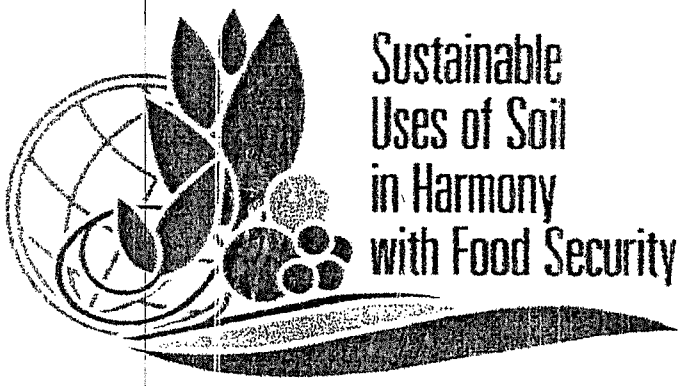
Proceedings
International Soil Conferences
2015

On the Auspicious Occasion for Celebration of
the International Year of Soils 2015



18-21 August 2015
The Regent Cha Am Beach Resort,
Phetchaburi, THAILAND

Land Development Department

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Effects of Organic and Chemical Fertilizers, and Bio-extract on Growth and Yield of Cucumber in two seasons

S. Sompanit, P. Pornsuriya and P. Promsomboon

Rajamangala University of Technology Tawan-ok Bangpra campus, Thailand
s.yoyo@hotmail.com

Abstract

The application of chemical fertilizer complemented with organic fertilizer to soil is considered as a good practice in plant cultivation system. The objective of this study is to determine the effects of chemical fertilizer combined with or without organic fertilizer on growth and yield of cucumber. The field experiments were carried out at Rajamangala University of Technology Tawan-ok during the two successive seasons in 2014 (Jan. – Mar., and May - July). The experimental design used was 2 × 6 split plot in randomized complete block design with three replications. Treatments of main plot were two cucumber cultivars namely Pumchaba and Hiso. Sub plot treatments were six applications of chemical fertilizers combined with and without organic fertilizers.

Plant length at 3 weeks: It was not significantly different between cultivars and among fertilizer treatments. Chemical fertilizers tended to give the longest plant at 3 weeks. Fresh plant weight at the last harvest was significantly different between cultivars in the season 2. Pumchaba cultivar had more fresh plant weight than Hiso cultivar. Fertilizer treatments were not different for this character in both season 1 and season 2. There were not significant differences for dried plant weight in both cultivar and fertilizer treatments. Total fruits per plant were not significantly different between cultivars in both seasons. Cucumber grown in the season 2 significantly gave more fruit number per plant than that in the season 1. Fertilizer treatments were significant in the season 2 and in the combined season. Chemical fertilizer and chemical fertilizer combined with cow manure appeared to give the highest total fruit number per plant. Yield of Pumchaba cultivar was more than Hiso cultivar in the combined analysis. Fertilizer treatments were significant in the season 2 and in the combined season. Yields of cucumber in the treatment of chemical fertilizer combined with cow manure were more than those in the organic fertilizer treatments. The results of this study revealed that chemical fertilizer combined with organic fertilizer seemed to be the best suited for cucumber cultivation, which conformed to the experiment of Roe *et al.* (1997). The application of chemical fertilizer combined with organic fertilizer could improve the cucumber yield in this experiment. Compost application was found not only to increase crop yield, but also to improve soil fertility in terms of organic C and N content, permeability, plant available water capacity and air-filled porosity (Mamo *et al.*, 1998). Bio-extract application did not affect the yield of cucumber since it had very low macronutrients (Nop-armornwadee *et al*., 2004).

The results revealed that cucumber cultivars were significantly different in yield per rai. The applications of chemical fertilizers (15-15-15 and 46-0-0 at the rate of 50 and 20 kg rai^{-1}, respectively) and chemical fertilizers (at the half rate) combined with compost-PD.1 or cow manure (1 ton rai^{-1}) were the best suited for cucumber cultivation; since they gave high total fruit number per plant and high yield per rai.

Introduction

Cucumber (*Cucumis sativum* L.) is one of the economically important vegetable crops produced in Thailand. Estimated area of cucumber cultivation in Thailand in 2013 was 72,602 rai (1 rai is 1,600 m^2) (Department of Agricultural Extension, 2014). The use of various organic fertilizers in the soil, generally in order to maintain and increase aggregate stability, and fertility of soils for farming and gardening has been of particular importance in the past decade. In this way, in addition of cost reduction and waste disposal, it will lead to more efficiency and usefulness (Lalandh *et al.*, 2000).

