# Evaluation of Determinate Tomato Variety Cultivation in West Jawa Highland Area in Indonesia

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## Introduction

Cultivation of vegetables particularly tomato is generally labor consuming. There is the need to develop labor-saving technologies to reduce cost of production, for industrial purposes and for future economical development. In tomato cultivation, staking and pruning practices increase yields and improve the quality of the crop, but raise the cost of production. There are two main types of tomato plants, namely, determinate (bush) and indeterminate (viny). Some varieties with intermediate nature are identified as semi-indeterminate. Determinate or semi-indeterminate varieties, with their characteristic stem elongation, achieve relatively good yield even without staking or pruning.

Distinctions are made between processing and fresh market tomatoes in some countries, such as Japan, because of the big differences in their quality standards. Tomatoes for fresh consumption have unique characteristics, which greatly depend upon the traditional consumer experiences in the locality (Opena, 1993). In many western countries, fresh or table-type tomatoes are preferably large, often more than 100 g in weight, smooth, uniform in shape, size and color, firm, with good shelf life for long-distance shipping, and with good tomato-like flavour. In some countries like Japan and Korea, pink-skinned tomatoes are preferred to red tomatoes. Survey about tomato consumers in Indonesia (West Java and Central Java) concluded that people commonly prefer tomatoes with medium size (80-120 g), smooth skin, regular with red color and good taste (van Lieshout, 1993). In North Sulawesi, tomatoes with small size and tasty acid are preferred.

Processing tomatoes are processed into several major products, for example, tomato paste, catsup, tomato juice and tomato sauce. Each product requires special desirable characteristics. In countries where the processing industry is very advanced, tomatoes with suitable characters for mechanization appear to be the most important. The quality of processing tomatoes is normally measured in terms of color, soluble solids, pH, total acidity, total solids and viscosity.

Six determinate tomato varieties were introduced from Japan through a collaborative work between JIRCAS and IVEGRI as new materials. These are used as processing tomato in Japan but which were evaluated not only as processing but also as labor-saving fresh market tomato under highland condition in Indonesia because the fruit qualities of these varieties are not so far from the standard of fresh market tomato in Indonesia.

In Indonesia, tomato growers commonly use banana leaves to make small pots without bottom for growing tomato seedlings and local soil for seedling media because of its low cost. However, soil is not always the best media. In fact, some soils are unsuitable for growing seedlings. Tropical environment is rich with materials that can be utilized in making proper nursery mixes, such as coconut fibre, rice husk, mosses, and dried (fully decomposed) manure. Utilization of plug trays and search for suitable seedling raising media made from low cost and locally produced materials, in combination with various experiments on tomato varieties were pursued. This approach helps vegetable farmers choose their materials for raising seedlings.

## MATERIALS AND METHODS

This present study consists of three experiments using tomato varieties listed in Table 1. The first and third experiments used the same varieties but not as all. In the second experiment all varieties were used.

### Experiment 1

This experiment was carried out in the dry season from September 2000 to January 2001 to determine the adaptability of Japanese processing tomato varieties as fresh fruit market varieties in Indonesia. Tomato varieties used in this experiment were Syouhou, Natsunokoma, Kagome 77, Red Kagome 932, NDM 051, NDM 153 and Arthaloka (indeterminate). Except for Arthaloka, all varieties are Japanese determinate varieties. Arthaloka is a local leading variety and used

**Table 1. Origin and type of tomato varieties used in the experiments**

| Variety | Origin of seed | Growth habit | Type |
|---|---|---|---|
| Syouhou | Nagano Prefecture Chushin Agricultural, Japan. | Determinate | Processing |
| Natsunokoma | NIVTS (National Research Institute of Vegetables and Tea Sciences), Japan. | Determinate | Processing |
| Kagome 77 (F1) | Kagome Company, Japan | Determinate | Processing |
| Red Kagome 932 (F1) | Kagome Company, Japan | Determinate | Processing |
| NDM 051 (F1) | Japan Delmonte Company | Determinate | Processing |
| NDM 153 (F1) | Japan Delmonte Company | Determinate | Processing |
| LV 3680 | AVRDC, Taiwan | Determinate | Processing |
| LV 3681 | AVRDC, Taiwan | Determinate | Processing |
| LV 3682 | AVRDC, Taiwan | Determinate | Processing |
| Opal | IVEGRI ( Inst. for Vegetables Research, Indonesia) | Determinate | Fresh tomato |
| Arthaloka | East West Seed Company, Indonesia | Indeterminate | Fresh tomato |

as a control. Tomato varieties were grown without pruning and supporting pole under a silver plastic film mulching condition, called creeping cultivation, a usual way to cultivate processing tomatoes. Arthaloka, with pruning and supporting pole, was grown as the standard standing cultivation variety for fresh fruit market. A randomized complete block design (RCBD) with 3 replicates was used. Spacing was 150 x 50 cm and plot size was 1.5 x 3 $m^2$. Fertilizer was applied at a rate of 10-10-10 g/$m^2$ of $N$-$P_2O_5$-$K_2O$ and sheep manure, at 2kg/$m^2$. Seed growing method involved the use of a mixture of soil and compost at a 1:1 ratio in banana leaf pots. The degree of outbreak of root knot nematode was determined using the following formula: Degree (No.) = (Heavy × 3+Medium × 2 + Light)/ (No. of all plants × 3) × 100.

