# Evaluation of Yield Components on *Capsicum* spp. under Two Production Systems

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***Abstract*—Thirty five lines of chilli were evaluated under inorganic and organic production systems. The objective of this study was to compare crop performance of chilli lines in terms of productivity that have good adaptation to inorganic and organic production systems. The chilli lines were carried out a Randomized Complete Block Design under inorganic and organic production systems. The results showed that there were highly significant ($p \leq 0.01$) for number of fruits/plant and yield/plant. The highest number of quality fruits was found on Chee: approximately 519.42 and 512.69 fruits/plant under inorganic and organic production systems, respectively. The lowest number of quality fruits was observed on Labmeunang line about 27.63 and 19.89 fruits/plant under the inorganic production system and organic production system, respectively. Chee line produced the highest yield under the chemical and organic production system about 701.22 and 630.61 grams/plant, respectively. Labmeunang line produced the lowest yield (26.45 grams/plant) under the organic production system.**

***Index Terms*—Capsicum spp., yield, system**

## I. Introduction

Chilli is an important crop in preparation of many food recipes water in many countries [1]. The pungency associated with many forms of Capsicum makes the fresh or dried fruits a desirable spice, and many medicinal properties have been attributed to capsaicin and its analogs [1], [2].

Chilli is a valuable spice and also an important cash crop in Thailand. The area of about 100,000 hectares in all parts of the country including the North, the Northeast, the Central Plain and the South is under chilli cultivation, and the most important production area is in the Southern part of Thailand as most food recipes in the South are rather hot.

Nowadays, the increase in population, our compulsion is not only to stabilize agricultural production but also to increase it further in sustainable manner [3]. Excessive use over years of agro-chemicals like pesticides and fertilizers has affected the soil health, leading to reduction in crop yield and product quality [4]. Hence, a natural balance needs to be maintained at all cost [5]-[8]

Chilli cultivars with good adaptation to organic production systems have not been investigated in Thailand. It is also important to compare the crop performance of chilli cultivars in terms of yield under both organic and inorganic production systems in order to provide recommendations to chilli growers. The objective of this study was to compare crop performance of chilli lines in terms of productivity. The information obtained in this study will be useful for providing recommendation to chilli growers under inorganic and organic production systems.

## II. Materials and Methods

### A. Plant Materials

Thirty five lines of chilli used in this study were selected from different areas in Thailand (Table I). The chilli lines were conducted in a Randomized Complete Block Design with four replications in two production systems (inorganic and organic) at the Faculty of Technology and Community Development, Thaksin University, Phatthalung Province, Thailand.

Prior to the setup of the experiment, the soil at two experimental sites was ploughed and sowed with sun hemp (*Crotalaria juncea* L.) as a green manure to improve soil conditions and provide fixed nitrogen to the crop (Fig. 1). The soil was ploughed again at flowering of sun hemp or 60 days after sowing for both trails.

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TABLE I. CHILLI USED IN THIS EXPERIMENT

| Genotypes | Characteristics | Original sources |
|---|---|---|
| Black hot | Medium plant | Bangkok province |
| Chaiprakan | Short plant | Samut Prakan province |
| Chee | High plant | Phatthalung province |
| Choypach | Medium plant | Supan buri province |
| Deehot | Medium plant | Supan buri province |
| Dinamai | Medium plant | Nakhon Pathom province |
| Dumnean | Short plant | Samut Prakan province |
| Haomkeaw | Medium plant | Samut Prakan province |
| Hot het | High plant | Samut Prakan province |
| Intira | Short plant | Bangkok province |
| Jindadang | Medium plant | Mae Hong Son province |
| Jindadum | Medium plant | Chiang Mai province |
| Jomthong | Short plant | Chiang Mai province |
| Karang | Medium plant | Mae Hong Son province |
| keenukaw | Medium plant | Phatthalung province |
| Keenuson | Short plant | Phatthalung province |
| Kungsalad | Medium plant | Maha Sarakham province |
| Labmeunang | Short plant | Maha Sarakham province |
| Maliwan | Short plant | Suphan Buri province |
| Manikhan | Short plant | Suphan Buri province |
| Mundum | Medium plant | Samut Prakan province |
| Nheumkeaw | Medium plant | Samut Prakan province |
| OP1 | High plant | Trang province |
| OP2 | High plant | Trang province |
| Patsiam | Short plant | Pathum Thani province |
| Pongpach | Short plant | Pathum Thani province |
| Pratadtong | Medium plant | Nonthaburi province |
| Pretty | Short plant | Nonthaburi province |
| Redhot | Short plant | Nakhon Pathom province |
| Saoykai | Medium plant | Songkhla province |
| Saoypet | Short plant | Nakhon Pathom province |
| Sriphai | Short plant | Nakhon Pathom province |
| Top green | Medium plant | Chiang Mai province |
| Top star | Medium plant | Chiang Mai province |
| Yhodtong | Short plant | Nakhon Si Thammarat |

