

Physicochemical Properties and Yield of Tomato Varieties under Plastic House Condition

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Abstract

Seven tomato varieties, Ahmita, BL-410, Ceres, Dalila, Makish, Srijana and Winsari were evaluated for physicochemical properties and fruit yield under plastic house condition during rainy seasons of two consecutive years 2012 and 2013 at the Regional Agriculture Research Station, Lumle, Kaski. The experiment was laid out in a complete randomized block design with four replications. The physicochemical analyses revealed that BL-410 had the highest total soluble solid (5.22 °Bx) while Srijana had the highest titratable acidity (0.903%) and vitamin C content (32.32 mg/100 g). It showed that Srijana was the most useful variety from nutritional perspective. BL-410 took least time to flowering (22.00 days), fruiting (28.00 days) and first harvesting (72.00 days) after transplanting. Ahmita produced maximum number of fruits per cluster (8.43). Ceres produced largest size (122.0 g) fruit while Winsari measured the tallest plant (120.5). Winsari produced highest marketable yield (105.8 t ha⁻¹). Thus, it has been recommended for commercial production. Srijana, which has highest nutritional value needs to be promoted with increasing its productivity.

Key words: physicochemical, plastic house, rainy season, tomato

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the major commercial vegetable crops and widely grown both in the Tarai and hills of Nepal. It is cultivated in 16,416 ha land in Nepal with a total production and productivity of 2, 82,481 and 17.71 t ha⁻¹ respectively (VDD 2013). It cannot be grown in the plains during June-October owing to high temperature and stagnation of water in the field during rainy season. Plastic house technology and hybrid varieties have increased the possibility of tomato cultivation during rainy season in high hills (Chapagain *et al.* 2011). Plastic house tomato cultivation technology is one of the successful technologies verified at Nepal Agricultural Research Council (NARC) and widely adopted by commercial farmers in western mid hills. However, continuous flow of new hybrid varieties and uncertainty of availability of desired varieties have created a dilemma among the farmers while selecting suitable tomato varieties. It emphasized the need for

continuous varietal evaluation and provide sufficient varietal options for farmers. Moreover, varietal recommendation along with their physicochemical properties provides additional opportunity in varietal selection.

The growth environment of a tomato variety affects its composition (Caliman *et al.* 2010). The most important quality criteria for tomatoes in Nepal are red color, firm, juicy texture, and good flavor (Karki 2005). These characteristics are manifested in total soluble solids (TSS), juice content, acidity, vitamin C content, etc. Total solids content of cultivated tomato amount to 4.5 to 8.5% of its fresh weight (André *et al.* 2005), though this percentage can be much higher in some wild species (Bertin *et al.* 2000). Glucose and fructose are the major components of the soluble solids (Malundo *et al.* 1995). Total soluble solids contents (TSS) are important for the industrialization process as product yield is directly related to °Brix, especially

when the objective is dehydration, concentration of the pulp, or both (Stevens 1972). Lycopene, ascorbic acid (vitamin C), and potassium contents are important for the nutritional value of tomato; they have beneficial effects on human health (Caliman *et al.* 2010). Tomatoes with high sugar and relatively high acid contents are the best flavored; low sugar and acid contents result in poor flavored tomatoes (Cantwell 1994). Vitamin C plays an important role in human health and it is found in fruits and vegetables in the form of ascorbic acid. Its main functions are in the prevention of scurvy and maintenance of skin and blood vessels (Lee & Kader 2000).

Methodology

The experiment was conducted at the Regional Agricultural Research Station, Lumle (1640 m), Nepal. Six tomato hybrids namely; Makis, Ahmita, Dalila, Srijana, Ceres, Winsari and one open-pollinated variety (BL-410) were evaluated in randomized complete block design with four replications for two consecutive years, 2012 and 2013. Individual plot size was 7 m² (2.8 x 2.5 m) with planting geometry of 70 x 50 cm. Twenty-five days old seedlings were transplanted during the second week of July, 2012 and 2013. The size of plastic house was 6 m wide and 20 m long with 2.80 m height at the center and 2 m at the side pole from soil surface. White coloured Silpaulin with the thickness of 120 g per square meter (GSM) was used as roofing material. Compost at the rate of 30 t and NPK 75:100:100 kg ha⁻¹ were applied as basal dose during field preparation and additional dose of nitrogen 75 kg ha⁻¹ was applied as top dressing at 30 days after transplanting. In addition, Miraculan was applied at the rate of 5 ml per liter of water at monthly intervals after transplanting. Irrigation was done as and when necessary. Observations on days to flowering and harvest, number of clusters per plant, fruit diameter, average fruit weight, plant height and marketable fruit yield were recorded. Fruit samples were collected and analyzed at the Food Technology Division, NARC, Khumaltar for total soluble solids (TSS), total titratable acids (TTA), juice content and vitamin C.