**Experiment 2**

Experiment 2 was carried out during the rainy season from January to May 2001. In the seed growing method, a mixture of soil and compost at a 1:1 ratio in seedling trays was used. The varieties used in this experiment are listed in Table 1, namely, LV 3680, LV 3681, LV 3682 and Opal. Similar to experiment 1, the creeping cultivation method was employed. Each plot, with size of 1.2 x 5.0 $m^2$, consists of one row with 10 plants. Arthaloka was grown with supporting pole (stick) at 20 plants/ plot, in two lines. Fertilizer was applied at 7.5-7.5-7.5 g/$m^2$ of $N$-$P_2O_5$-$K_2O$ with 15-15-15 compound and sheep manure, at 3kg/$m^2$. The plots were covered with silver plastic mulch. Pests and diseases were controlled by application of Furadan, Sherpa, Antracol, Dithane, Ridomil and Curacron. During the experiment, the plants were attacked mostly by late blight because the weather was suitable for disease development.

Damage of every plant due to late blight was assessed weekly. The following symptom scale was employed (Yang, 1978).

0 = no late blight observable (plants look healthy)
1 = one leaf is infected
2 = 1/3 part of plant is infected
3 = 2/3 part of plant and or 1/3 part of stem is infected
4 = all parts of plant are totally infected and/ or 2/3 part of stem is infected
5 = all leaves and stems dead

Damage intensity formula employed is as follows:

$$I = \frac{\text{Sum}(n \times v)}{Z \times N} \times 100\%$$

Where: I = Intensity of damage
n = number of observed plants for every damage category
v = scale value of every damage category
Z = highest scale value for the damage category
N = number of observed plants

**Experiment 3**

Experiment 3 was carried out from May to October 2002 where comparison was done not only of tomato varieties, but also of seed growing methods using several media in seedling trays.
The media were as follows:

A= no NPK = Husk 2 + coconut fiber 1 + Lembang soil 1 + OKF-1
B= + NPK = Husk 2 + coconut fiber 1 + Lembang soil 1 + 0.5 g NPK granule + OKF-1
C= JIRCAS standard = Husk 1 + Lembang soil 2 + Manure 0.5 (horse manure)

OKF-1 is a liquid fertilizer and diluted at the rate of N 30 ppm and uses as irrigation water.

Tomatoes were grown using creeping cultivation at six plants per plot, with 0.5m spacing between plots. Arthaloka was grown with a supporting pole at 12 plants/ plot in two lines. The plots (1.2 x 3 m) were covered with silver plastic mulch. No replication was made. The plants were fertilized with was 7.5-7.5-7.5 g/$m^2$ of N-$P_2O_5$-$K_2O$ (15-15-15) and were manured with 3kg/$m^2$ sheep compost. Pest and diseases were controlled by application of Furadan, Sherpa, Antracol, Dithane, Ridomil and Curacron.

## RESULTS AND DISCUSSION

### Experiment 1

Yields of marketable and rotten fruits of test varieties are shown in Table 2 and Fig. 1. The highest total yield was obtained from Arthaloka variety (with stick). On the other hand, the yield of Arthaloka (without stick) was the third among the tested varieties but only half of standing cultivation. On the contrary, the number of rotten fruit or weights of Arthaloka were almost the same irrespective of using stick or not. Although Arthaloka is an indeterminate tomato variety and is not suited for creeping cultivation, total yield decrease and relative increase of rotten fruits for marketable fruits of creeping Arthaloka clearly indicate the disadvantage of creeping cultivation in terms of the amount of fruit production and healthy growth of fruits.

The total yields of all Japanese varieties were lower than that of Arthaloka (with stick), which is the standard of common tomato cultivation. But if labor-saving technology is taken into account, it is comparable with the creeping Arthaloka. On the other hand, the total yield of NDM 153 variety is close that of Arthaloka (without stick) and the marketable fruit yield was fairly better than Arthaloka (without stick). NDM153 and Natunokoma, a Japanese variety, were also better than Arthaloka (without stick) because they had low ratio of rotten fruits. The other Japanese varieties had absolutely low fruit production and consequently, low marketable fruit yield.

To determine the cause of low fruit productivity of Japanese varieties, plant growth and condition of root at the last harvesting time were observed and are shown in Table 3 and Fig. 2. Stem and waste, namely, top plant parts of the Japanese variety as were smaller than those of Arthaloka. Root weights of some Japanese varieties were bigger than or almost the same as Arthaloka, but the degree of damage by root-knot nematode (*Meloidogyne* sp) was more severe than those of Arthaloka. Damage of root system might decrease its function affecting the growth of top part more severely in Japanese varieties in proportion to the degree of root damage. Although NDM 051 variety gave the highest number of damaged plants, highest damaged root weight and the highest degree of outbreak, this variety has the heaviest root weight and as a result, it has reached medium yield level. Resistance of Japanese varieties to root knot nematode must be strengthened or must be cultivated in nematode free fields.