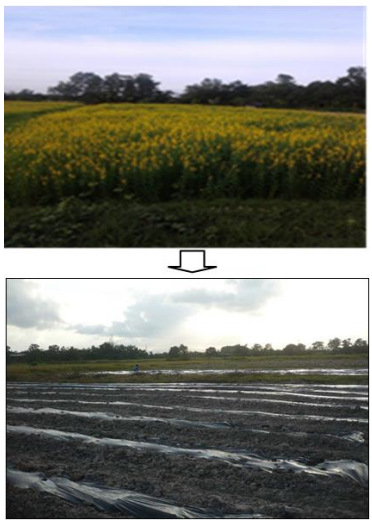

Figure 1. Prepared for planting.

### B. Experiment Conditions

The seedlings were transplanted in the plots of 1.5×5m that could accommodate two rows with six plants for each row. Therefore, each plot had 12 plants.

Inorganic fertilizer (formula 15-15-15) was applied to the inorganic trial at the rate of 650kg $ha^{-1}$ and compost manure was applied to organic trial at the rate of 650kg $ha^{-1}$. The full rates of the fertilizers (both chemical and manure) were applied in two splits at the 325kg $ha^{-1}$ at transplanting and at 28 days after transplanting. The first split, the fertilizers were applied at the bottoms of the hills shortly before transplanting. The second split, the fertilizers were applied around the stems of the plants and hilled up by hoes (pilling soil up around the base of the plant). Insects and diseases were practiced by biological control methods (Fig. 2).

Figure 2. Lemongrass water for insect protection.

### C. Data Collection

Germination was observed at 21 day after planting from total number of 104 seeds in each treatment and survival percentage was also recorded at 30 day after transplanting from total number of 28 plants in each plot.

Fruit width, fruit length, fruit weight, number of fruits/plant were measured for 60 fruits/treatment. In addition, yield/plant was also recorded all lines. The fruits of the crop were harvested for yield assessment at fully ripening stage as indicated by red color of the fruits, and yield was accumulated until three months after transplanting.

### D. Statistical Analysis

Data for separate locations were analyzed statistically according to a randomized complete block design. All analyses were done using the statistical programme of SPSS (Statistical Package for the Social Science for Windows) version 16.0. Significant treatment differences were separated using the Duncan's new Multiple Range Test (DMRT) at 0.01 probability level.

## III. RESULTS AND DISCUSSION

### A. Soil Content

Soil content for this research is shown in Table II. The soil had 1.16-1.15% of organic matter, 0.14-0.15% of total nitrogen contents, 34.33-37.01mg.$kg^{-1}$ of phosphorus, 65.01-82.35 mg.$kg^{-1}$ of potassium, and 0.07 –0.08 ds/m of electric conductivity (EC) for chilli planting under inorganic production system. While, chilli organic production system had organic matter, nitrogen contents, phosphorus, potassium and electric conductivity in before planting 1.02%, 0.15%, 37.33mg.$kg^{-1}$, 41.67mg.$kg^{-1}$ and 0.06 ds/m, respectively.

TABLE II. SOIL CONTENT

| Parameters | Inorganic production system | | Organic production system | |
|---|---|---|---|---|
| | Before Planting | After Planting | Before Planting | After Planting |
| Organic matter | 1.16% | 1.15% | 1.02% | 1.28% |
| Nitrogen | 0.15% | 0.14% | 0.15% | 0.15% |
| $P_2O_5$ (mg $kg^{-1}$) | 34.33 | 37.01 | 37.33 | 39.33 |
| K (mg $kg^{-1}$) | 82.35 | 65.01 | 41.67 | 31.67 |
| pH ($H_2O$) | 4.27 | 4.57 | 4.23 | 4.40 |
| EC (ds/m) | 0.08 | 0.07 | 0.06 | 0.07 |

### B. Germination and Survival Percentages

The results showed that Chee was the highest seed germination percentage about 95.19 and 94.23% producing under inorganic production system and organic production systems, respectively (Table III).

