

Original Research Paper

Preliminary Study of Tomato Hybrids for Yield and Morphological Quality Attributes Under Khumaltar Condition, Nepal

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Article history

Received: 15-06-2019

Revised: 04-09-2019

Accepted: 19-11-2019

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Abstract: An experiment was conducted to evaluate tomato hybrids (*Lycopersicon esculentum*) for qualitative attributes of tomato fruits in Horticulture Research Division, Nepal Agriculture Research Council, Khumaltar, Lalitpur, Nepal. Fruits from newly developed eleven hybrids from council and an existing popular tomato hybrid, “Srijana” were selected to evaluate and characterize yield and quality attributes. In this study vegetative character, fruit quality parameters and yield of tomato hybrids were observed and recorded. Fruit quality parameters of each hybrids were distinctly varied with each other. Indeterminate growth habit was observed from HRA 13× HRD 7, HRA 14× HRD 7, HRA 17× HRD 1, HRA 17× HRD 1, HRA 20× HRD 4, HRA 20× HRD 1 and Sirjana while HRA 15× HRD 6, HRA 16× HRD 1, HRA 16× HRD 4 and HRA 20× HRD 6 showed determinant type of growth habit. The total fruit yield per hectare ranged from 80.83 ton/ha (HRA 14× HRD 7) to 45.89 ton/ha (HRA 15× HRD 6). Yield of hybrids HRA 13× HRD 7, HRA 13× HRD 7, HRA 20× HRD 1, HRA 20× HRD 2, HRA 20× HRD 6 and HRA 16× HRD 1 had 78.50 ton/ha, 73.75 ton/ha, 70.44 ton/ha, 68.72 ton/ha, 64.64 ton/ha respectively which were superior to an existing popular variety, Srijana (62.33 ton/ha). Hybrids having indeterminate growth can be recommended for plastic house cultivation and hybrids with determinate growth habit will be suitable for seasonal cultivation. Study on consumer preference and multiyear multi location trial of the good performer hybrids is to be done before recommendation and promotion of these hybrids in Nepal.

Keywords: Evaluation, Hybrid, Tomato, Yield

Introduction

Nepal is nearly self dependent on fresh tomato as compared to other vegetables and spices. Among total cultivated area, 21389 ha is covered by tomato with production of 400674MT (MOALD, 2018). While studying feasibility of tomato cultivation, 22 districts are considered as potential district for tomato production in Nepal (NARC, 2013). Productivity of tomato in Nepal is less, 19 ton/ha (MOALD, 2018) as compare to other countries. One of the major reasons behind the low productivity is due to the unavailability of suitable high yielding variety (Shrestha and Sah, 2014). Some constraints like pest, diseases, expensive inputs and difficulties associated with breeding techniques have

also contributed to lower productivity of tomato in Nepal. In Nepal, hybridization program is limited to very few crops including tomato. Only one tomato hybrid “Srijana” is developed and commercialized in Nepal. Most of the hybrid varieties are comes from other countries (Gairhe *et al.*, 2016) which may not meet the consumer demand in term of quality, taste and looks. Gradual varietal deterioration of Srijana hybrid is also reported however it is popular among producers and preferred by consumer due to its attractive size and shape (Devkota *et al.*, 2018). Farmers of rural areas are facing problem of getting desirable varieties during planting season and selecting new hybrids what is available in market cannot ensure quality of consumer’s choice product (Timsina and Shivakoti, 2018; Magar, 2015;

Adhikari, 2017; Rai *et al.*, 2019). To increase tomato production, development of hybrid varieties having desirable characters has proven to be an effective strategy (Islam *et al.*, 2012). According to Chaudhary and Khanna (1972) yield of open pollinated tomato is 20 to 25% less as compared to hybrids (Islam *et al.*, 2012). Varietal development and continuous evaluation is needed for providing sufficient varietal options for the producers (Chapagain *et al.*, 2014). Therefore research should be oriented to develop high yielding tomato varieties which also meet the demand consumer in reference with fruit quality.

Materials and Methods

The experiment was conducted in Horticultural Research Division of Nepal Agricultural Research Council, Khumaltar, Lalitpur (Fig. 4). Experimental design was Randomized Complete Block Design (RCBD) with 12 treatment and 3 replications having 36 numbers of plots. Among twelve treatments; Srijana and eleven other hybrids (F_1), developed by crossing HRD and HRA lines were selected as treatments for the experiment. There were altogether twelve F_1 hybrids of tomato. Chemical fertilizer was applied at the rate of 200:150:150(NPK) kg per ha and 15 ton FYM. Full dose of FYM, DAP and MOP were used as basal dose. Urea was applied 5 gram as a basal dose before transplanting by making small pit and 5.5 gram as split dose per plant applied during cultural practices 35 days after transplanting. Fruits from different hybrids were harvested from randomly selected plants for characterization and randomly selected plants were selected to measure other vegetative characters. Classification of plants and fruit was done with reference of descriptor for tomato (*Lycopersicon* spp.) published by International Plant Genetic Resource Institute (IPGRI). While evaluating tomato hybrids some traits are also classified by taking reference of researches done in Nepal Agriculture Research Council (NARC). Data were analysed by MSTATC soft ware and mean separation was done by Duncan multiple range test at 0.05 LSD level. Soil test was not done before transplanting but land was cultivated land and used to have two crops a year in crop rotation. Soil fertility used to have medium fertility level; NPK availability and pH 5.5 to 6.5 with sandy loam soil structure.