### Experiment 2

There were no symptoms of diseases in the field until 14 days after planting but late blight (*Phytophthora infestans*) started to attack the plants 15 days after transplanting (DAT), and it progressed afterwards as shown in Fig. 3. The symptoms appeared on foliage and fruit. Irregular greasy-appearing greyish areas developed on leaves. These areas expand rapidly during moist conditions and a white downy mold appeared at the margin of the affected area on the lower surface of leaves. Most of the flowers and fruits and even stems were attacked. Although foliar damage ranged from 50 - 75%, the damage observed then was generally severe, and the yields of all varieties were low, although they differed in detail. At 21 DAT, the development of the disease was almost lower than 20 % among Japanese varieties, at 35 DAT, 30 %, and at 49DAT 50%. On the other hand, AVRDC varieties and Indonesian varieties including Arthaloka suffered 20% foliar damage at 21 DAT, more than 30% at 35 DAT and up to 65 % at 49 DAT. Although the development of damage after 63 DAT varied among varieties, the Japanese varieties were found not weaker than the others.

Yields per area of tested varieties are shown in Fig. 4. As the population of Arthaloka (with stick) was twice as that of the others, its observed yield per plant becomes half of the others.

In this study, the yield potential of all varieties were generally low compared to the successful case where the yield potential could reach 7000 g/$m^2$. The highest yield was obtained from Arthaloka with stick (3272 g/

**Table 2. Yield of tomato varieties (per plant)cultivated using creeping method (Lembang, October 2000 - January 2001)**

| Variety | Rotten fruit | | Marketable fruit | | Small fruit | | Total yield |
|---|---|---|---|---|---|---|---|
| | No. | Weight (g) | No. | Weight (g) | No | Weight (g) | (g) |
| Arthaloka with stick | 11.9 | 489.3 | 20.5 | 1537.6 | 0.3 | 13.5 | 2040.4 |
| Arthaloka without stick | 14.2 | 505.3 | 10.0 | 635.7 | 0.1 | 4.9 | 1145.9 |
| Kagome 77 | 7.7 | 333.2 | 7.0 | 521.9 | 0.0 | 0.0 | 855.1 |
| Natunokoma | 12.3 | 271.1 | 18.1 | 711.0 | 1.7 | 34.3 | 1016.4 |
| NDM 051 | 8.5 | 193.9 | 15.1 | 758.6 | 0.0 | 0.0 | 952.5 |
| NDM 153 | 5.2 | 225.2 | 12.2 | 932.4 | 0.1 | 2.4 | 1160.0 |
| Red Kagome 932 | 8.4 | 280.7 | 8.3 | 449.8 | 0.1 | 1.2 | 731.7 |
| Syouhou | 9.7 | 421.1 | 5.1 | 360.1 | 0.0 | 0.0 | 781.2 |
| l.s.d. 5% | 5.2 | 207.6 | 6.2 | 396.5 | 0.9 | 19.6 | |
| F(Variety : A) | 22.3 | 19.9 | 55.7 | 51.5 | 6.8 | 8.4 | |
| F(Harvesting time : B) | 2.6 | 2.7 | 6.3 | 7.1 | 3.5 | 3.0 | |
| F(AxB) | 2.1 | 1.9 | 3.1 | 2.7 | 3.5 | 3.0 | |