TABLE III. GERMINATION PERCENTAGE OF SEEDS

| Lines | Germination percentage (%) | |
|---|---|---|
| | Chemical production system | Organic production system |
| Black hot | 88.46 | 85.58 |
| Chaiprakan | 78.85 | 74.04 |
| Chee | 95.19 | 94.23 |
| Choypach | 86.54 | 81.73 |
| Dehot | 92.31 | 91.35 |
| Dinamai | 85.58 | 85.58 |
| Dumnean | 93.27 | 92.31 |
| Haomkeaw | 91.35 | 90.38 |
| Hot het | 86.54 | 82.69 |
| Intira | 88.46 | 85.58 |
| Jindadang | 89.42 | 89.42 |
| Jindadum | 94.23 | 92.31 |
| Jomthong | 88.46 | 88.46 |
| Karang | 83.65 | 80.77 |
| Keenukaw | 86.54 | 83.65 |
| Keenuson | 82.69 | 78.85 |
| Kungsalad | 89.42 | 89.42 |
| Labmeunang | 78.85 | 77.88 |
| Maliwan | 76.92 | 75.96 |
| Manikhan | 86.54 | 82.69 |
| Mundum | 87.50 | 85.58 |
| Nheumkeaw | 90.38 | 88.46 |
| OP1 | 82.69 | 78.85 |
| OP2 | 86.54 | 79.81 |
| Patsiam | 87.50 | 83.65 |
| Pongpach | 81.73 | 80.77 |
| Pratadtong | 92.31 | 91.35 |
| Pretty | 87.50 | 85.58 |
| Redhot | 94.23 | 93.27 |
| Saoykai | 80.77 | 77.88 |
| Saoypet | 80.77 | 77.88 |
| Sriphai | 79.81 | 77.88 |
| Top green | 82.69 | 82.69 |
| Top star | 83.65 | 83.65 |
| Yhodtong | 78.85 | 77.88 |

Survival percentages ranging from 50.00 to 85.71% and 42.86 to 85.71% were recorded under inorganic production system and organic production system, respectively (Table IV). Top star had the highest survival percentages of 85.71% under chemical and organic production systems, whereas Labmeunang had the lowest survival percentages of 50% under inorganic production system and 42.86% under organic production system. Similar results was reported by Dahanayake [9]

### C. Meteorology

Air temperatures chilli planting between December 2012 and June 2013 were 24.39 ℃ to 33.89 ℃. Average air temperatures were 28.45 ℃. The relative humidity values were between 63.07% and 96.13% and the average relative humidity value was 81.34% (Fig. 3). However, compare the incidence of this experiment. Environment is a contributing factor to the diseases and insects due to the temperature and high humidity [10], [11].

### D. Morphological Characters of Chilli

In this study, genotypes of chilli were highly significantly different ($p \leq 0.01$) for fruit width, fruit length, fruit number, fruit weight and fruit yield under the inorganic production system. Means for fruit width ranged from 0.39cm in Labmeunang to 2.21cm in Saoypet, whereas means for fruit length were between 4.12cm in Karang and 12.71cm in Jomthong. While, under organic production system, chilli genotypes were also significantly different ($p \leq 0.01$) for fruit width, fruit length, fruit numbers, fruit weight and fruit yield same. Means for fruit width were between 0.33cm in Labmeunang and 2.16cm in Saoypet, whereas means for fruit length were between 4.10cm in Karang and 14.90cm in Nheumkeaw (data not show).