Results and Discussion

Climatic Condition of Experimental Site

The experimental site was characterized by three distinct seasons; the rainy season (May to October), the winter (November to February) and the spring (March to

April). The agro meteorological data for the crop growing period was obtained from Agrometeorological station of NARC, Khumaltar. Climatic condition of experimental site is shown by Fig. 1 and 2.

Growth Habit of Tested Hybrids

Indeterminate type of growth habit was found in HRA 13×HRD 7, HRA 14×HRD 7, HRA 17×HRD 1, HRA 20×HRD4, HRA 20×HRD1 and Srijana whereas HRA 18×HRD 2 and HRA 20×HRD 2 exhibited semi determinate type of growth habit (Table 1). Hybrids HRA 15×HRD 6, HRA 16×HRD 1, HRA 16×HRD 4 and HRA 20×HRD 6 were characterized as determinate type among tested hybrids. Growth habit was identified after its almost final growth period. Gairhe *et al.* (2016) and Magar *et al.* (2016a) also observed similar growth habit of Srijana in their study.

Leaf Angle of Tested Hybrids

According to the angle made by leaf to the stem, hybrids were classified as semi erect, horizontal and drooping type. Hybrids HRA 20×HRD 4 and HRA 20×HRD1 showed drooping type of leaf, hybrids HRA 17×HRD 1, HRA 20×HRD 2 and Srijana showed horizontal type of leaf while rest of other hybrids showed semi erect type of leaf (Table 1).

Plant Size of Tested Hybrids

Hybrids HRA 15×HRD 6, HRA 16×HRD 1, HRA 16×HRD 4 and HRA 20×HRD 6 are classified as small sized, intermediate size of plant were found in HRA 14×HRD 7, HRA 17×HRD 1, HRA 18×HRD 2 and HRA 20×HRD 2 whereas HRA 14×HRD 7, HRA 20×HRD1 and Srijana are classified as large sized varieties (Table 1).

Color of Immature Fruit

Green color of immature fruits were found in hybrids HRA 20×HRD 2 and Srijana while genotype HRA 20×HRD 4 showed greenish white and whitish green colored immature fruits were common in hybrids HRA 16×HRD 4 and HRA 17×HRD 1. Rest of all hybrids showed light green colored immature fruits (Table 1 and Fig. 3).

Color of Fruits After Ripening

Fruits of hybrids HRA 15×HRD 6 and HRA 16×HRD 1 attained orange red color while ripening. Red color was common in HRA 13×HRD 7, HRA 14×HRD 7, HRA 16×HRD 4, HRA 17×HRD 1 and HRA 18×HRD 2 and HRA 20×HRD 2, HRA 20×HRD 6, HRA 20×HRD1 and Srijana produced dark red colored ripened fruits (Table 1 and Fig. 3).