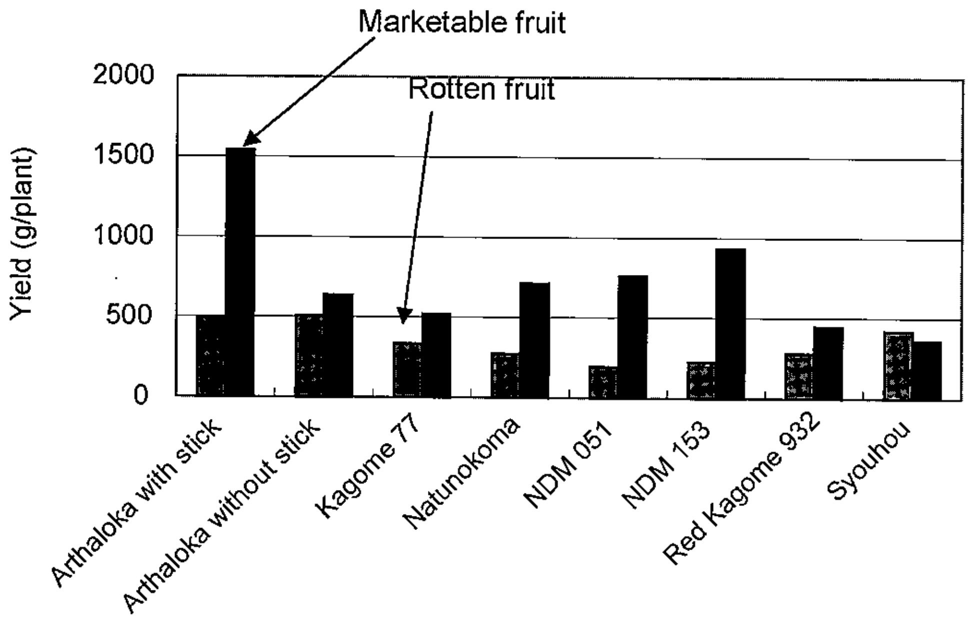


**Fig1. Yield of tomato varieties (Lembang, rainy season 2001)**

**Table 3. Damage of tomato root caused by root knot nematodes at last harvest time (Lembang, rainy season, 2001)**

| Variety | No.of plants | No. of damaged plant | | | | Root (g) | Damaged root (g) | | Stem/ waste (g) | Degree of Outbreak | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Heavy | Med. | Light | Healthy | | Heavy | Light | | No. | Wt |
| Arthaloka (with stick) | 5.0 | 3.0 | 1.3 | 0.7 | 0.0 | 140.1 | 60.4 | 18.2 | 60.7 | 82 | 48 |
| Arthaloka (without stick.) | 5.0 | 2.7 | 0.7 | 1.7 | 0.0 | 102.6 | 25.3 | 16.3 | 59.7 | 73 | 33 |
| Kagome 77 | 5.0 | 3.0 | 2.0 | 0.0 | 0.0 | 95.9 | 50.1 | 16.0 | 29.3 | 87 | 60 |
| Natsunokoma | 4.7 | 4.0 | 0.3 | 0.3 | 0.0 | 141.5 | 78.9 | 17.9 | 43.6 | 92 | 61 |
| NDM 051 | 5.0 | 4.3 | 0.7 | 0.0 | 0.0 | 159.6 | 113.7 | 13.2 | 31.5 | 96 | 75 |
| NDM 153 | 3.7 | 3.3 | 0.3 | 0.0 | 0.0 | 122.6 | 85.9 | 10.0 | 26.3 | 96 | 70 |
| Red Kagome 932 | 4.7 | 3.0 | 0.7 | 1.0 | 0.0 | 129.2 | 75.6 | 20.0 | 32.2 | 82 | 63 |
| Syouhou | 5.0 | 4.3 | 0.7 | 0.0 | 0.0 | 90.2 | 57.3 | 5.5 | 27.0 | 95 | 67 |
| l.s.d. 5% | 0.9 | 2.2 | 1.5 | 1.4 | | 71.3 | 58.2 | 10.7 | 20.0 | 21.7 | 17.2 |
| F value | 2.6 | 0.8 | 1.2 | 1.8 | | 1.1 | 1.9 | 1.9 | 4.5 | 1.3 | 5.6 |