TABLE IV. SURVIVAL PERCENTAGE OF SEEDLING

| Lines | Survival percentage (%) | |
|---|---|---|
| | Chemical system | Organic system |
| Black hot | 75.00 | 75.00 |
| Chaiprakan | 71.43 | 67.86 |
| Chee | 78.57 | 64.29 |
| Choypach | 67.86 | 64.29 |
| Dehot | 71.43 | 67.86 |
| Dinamai | 71.43 | 71.43 |
| Dumnean | 57.14 | 53.57 |
| Haomkeaw | 60.71 | 57.14 |
| Hot het | 85.71 | 82.14 |
| Intira | 75.00 | 67.86 |
| Jindadang | 57.14 | 53.57 |
| Jindadum | 85.71 | 78.57 |
| Jomthong | 82.14 | 75.00 |
| Karang | 71.43 | 71.43 |
| Keenukaw | 60.71 | 53.57 |
| Keenuson | 53.57 | 50.00 |
| Kungsalad | 53.57 | 46.43 |
| Labmeunang | 50.00 | 42.86 |
| Maliwan | 67.86 | 60.71 |
| Manikhan | 64.29 | 60.71 |
| Mundum | 82.14 | 78.57 |
| Nheumkeaw | 71.43 | 71.43 |
| OP1 | 71.43 | 67.86 |
| OP2 | 67.86 | 64.29 |
| Patsiam | 75.00 | 71.43 |
| Pongpach | 75.00 | 71.43 |
| Pratadtong | 85.71 | 82.14 |
| Pretty | 82.14 | 78.57 |
| Redhot | 75.00 | 71.43 |
| Saoykai | 64.29 | 64.29 |
| Saoypet | 67.86 | 60.71 |
| Sriphai | 53.57 | 53.57 |
| Top green | 67.86 | 67.86 |
| Top star | 85.71 | 85.71 |
| Yhodtong | 82.14 | 82.14 |

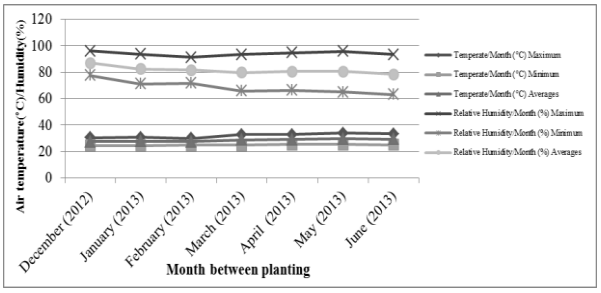


Figure 3. Meteorological data in Phatthalung Province

### E. Fruit Yield of Chill

Inorganic production system, chilli lines were significantly different ($p \leq 0.01$) for fruit number and fruit yield. Means for fruit numbers per plant ranging from 27.63 fruits in Labmeunang to 519.42 fruits in Chee.

Organic production system, chilli lines were also significantly different ($p \leq 0.01$) for fruit number and fruit yield. Chee had the highest fruit number of 512.69 fruits/plant, and Labmeunang was the genotype lowest fruit numbers/plant (19.89 fruits) (Table V).

The results of yields and pod numbers of chilli found that the plant tested under the inorganic production system had higher yield than chilli production under organic production system [12], [13], this is consistent with reports of growing plants during the growing season. It was found that the average yield and yield components of plants tested under the chemical and organic system [14]-[16] or the yield of green beans had the same effect [17]. For comparison total yields showed that the production yields under inorganic (chemical) production system had more yield than organic production system about 20-65%. Similar to Saleque *et al.* [18], Naik *et al.* [19] and Yadav *et al.* [20] who observed that cost value of organic manure and chemical fertilizers.