Vogtmann *et al.* (1993) studied the effect of compost on the yield and quality of some vegetables compared with chemical fertilizers and found that compost treatments resulted in lower vegetable yields in the first two years, but there were no different after the third year. Kostov *et al.* (1995) reported that it was more economical to use composting vegetable residues for greenhouse cucumber production than cattle manure. Roe *et al.* (1997) studied cucumbers in a sandy soil fertilized with compost or mineral fertilizers and found that yields were usually higher when compost was combined with mineral fertilizers. Use of organic manure and chemical fertilization increased soil nutrients and microbial biomass. Application of organic manures significantly increased levels of organic C and N and the formation of water-stable aggregates, as compared with application of chemical fertilizers Adrien (2006).

Compost can be used as a nutrient source on farms to reduce livestock manure waste and fertilizer purchases (Menalled *et al.* 2005). There are also benefits to using compost as a soil amendment, such as increasing soil organic matter, water and nutrient holding capacity, soil aggregation, and soil microbial activity (Gonzales and Cooperband 2002; Salem *et al.*, 2010). The complementary use of organic and inorganic fertilizers has been also recommended for sustenance of long term cropping in the tropics (Ipimoroti *et al.*, 2002).

The objectives of this study were to assess the effects of using organic and chemical fertilizers on growth and yield of two cucumber cultivars, and to determine the effect of growing seasons on yield of the two cucumber cultivars.

Materials and Methods

The experiments were carried out at the farm of Faculty of Agriculture and Natural Resources, Rajamangala University of Technology Tawan-ok during the two

successive seasons in 2014 (Jan-Mar and May-July). For each season, the experiment was arranged in a 2 × 6 split plot in randomized complete block design with three replications. Treatments of main plot were two cucumber cultivars namely Pumchaba and Hiso. Sub plot treatments were applications of organic fertilizers combined with and without chemical fertilizers, which were included (1) chemical fertilizers only as control (15-15-15 and 46-0-0 at the rate of 50 and 20 kg/rai, respectively), (2) Compost (PD. 1) at the rate of 2 ton rai^{-1}, (3) Compost (PD. 1) at the rate of 2 ton rai^{-1} combined with watering with bio-extract at the ratio of 1:500 (bio-extract : water, v/v) once a week, (4) cow manure at the rate of 2 ton rai^{-1}, (5) Compost (PD. 1) at the rate of 1 ton rai^{-1} combined with chemical fertilizers at the half rate of control, and (6) cow manure at the rate of 1 ton rai combined with chemical fertilizers at the half rate of control. Each experimental unit (plot size) was 1 × 5 m^2, 2 rows per plot, with 50 × 80-cm spacing (plant × row), 20 plants per plot (1 plant/hill). Plants were grown under trellising system using bamboo stakes, standard furrow irrigation, cultural practices, and pest control practices. Data were recorded on Plant length at 3 weeks, fresh and dried plant weight, total fruits/plant and yield rai^{-1}. Analyses of variance were performed according to the experimental design. Means were significantly tested by Duncan's new multiple range test. Combined analyses of the two seasons were performed for characters with having homogeneity of error variance.

Results

1. Chemical properties of the three organic fertilizers (Table 1)

Compost-PD.1 was higher in the percentage of N, P_2O_5, K_2O and Na than Cow manure and Bio-extract, whereas cow manure had higher C:N ratio and percentage of organic matters than compost-PD.1. Bio-extract (fish fermented) was very low in macronutrients. Nop-armornwadee *et al.* (2004) reported from analytical results of 177 bio-extract samples and concluded that there were insufficient macronutrients for plant growth. Based on macronutrients, compost-PD.1appeared to be the best suited for plant cultivation.

2. Chemical properties of the experimental field

Soil samples were collected from 36 plots (experimental units) before commencing the experiments and were analyzed for chemical properties as shown in Table 2. There were not different ($P \geq 0.05$) for all chemical properties among plots as analyzed following the experimental design.

Table 1 Some physical and chemical properties of organic fertilizers.