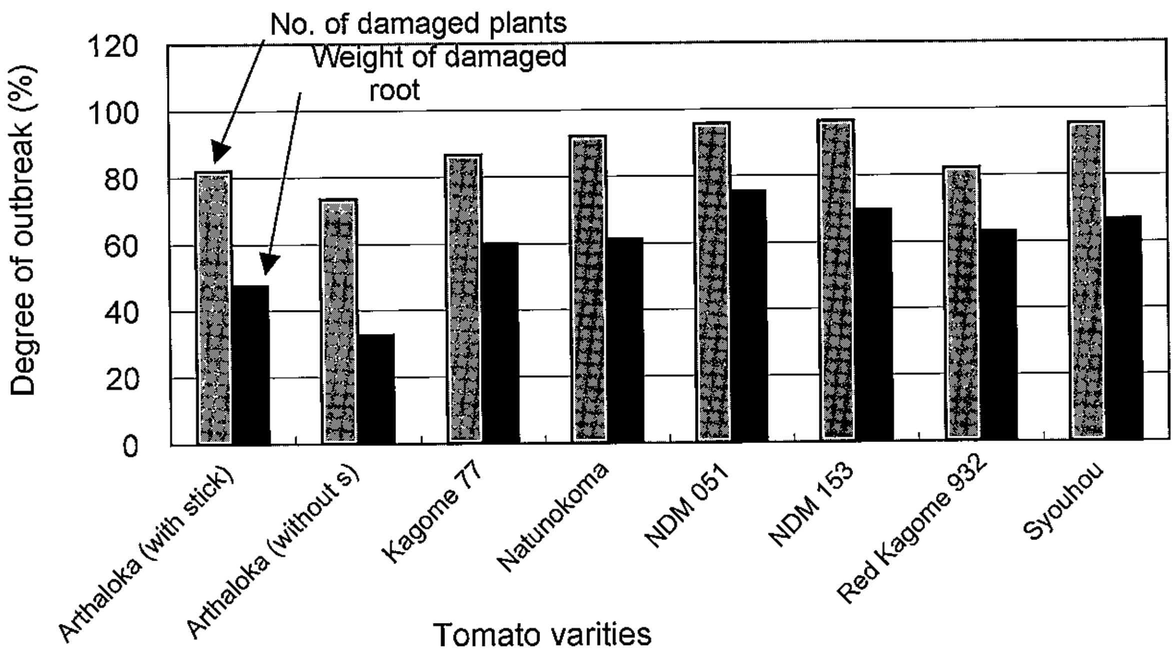


**Fig2. Damage of tomato roots caused by root knot nematodes**

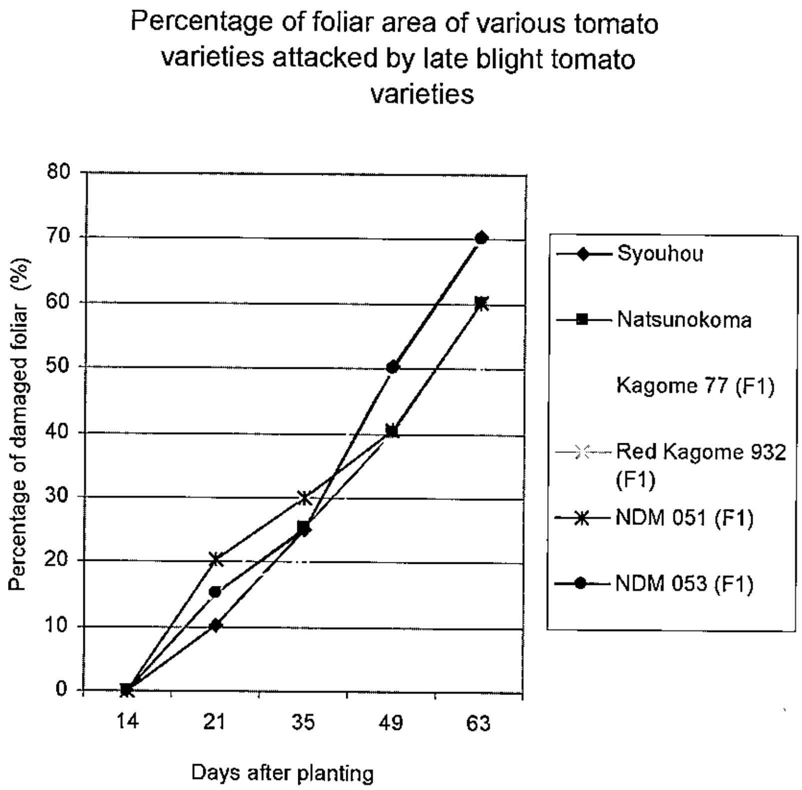


**Fig3a. Development of late blight on infected foliar area of Japanese tomato varieties (Lembang, rainy season 2001)**

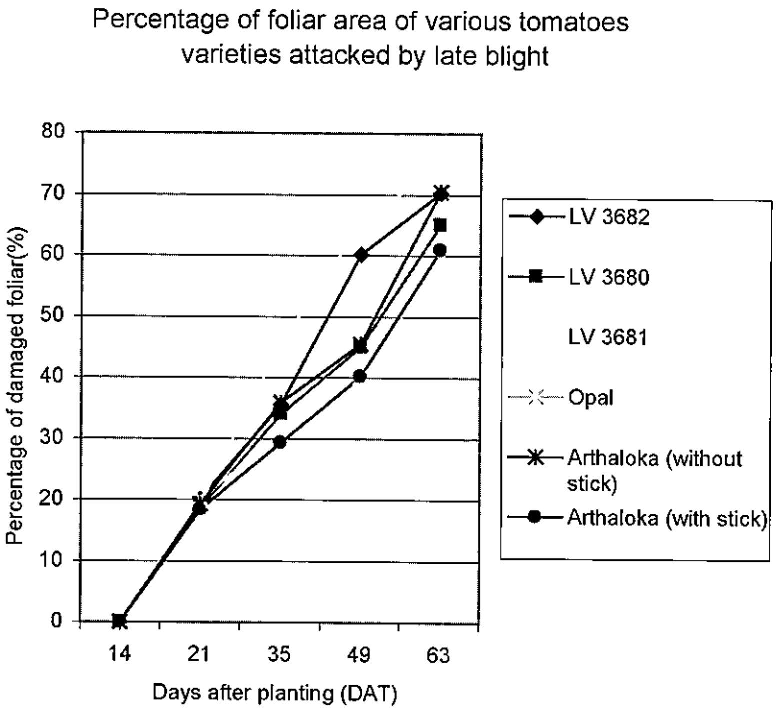


**Fig3b. Development of late blight on infected foliar area of Indonesian and AVRDC tomato varieties (Lembang, rainy season 2001)**