TABLE V. MEANS FOR FRUIT NUMBER AND YIELD OF CHILLI LINES PLANTED UNDER TWO PRODUCTION SYSTEMS

| Lines | Fruit numbers/plant | | Fruit yield/plant | |
|---|---|---|---|---|
| | Inorganic production system | Organic production system | Inorganic production system | Organic production system |
| Black hot | 63.02$^{hij}$ | 53.39$^{hij}$ | 513.74$^{cdef}$ | 430.32$^{d}$ |
| Chaiprakan | 58.22$^{jk}$ | 46.46$^{jk}$ | 253.26$^{ef}$ | 196.53$^{hij}$ |
| Chee | 519.42$^{a}$ | 512.69$^{a}$ | 701.22$^{a}$ | 630.61$^{a}$ |
| Choypach | 55.20$^{jk}$ | 43.47$^{jk}$ | 112.06$^{jk}$ | 83.90$^{l}$ |
| Dehot | 60.60$^{ijk}$ | 51.86$^{hij}$ | 194.53$^{ghi}$ | 161.80$^{ij}$ |
| Dinamai | 107.42$^{fg}$ | 96.64$^{efg}$ | 215.70$^{gh}$ | 187.48$^{ij}$ |
| Dumnean | 100.42$^{fg}$ | 88.66$^{efg}$ | 236.99$^{efg}$ | 200.37$^{hi}$ |
| Haomkeaw | 53.46$^{jk}$ | 43.72$^{jk}$ | 421.37$^{cdef}$ | 339.70$^{efg}$ |
| Hot het | 121.20$^{ef}$ | 101.43$^{def}$ | 164.35$^{hij}$ | 127.80$^{ijk}$ |
| Intira | 82.23$^{ghi}$ | 70.47$^{fgh}$ | 108.54$^{k}$ | 86.64$^{l}$ |
| Jindadang | 82.80$^{ghi}$ | 74.06$^{fg}$ | 136.62$^{ijk}$ | 113.31$^{jk}$ |
| Jindadum | 219.32$^{d}$ | 187.58$^{d}$ | 362.76$^{def}$ | 292.62$^{fgh}$ |
| Jomthong | 64.27$^{hij}$ | 50.53$^{ijk}$ | 700.80$^{a}$ | 511.36$^{bc}$ |
| Karang | 229.20$^{cd}$ | 223.46$^{cd}$ | 224.62$^{fgh}$ | 198.88$^{hij}$ |
| Keenukaw | 186.04$^{e}$ | 179.33$^{de}$ | 230.69$^{efgh}$ | 206.23$^{ghi}$ |
| Keenuson | 287.35$^{c}$ | 278.63$^{c}$ | 379.30$^{def}$ | 370.58$^{de}$ |
| Kungsalad | 51.06$^{kl}$ | 43.32$^{jk}$ | 522.34$^{cde}$ | 438.83$^{cd}$ |
| Labmeunang | 27.63$^{n}$ | 19.89$^{n}$ | 38.41$^{l}$ | 26.45$^{m}$ |
| Maliwan | 76.43$^{hi}$ | 59.52$^{ghi}$ | 679.00$^{ab}$ | 522.59$^{b}$ |
| Manikhan | 139.63$^{ef}$ | 120.87$^{def}$ | 274.51$^{def}$ | 223.61$^{gh}$ |
| Mundum | 82.68$^{ghi}$ | 71.95$^{fgh}$ | 540.73$^{cd}$ | 463.36$^{c}$ |
| Nheumkeaw | 51.36$^{kl}$ | 40.67$^{kl}$ | 651.86$^{bc}$ | 512.85$^{bc}$ |
| OP1 | 396.76$^{b}$ | 389.02$^{b}$ | 618.95$^{bc}$ | 571.86$^{b}$ |
| OP2 | 380.46$^{b}$ | 366.77$^{b}$ | 604.93$^{bcd}$ | 542.82$^{b}$ |
| Patsiam | 84.66$^{g}$ | 73.92$^{fg}$ | 164.92$^{hi}$ | 133.80$^{ijk}$ |
| Pongpach | 52.35$^{jkl}$ | 41.67$^{jkl}$ | 290.44$^{edef}$ | 226.68$^{gh}$ |
| Pratadtong | 60.32$^{ijk}$ | 50.57$^{ij}$ | 141.51$^{ij}$ | 114.24$^{jk}$ |
| Pretty | 52.71$^{jkl}$ | 44.93$^{jk}$ | 293.49$^{def}$ | 244.87$^{fgh}$ |
| Redhot | 81.65$^{ghi}$ | 70.92$^{fgh}$ | 150.56$^{hij}$ | 124.82$^{ijk}$ |
| Saoykai | 67.32$^{hij}$ | 57.58$^{ghi}$ | 148.91$^{ij}$ | 121.49$^{jk}$ |
| Saoypet | 58.82$^{jk}$ | 46.03$^{jk}$ | 352.59$^{def}$ | 272.04$^{fgh}$ |
| Sriphai | 48.32$^{l}$ | 37.53$^{l}$ | 210.19$^{ghi}$ | 159.13$^{ijk}$ |
| Top green | 30.41$^{m}$ | 22.67$^{m}$ | 129.36$^{ijk}$ | 94.53$^{kl}$ |
| Top star | 75.23$^{hi}$ | 67.48$^{fgh}$ | 377.45$^{def}$ | 333.35$^{efg}$ |
| Yhodtong | 162.12$^{e}$ | 154.38$^{de}$ | 340.45$^{def}$ | 314.94$^{fg}$ |
| C.V. | 11.45 | 10.24 | 12.34 | 10.98 |

Means in the same column with the same letter(s) are not significantly different by Duncan's New Multiple Range Test (DMRT) at 0.01 probability level.

## IV. CONCLUSION

In conclusion, Morphological characters yield components in the chilli lines varied significantly between all lines of chilli produced under the inorganic production system produced a higher yield than the organic production system. However, Chee line recorded the highest yield in two systems. Then we recommended that Chee line should also be used for further breeding, physiological as well as pungency studies.

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