Properties	Compost-PD.1	Cow manure	Bio-extract
Organic matters (% w/w)	34.26	73.96	-
C/N ratio	10.00	25.00	-
N (%)	1.93	1.74	0.09
P2O5 (%)	6.61	1.42	0.01
K2O (%)	3.20	0.62	1.48
Na (%)	0.48	0.26	-
pH	-	-	3.03
EC (dS m-1)	-	-	10.07
Humic acid (%)	-	-	0.30

Table 2 Chemical properties of the experimental field.

	OM (%)	N (%)	P (ppm)	K (ppm)	pH	EC (dS m^{-1})
Mean	0.55	0.03	391.87	74.30	5.77	0.02

Table 3 Mean of squares for plant length at 3 weeks (cm), fresh and dried plant weight (kg/5 plants), number of fruits per plant and yield (ton rai^{-1}) of cucumber in season 1 (S1) and season 2 (S2).

Sources	Plant length at 3 wks		Fresh plant weight		Dried plant weight		Total fruits per plant		Yield	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Block	36.13	1691.59	0.272	0.370	0.0080	0.002	14.74	278.25	1.68	11.87
Cultivars (C)	36.00	169.43	0.015	0.871*	0.0009	0.005	49.12	6.29	11.70	2.60
Error a	45.67	48.62	1.594	0.029	0.0049	0.004	22.34	6.02	2.38	0.28
Fertilizers (F)	61.92	166.94	0.051	0.122	0.0002	0.003	8.59	44.90*	0.96	2.48**
C x F	32.66	135.52	0.100	0.066	0.0019	0.002	6.78	27.07*	0.69	1.40*
Error b	74.73	83.56	0.359	0.132	0.0016	0.002	7.70	9.00	0.71	0.48

3. Analysis of variance

Mean of squares for plant length (at 3 weeks), fresh plant weight, dried plant weight, total fruits per plant and Yield of two cucumber cultivars applied with six fertilizer treatments in two seasons were shown in Table 3. Their mean of squares of combined experiments between season 1 and 2 were shown in Table 4. Cultivars were significantly different for fresh plant weight in the season 2 and for yield in combined seasons. Fertilizer treatments were significantly different for total fruits per plant and yield in the season 2 and in combined seasons. Growing seasons were significantly different in plant length and total fruits per plant of cucumber (Table 4).

Table 4 Mean of squares of combined experiments (season 1 and 2) for plant length at 3 weeks (cm), fresh and dried plant weight (kg/5 plants), number of fruits per plant and yield (ton rai^{-1}) of cucumber.

Source	Plant length at 3 wks	Fresh plant weight	Dried plant weight	Total fruits per plant	Yield
Seasons (S)	18218.12**	5.260	0.0053	542.85**	3.324
Block/Seasons	858.86	0.321	0.0051	146.50	6.378
Cultivars (C)	180.82	0.558	0.0050	45.28	12.659*
S x C	24.62	0.328	0.0008	10.12	1.635
Error$_a$	47.14	0.812	0.0046	14.18	1.329
Fertilizers (F)	142.89	0.144	0.0009	43.38**	2.981**
S x C	85.96	0.029	0.0024	10.12	0.467
C x F	106.06	0.195	0.0013	26.26*	1.617*
S x C x F	62.12	0.171	0.0022	7.58	0.481
Error$_b$	79.14	0.245	0.0019	8.35	0.595

Growth and yield of cucumber

Plant length at 3 weeks: It was not significantly different between cultivars and among fertilizer treatments (Figures 1 and 2). Chemical fertilizers tended to give the longest plant at 3 weeks (Figure 2).

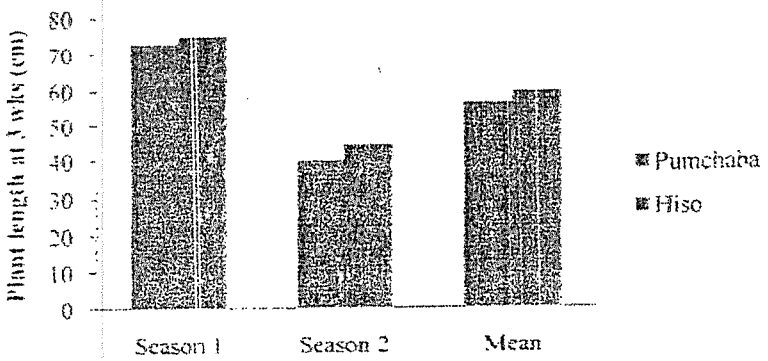

Figure 1 Plant length at 3 weeks of two cucumber cultivars in two seasons.