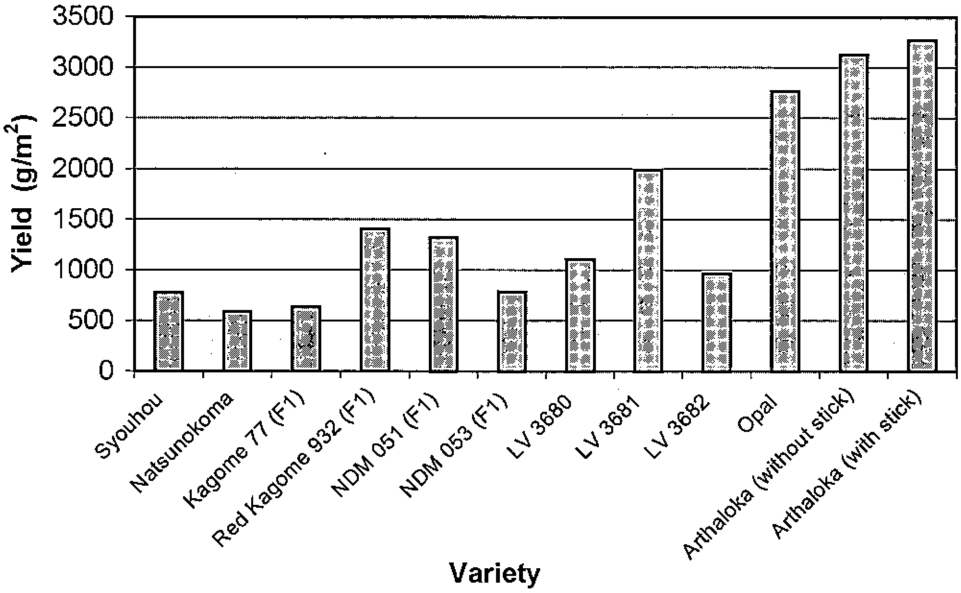


**Fig4. Yield potential (g/m2) of eleven tomato varieties**

$m^2$) and was almost the same as that of without stick (creeping). This indicates that creeping cultivation does not always decrease the productivity of an indeterminate variety. Opal was the third followed by LV3881 in terms of productivity. Yields of all Japanese varieties and some of AVRDC varieties were low. Among the Japanese varieties, the yield of NDM 153 and NDM 051 were higher but fairly lower than Arthaloka without stick, probably due to poor growth of top plant parts. As mentioned above, the damage of foliage due to diseases on Japanese varieties was not as severe as that of Indonesian varieties and therefore, the poor top growth of Japanese varieties could have been due to lower ability for foliage growth or weaker root system. In order to improve the productivity of Japanese varieties, foliage growth must be increased, which could be done through good seedling preparation and suitable field preparation including nematode control.

Fruit characteristics of tested varieties are shown in Table 4 and 5. Although firmness of the fruit is important to avoid the damage during transportation and circulation, the shape and color of Japanese varieties are acceptable to Indonesian fresh tomato market.

Quality requirements for processing tomatoes are specific, namely, high solids content, at least 4.5 degree Brix, pH lower than 4.4, firmness, easy peeling, crack resistance, and excellent red color (Villareal, 1980). If these characteristics were required, all tomato varieties in this experiment would have been considered not suitable as processing tomatoes. In Indonesia however, these could be used as cooking tomato. Arthaloka is suitable for long distance transportation because of its thick pericarp (6.4 mm) and firmness 4.3. The other varieties, such as Red Kagome 932 (F1), NDM 051 (F1), NDM 153 (F1) and LV 3680, with pericarp thickness of about 6 mm and firmness 2.7-4.3, could be suitable. However, the jelly content of NDM 153 (F1) is only 75% making its use for this purpose rather difficult. The worst variety for transportation was Opal, with firmness of 8.2 and pericarp thickness of 5.3 mm.

High TSS values and pH of Japanese varieties might give an impression of sweetness and could be evaluated as good tasting varieties.

**Experiment 3**

In this experiment, Japanese varieties were evaluated in terms of seedling growth by using three seedling raising media. Medium A consists of Husk 2, coconut fiber 1 and Lembang soil 1 with diluted liquid fertilizer irrigation. Medium B was the same as A but added with compound granule fertilizer. Medium C consists of a mixture of Husk 1, Lembang soil 2, Manure 0.5 (horse manure) and compound granule fertilizer without liquid fertilizer.

In Table 6, growth of seedlings in three kinds of nursery media is shown. Data on T/R ratio were obtained at transplanting time. Yield refers to total marketable fruit yield of the full season. R in the last line in the table refers to correlation coefficient between yields.

**Table 4. Characteristics of tomato varieties used in this study.**

| Variety | Fruit shape | Blossom end scar | Stem end scar | Locule number | Pericarp thickness (mm) |
|---|---|---|---|---|---|
| Syouhou | Plum | Dot | Medium | 3 | 5.6 |
| Natsunokoma | Plum | Nimpled | Medium | 2-3 | 5.9 |
| Kagome 77 (F1) | Oblate irregular | Stellate | Large | 4-7 | 4.9 |
| Red Kagome 932 (F1) | Deep oblate, irregular | Dot | Medium | 2-3 | 6.3 |
| NDM 051 (F1) | Plum | Dot | Large | 2-3 | 6.0 |
| NDM 153 (F1) | Plum | Nimpled | Large | 2.0 | 6.0 |
| LV 3682 | Round | Dot | Large | 2.0 | 5.7 |
| LV 3680 | Plum | Nimpled | Large | 2-3 | 6.5 |
| LV 3681 | Round | Stellate | Large | 3.0 | 5.6 |
| Opal | Plum | Dot | Small | 2-3 | 5.3 |
| Arthaloka | Square | Dot | Large | 2-4 | 6.4 |

