extension.tennessee.edu/publications/documents/SP291-R.pdf

Johnson, D. A. (1990). Effect of crop debris management on severity of stemphylium purple spot of asparagus. Plant Disease 74:413-415.

Kowapradi, S., Pongnak, W. and Soytong, K. (2007). Biological ash from bottom coal ash mixed with beneficial fungi on the growth of rice var pathumthani 1. Journal of Agricultural Technology 3:129-136.

Kosom, P. (1985). A Study of cost and rate of return on investment in asparagus plantation at Hupkapong. (Master's Thesis). Chulalongkorn University.

Inmark, S. (2000). Application of biological products for growing super sweet corn. (Special Problem). King Monkut's institute of technology Ladkrabang(KMITL).

George, K and Raeven, T. (2001). Organic Asparagus Production. University of California. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.669.1716&rep=rep1&type=pdf

James, A. R. and Joyce, E. F. (2000). IFOAM/IOIA international organic inspection manual. Germany: IFOAM.

Sibounnavong, P. (2006). Cultivation of Kangkong (Impomoea Aquatica). (Special Problem). National university of Laos.

Sibounnavong, P., Sysouphanthong, P., Xay, L., Phoutasay, P., Promrin, K., Pongnak, W. and Soytong, K. (2006). Application of biological products for organic crop production of Kangkong (*Ipomoea aquatica*). International Journal of Agricultural Technology 2:177-189.

Soytong, K., Kanokmedhakul, S., Kukongviriyapan, V. and Isobe, M. (2001). Application of *Chaetomium* species (Ketomium) as a new broad spectrum biological fungicide for plant disease control: A review article. Fugal Diversity 7:1-15.

Soytong, K., Sibounnavong, P. and Adthajadee, A. (2010). Evaluation of CM product to promote plant growth. Journal of Agricultural Technology 7:105-113.

Suwan, S, Isobe, M., Kanokmedhakul, S., Lourit, N., Kanokmedhakul, K., Soytong, K and Koga, K. (2000). Elucidation of high micro-heterogeneity of an acidic-neutral trichotoxin mixture from Trichoderma harzianum by electrospray ionization quadrupole time-of-flight mass spectrometry. Journal of Mass Spectrometry 35:1438-1451.

Wikipedia. (2017). Environmental impact from pesticide. Retrieved from https://en.wikipedia.org/wiki/Environmental_impact_of_pesticides#cite_noteTashkent-2.

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