Fresh plant weight at the last harvest was significantly different between cultivars in the season 2 (Figure 3). Pumchaba cultivar had more fresh plant weight than Hiso cultivar. Fertilizer treatments were not different for this character in both season 1 and season 2 (Figure 4). There were not significant differences for dried plant weight in both cultivar and fertilizer treatments (Table 3).

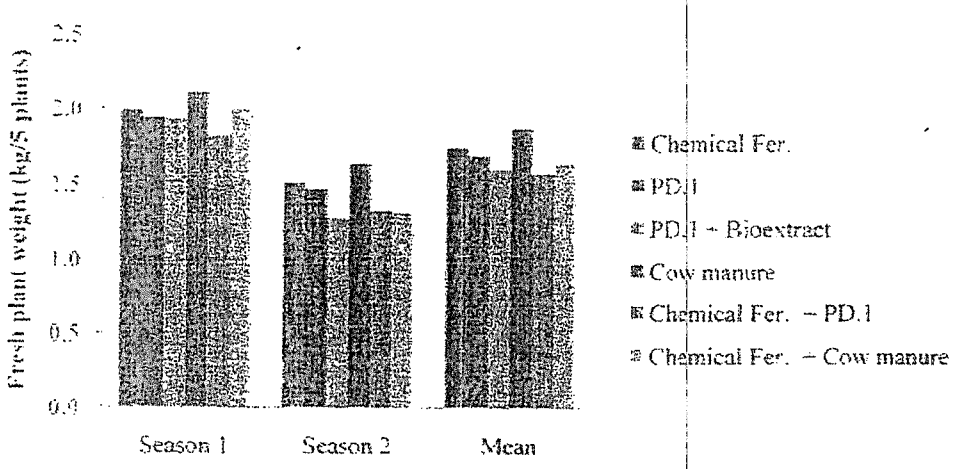

Figure 4 Effect of fertilizer treatments on fresh plant weight of cucumber.

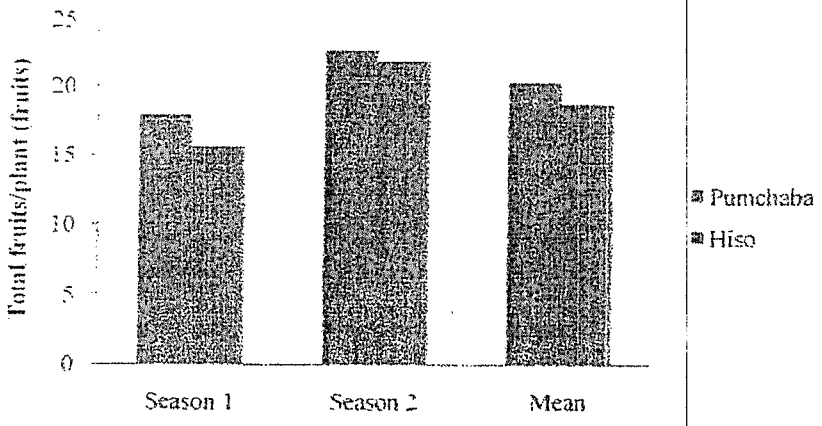

Figure 5 Total fruits per plant of two cucumber cultivars in two seasons.

The results of this study revealed that chemical fertilizer combined with organic fertilizer seemed to be the best suited for cucumber cultivation, which conformed to the experiment of Roe *et al.* (1997). The application of chemical fertilizer combined with organic fertilizer could improve the cucumber yield in this experiment. Compost application was found not only to increase crop yield, but also to improve soil fertility in terms of organic C and N content, permeability, plant available water capacity and air-filled porosity (Mamo *et al.*, 1998). Bio-extract application did not affect the yield of cucumber since it had very low macronutrients (Nop-armonwadee *et al.*, 2004).

Conclusions

From the results it could be concluded that the applications of chemical fertilizers (15-15-15 and 46-0-0 at the rate of 50 and 20 kg rai^{-1}, respectively) and chemical fertilizers (at the half rate) combined with compost-PD.1 or cow manure (1 ton rai^{-1}) were the best suited for cucumber cultivation, since they gave high total fruit number per plant and high yield per rai.

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