**Table 5. Textural properties of tomato varieties used in the study.**

| Name | Jelly content (100%) | Firmness (mm/sec/50 g) | TSS (°Brix) | pH |
|---|---|---|---|---|
| Syouhou | 100 | 3.8 | 4.6 | 5.0 |
| Natsunokoma | 100 | 3.8 | 5.0 | 4.6 |
| Kagome 77( F1) | 100 | 4.9 | 5.0 | 5.2 |
| Red Kagome 932 (F1) | 100 | 2.7 | 5.2 | 4.8 |
| NDM 051 (F1) | 100 | 4.1 | 5.2 | 5.2 |
| NDM 153 (F1) | 75 | 4.3 | 5.4 | 4.7 |
| LV 3682 | 100 | 4.4 | 4.4 | 4.8 |
| LV 3680 | 100 | 3.2 | 3.6 | 4.1 |
| LV 3681 | 100 | 2.3 | 4.2 | 4.5 |
| Opal | 100 | 8.2 | 3.8 | 3.8 |
| Arthaloka (without stick) | 100 | 3.6 | 4.0 | 3.6 |
| Arthaloka (with stick) | 100 | 4.3 | 4.0 | 4.8 |

Seedling raising medium strongly affected seedling growth and resulted to significant differences in all characters of seedlings. For all characters studied, media B gave the highest value and media A gave lowest. In terms of yield, all media gave the same but not significant. Moreover, Table 6 showed that each character of seedlings did not have significant correlation with the yield except for T/R (shoot root ratio). The results obtained did not indicate the importance of seedling raising media because all varieties increased their yields especially Japanese varieties compared to experiment 1. The tree seedling raising media used in these experiments were selected from another experiment as better media.

Fig. 5 shows the scatter diagram of relationship between T/R and tomato yield/plant. It indicated that increase in T/R was relevant to increasing tomato yield per plant. We assume that small T/R ratio has an advantage for establishing plant rapidly when seedlings were transplanted in the field as the relatively large root system might support the top part more firmly than large T/R seedlings. But in this experiment, the results were opposite. When plug trays were used for raising seedlings, large T/R value indicated the ability of rapid growth under limited conditions In order to obtain high yield, good foliage growth has been recognized as necessary as was shown in experiment 1 and 2. Moreover, tomato plants have strong resistance for drought and the large T/R value obtained under this condition, which indicate vigorous foliage growth

**Table 6. Effect of seedling raising media on the growth of tomato seedlings and yield.**

| Variety | No. of leaves | Plant length (cm) | Top (fresh) weight (g) | Top (dry) weight (g) | Root (dry) Weight (g) | T/R | Yield/ plant (g) |
|---|---|---|---|---|---|---|---|
| Arthaloka | 2.8 | 15.9 | 1.1 | 0.16 | 0.038 | 4.06 | 1725 |
| B | 3.7 | 27.7 | 4.5 | 0.37 | 0.061 | 6.05 | 2166 |
| C | 3.7 | 24.9 | 3.0 | 0.30 | 0.055 | 5.98 | 2082 |
| l.s.d. 5% | 0.5 | 3.6 | 1.2 | 0.09 | 0.014 | 1.19 | 521 |
| Syouhou | 3.9 | 25.5 | 2.8 | 0.30 | 0.059 | 5.01 | 1961 |
| Natsunokoma | 3.8 | 20.0 | 2.5 | 0.24 | 0.050 | 4.66 | 1408 |
| Kagome 77 | 3.7 | 24.3 | 4.0 | 0.36 | 0.066 | 5.23 | 1866 |
| Red-Kagome | 3.4 | 23.2 | 2.9 | 0.28 | 0.049 | 5.39 | 1630 |
| NDM-051 | 3.4 | 23.3 | 3.6 | 0.36 | 0.069 | 5.09 | 2017 |
| NDM-153 | 3.2 | 24.6 | 2.9 | 0.27 | 0.050 | 5.19 | 2461 |
| Arthaloka | 2.4 | 19.0 | 1.3 | 0.12 | 0.018 | 6.99 | 2595 |
| l.s.d. 5% | 0.7 | 5.6 | 1.8 | 0.14 | 0.021 | 1.81 | 796 |
| F value (Media) | 13.1 | 27.2 | 18.7 | 12.8 | 7.2 | 8.6 | 1.9 |
| F value (Variety) | 4.7 | 1.8 | 2.0 | 3.2 | 6.3 | 1.6 | 2.7 |
| R | -0.11 | 0.26 | 0.07 | 0.04 | -0.10 | 0.55 | |