Determination of total soluble solids (TSS), vitamin-C and acidity

The TSS were measured by using Abbe refractometer and the values were corrected to 20°C. The titratable acidity (as anhydrous citric acid) was determined by titrating the sample solution with 0.1 N of NaOH using

Phenolphthalein as an indicator. The vitamin-C content was determined by 2,6-dichlorophenol-indophenol visual titration method (Ranganna 1997).

Diseases and insects pests were observed regularly in tomatoes. Kryloxyl (Metalaxyl 8% and Mancozeb 64% a fungicides) was sprayed at the rate of 2g/ liters at 15 days interval after first observation of late blight disease. Imidacloprid was sprayed at the rate of 0.25 ml/ liter of water twice during the cropping season for controlling the white flies.

Analysis of variance (ANOVA) was computed for determining significance levels of variation among the treatments using Genstat Discovery Edition 3 (Genstat 2007) software. The significance of differences among treatment means were tested using Duncan's Multiple Range Test (DMRT) through MSTAT computer software (MSTAT 1990).

Results and Discussion

Chemical properties of tomato varieties

Significant variation was recorded in total soluble solid (TSS), titratable acidity and vitamin C content among tomato varieties in pooled analysis of variance (Table 1). However, juice content did not vary. The highest juice content (69.00 %) was recorded from Ceres and the lowest from Makish (54.80 %). The TSS ranged from 5.22 to 4.05 °Bx. The highest TSS was obtained from open pollinated var. BL-410 and the lowest from Winsari. BL-410 could be useful for processing industry. In the industry, this parameter dictates the factory yield in which the highest tomato total solids content amount to less tomato to be used to produce processed tomato product (Aoun, 2013).

Vitamin C content and the titratable acidity ranged from 32.32 to 16.52 mg 100 g⁻¹ and 0.903 to 0.495% respectively. The highest titratable acidity and vitamin C were obtained from Srijana. The result indicated that Srijana could be a useful variety from nutritional perspective. In addition, it has been known that higher fruit acidity is an advantage as it lowers the incidence for fungal infection in tomato (Mohammed *et al.* 1999).

The chemical composition obtained from the study was greater than those reported by Karki (2005) from open field condition in tomato var. Abinash-2. It could be due to the differences of tomato varieties and production condition. The growth environment of affects the compositions of tomato fruits (Caliman *et al.* 2010).

Table 1. Mean values for chemical properties of tomato varieties under plastic house at Lumle during the years 2012 and 2013

Varieties	Juice content (%)	Total soluble solid ($^{\circ}$ Bx)	Vitamin C (mg 100 g ⁻¹)	Titrate acidity (%)
Ahmita	58.10 [†]	5.15a	17.68bc	0.801ab
BL 410	68.30	5.22a	16.52c	0.857a
Ceres	69.00	4.23ab	17.10c	0.552bc
Dalila	59.80	4.95ab	22.03b	0.739abc
Makis	54.8	4.93ab	20.65bc	0.777abc
Srijana	67.30	5.20a	32.32a	0.903a
Winsari	60.60	4.05b	16.67c	0.495c
Mean	62.50	4.82	20.42	0.732
P value	0.309	0.05	<.001	0.025
LSD (0.05)	-	0.888	4.216	0.2588
CV(%)	19.5	15.5	17.4	29.8

[†] Mean of 4 replications. In the columns means followed by the same letter are not significantly different ($p < 0.05$) by DMRT

Vegetative, flowering and fruit characteristics

Pooled analysis of variance carried out for all the characters differed significantly (Table 2). The tallest plant height (120.50 cm) was recorded in Winsari followed by Srijana (118.40 cm). The variety BL-410 took the least time to flowering (22.00 days), followed

by Makis (26.00 days) and Winsari (26.00 days). Similarly, the cultivar BL-410 took 72.00 days to the first harvest and thus was the earliest one, while Dalila was the late variety taking 80.00 days for the first harvest after transplanting. The days to first harvest was envisaged as an index of earliness.