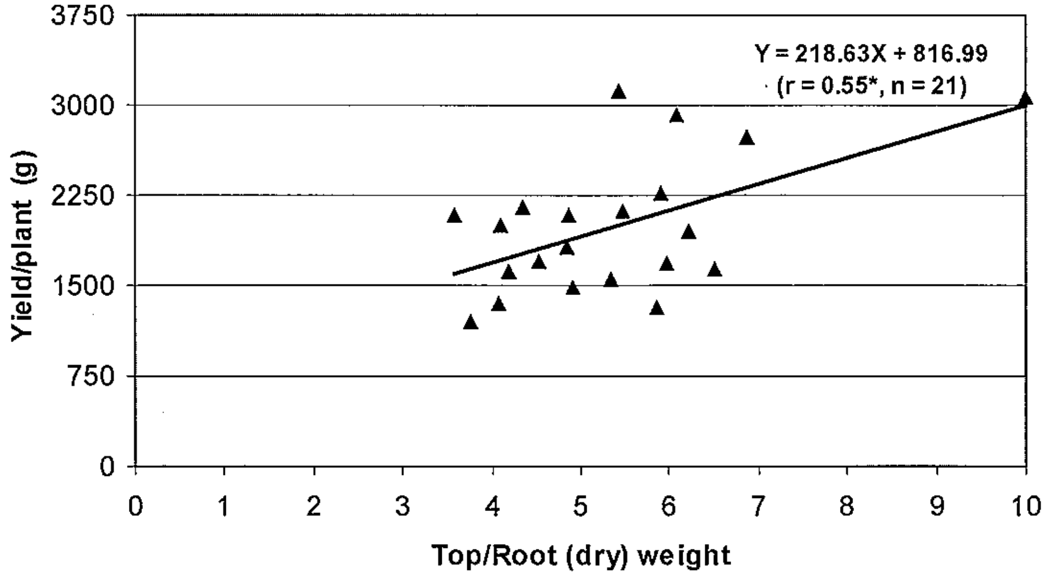


**Fig5. Relationship between T/R and yield/plant of tomato**

ability, can be desirable characters important to obtain high yield in Java highlands.

Tomato fruit characters are shown in Table 7. The quality requirements for processing tomatoes as previously mentioned are: (1) solid content (TSS) higher than 4.5° Brix (2) pH is lower than 4.4. The pH of all varieties and all treatments as shown in Table 7 were fairly lower than 4.4, while the total soluble solid contents (TSS) varied among varieties and treatments. In B medium, Natsunokoma was the only variety that can clear the quality requirement for processing tomato. While in A medium, NDM 153, Arthaloka (with stick) and Arthaloka (without stick) were suitable and in C medium, NDM 153 and Arthaloka (without stick) were found suitable for processing tomato.

**Table 7. Textural properties of tomato varieties used in this study (Lembang, July 2002)**

| Treatment /Variety | Jelly contain (%) | Firmness | TSS ( °Brix) | PH | Pericarp thickness (mm) |
|---|---|---|---|---|---|
| Syouhou | | | | | |
| A | 100 | 2.67 | 4.43 | 2.60 | 6.40 |
| B | 100 | 2.73 | 4.00 | 2.52 | 5.85 |
| C | 100 | 1.90 | 3.90 | 2.52 | 5.14 |
| Natsunokoma | | | | | |
| A | 98 | 2.97 | 4.30 | 2.50 | 5.10 |
| B | 96 | 3.03 | 5.03* | 2.60 | 5.20 |
| C | 100 | 2.93 | 3.50 | 2.70 | 4.73 |
| Kagome 77 | | | | | |
| A | 100 | 1.80 | 4.37 | 2.40 | 5.48 |
| B | 100 | 2.50 | 4.12 | 2.44 | 4.63 |
| C | 100 | 2.90 | 3.97 | 2.43 | 6.73 |
| Red Kagome 932 | | | | | |
| A | 100 | 2.37 | 4.00 | 2.67 | 5.87 |
| B | 100 | 2.60 | 4.38 | 2.63 | 5.89 |
| C | 98 | 2.60 | 4.26 | 2.58 | 6.12 |
| NDM 051 | | | | | |
| A | 93 | 2.80 | 4.37 | 3.00 | 7.90 |
| B | 100 | 2.37 | 4.26 | 2.78 | 5.62 |
| C | 100 | 2.27 | 4.18 | 2.68 | 5.71 |
| NDM 153 | | | | | |
| A | 90 | 2.73 | 4.87* | 2.63 | 7.22 |
| B | 80 | 1.40 | 4.36 | 2.76 | 7.19 |
| C | 93 | 3.07 | 4.52* | 2.78 | 6.57 |
| Arthaloka (stick) | | | | | |
| A | 100 | 2.70 | 4.73* | 2.43 | 6.88 |
| B | 100 | 2.70 | 5.35 | 2.55 | 6.35 |
| C | 100 | 2.63 | 4.37 | 2.57 | 6.83 |
| Arthaloka (without stick) | | | | | |
| A | 100 | 3.33 | 5.10* | 2.60 | 6.33 |
| B | 100 | 2.73 | 4.47 | 2.67 | 7.10 |
| C | 100 | 3.10 | 4.77* | 2.50 | 6.07 |

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