Table 2. Mean values for plant and yield contributing characteristics of tomato varieties under plastic house at Lumle during the years 2012 and 2013

Varieties	Plant height (cm)	Days to first flowering	Days to 50% flowering	Days to first fruiting	Days to first harvesting	Fruits/cluster	Average fruit weight (g)
Ahmita	108.6ab	28.00a [†]	30.83abc	33.67a	78.00abc	8.43a	40.3d
BL 410	105.0bc	22.00b	27.83d	27.50b	71.50d	6.43c	51.5cd
Ceres	114.9ab	27.83a	31.50abc	32.50a	79.00ab	7.00bc	122.0a
Dalila	93.1c	28.17a	32.67ab	33.17a	80.00a	7.37bc	53.3cd
Makis	92.2c	25.50a	33.33a	30.17ab	75.33bc	7.17bc	63.3c
Srijana	118.4ab	26.50a	30.33bcd	30.50ab	75.00cd	7.57ab	53.3cd
Winsari	120.5a	25.67a	29.50cd	31.00ab	78.50abc	7.80ab	80.7b
Mean	107.5	26.24	30.43	31.21	76.76	7.40	66.3
P value	<.001	<.001	.012	0.004	<.001	<.004	<.001
LSD (0.05)	12.64	3.538	2.381	0.898	3.545	0.898	15.30
CV (%)	9.9	8.0	6.6	10.2	3.9	10.2%	19.4

[†] Mean of 4 replications. In the columns means followed by the same letter are not significantly different ($p < 0.05$) by DMRT

Number of clusters per plant, number of flowers per cluster, and fruits per plant are the most important yield attributes in tomato (Pandey *et al.* 2006). Among the varieties tested, the maximum numbers of fruits per cluster (8.43) were observed in Ahmita while the largest average size of fruit (120.5 g) was recorded from Ceres. The trend observed in the results indicates that the higher yield depends on the number of fruits and weight of fruits per plant as well as earliness. It was apparent that fruit number and weight per plant showed a positive association with fruit yield of tomato.

Marketable fruit yield (t ha⁻¹)

Pooled analysis of variance among the varieties on marketable fruit yield was highly significant (Fig. 1). Winsari produced the highest marketable fruit yield (105.80 t ha⁻¹) followed by Ceres (99.9 t ha⁻¹). Marketable fruit yield is the major determinant character while selecting a particular variety for commercial cultivation (Chapagain *et al.* 2011). Winsari is very popular in the western hills of Nepal due to its productivity and medium sized fruits.

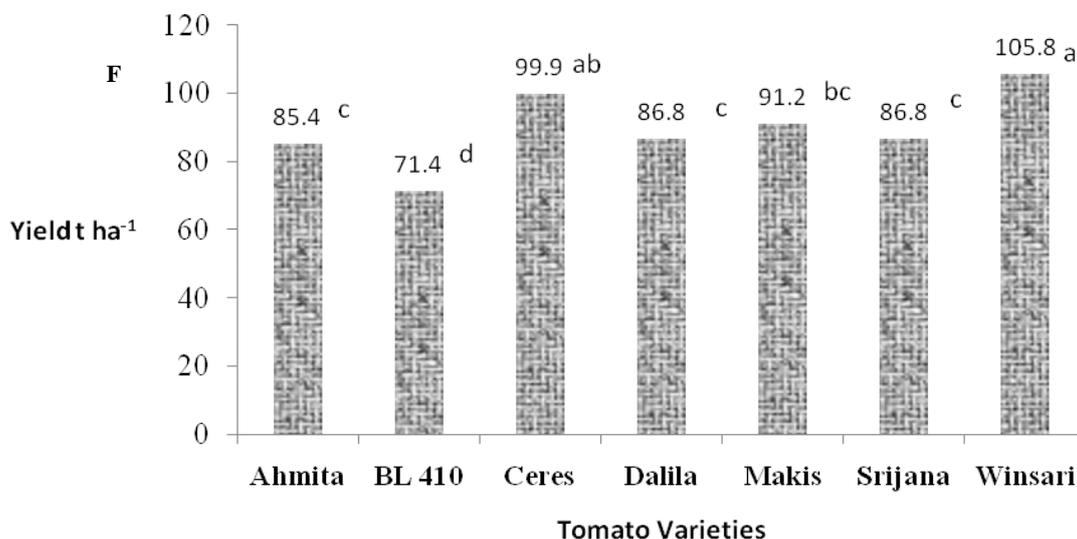


Fig. 1. Mean values for marketable fruit yield (t ha⁻¹) of tomato varieties under plastic house at Lumle, during the years 2012 and 2013. In the figures same letters are not significantly different by DMRT at $P=0.05$

The greater TSS properties of BL-410 could be utilized in breeding program to increase the TSS of commercial varieties. Winsari, which produced the highest marketable fruit yield, is one of the popular varieties in Kaski district and should be up-scaled in similar agro-climatic zones of Nepal. Srijana having excellent nutritional value, needs further promotion with increasing its productivity. Further research on agronomical practices and varietal evaluation of tomatoes is needed to increase the productivity in plastic house production system.

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