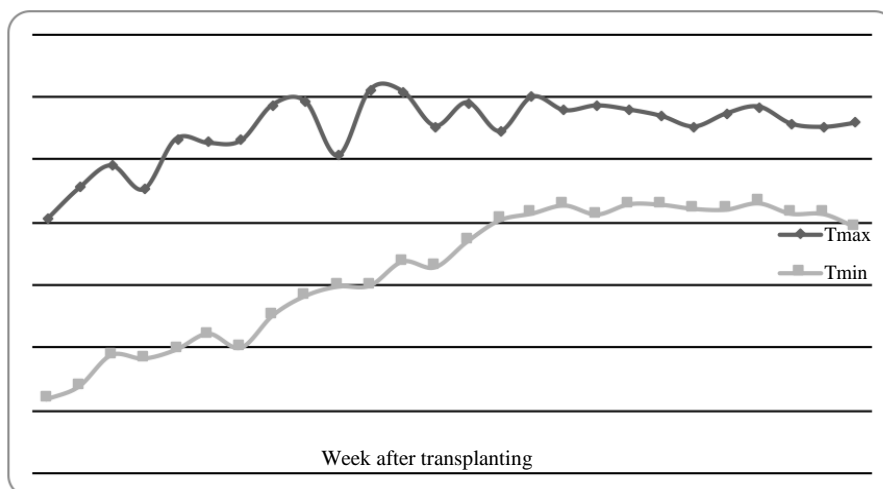


Fig. 1: Weekly maximum and minimum temperature during field trial at Khumaltar

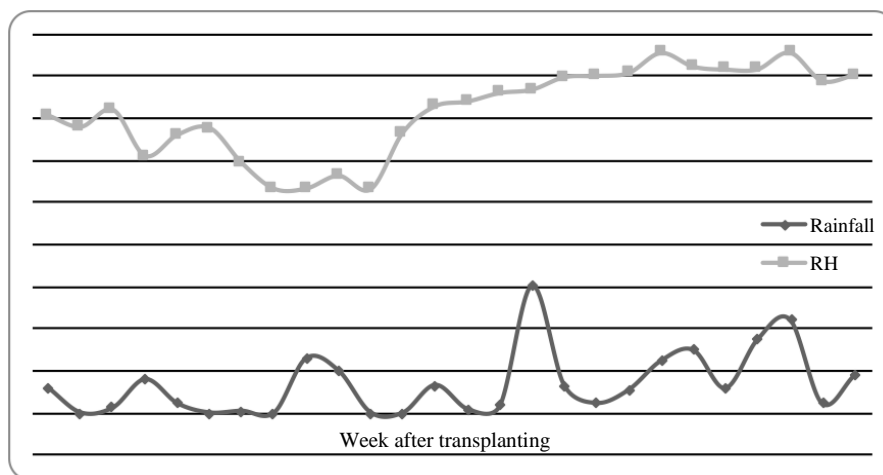


Fig. 2: Relative humidity and rainfall pattern during study period at Khumaltar

Shape of the Fruit

According to the shape, fruits are classified as round, slightly flattened, oval and flat. Hybrids HRA 13× HRD 7, HRA 18× HRD 2 and HRA 20× HRD 6 exhibited round shaped, HRA 15× HRD 6, HRA 20× HRD 2, HRA 20× HRD1 and Srijana exhibited oval shaped, hybrids HRA 14× HRD 7, HRA 16× HRD 4, HRA 20× HRD 4 slightly flattened shaped and 4 showed flat shaped fruits (Table 1 and Fig. 3).

Shoulder Shape of Fruit

Fruits of genotype HRA 16× HRD 4 formed had flat shape of shoulder while fruits of HRA 16× HRD 1 and HRA 17× HRD 1 showed moderately depressed shape of shoulder. Rest of all hybrids is classified as slightly

depressed type of fruit according to the shoulder shape of the fruit (Table 1 and Fig. 3).

Type of Fruits

HRA 16× HRD 1, HRA 16× HRD 4, HRA 17× HRD 1 and HRA 20× HRD1 produced salad type of fruits while rest of all hybrids produced juicy fruits (Table 1).

Cross Sectional Shape of the Fruit

Fruits having round cross section were observed from the hybrids HRA 13× HRD 7, HRA 15× HRD 6, HRA 20× HRD 2, HRA 20× HRD 6 and HRA 20× HRD1 whereas all other hybrids yield fruits having irregular cross sectional area while cutting individual fruit horizontally (Table 1 and Fig. 3).



Fig. 3: Hybrids showing morphological fruit characteristics.



Nursery bed of tomato hybrids



Field observation with senior scientist of NARC



Data collection



Data collection



Yield measurement of tomato hybrids



Lab analysis for pH value measurement

Fig. 4: Research activities conducted in field and laboratory

Table 1: Qualitative characteristics of tomato hybrids tested in Khumaltar, Lalitpur

Hybrids	Leaf Angle	Color of immature fruit	Fruit End	Fruit Shape	Type of Fruit	Cross section	Shoulder Shape	Growth Habit	Plant size	Color of ripened fruit
HRA 13 X HRD 7	Semi erect	Light green	Round	Round	Juicy	Round	Slightly depressed	Indeterminate	Intermediate	Red
HRA 14 X HRD 7	Semi erect	Light green	Round	Slightly flattened	Juicy Large	Irregular Red	Slightly depressed	Indeterminate	Large	Red
HRA 15 X HRD 6	Semi erect	Light green	Pointed	Oval	Juicy	Round	Slightly depressed	Determinate	Small	Orange red
HRA 16 X HRD 1	Semi erect	Light green	Round	Flat	Salad	Irregular	Moderately depressed	Determinate	Small	Orange red
HRA 16 X HRD 4	Semi erect	whitish green	Round	Slightly flattened	Salad	Irregular	Flat	Determinate	Small	Red
HRA 17 X HRD 1	Horizontal	whitish green	Round	Oval	Salad	Irregular	Slightly depressed	Indeterminate	Intermediate	Red
HRA 18 X HRD 2	Semi erect	Light green	Pointed	Round	Juicy	Irregular	Slightly depressed	Semi determinate	Intermediate	Red
HRA 20 X HRD 2	Semi erect	Green	Round	Oval	Juicy	Round	Slightly depressed	Semi determinate	Intermediate	Dark red
HRA 20 X HRD 4	Drooping	Greenish white	Pointed	Slightly flattened	Juicy	Irregular	Slightly depressed	Indeterminate	Large	Red
HRA 20 X HRD 6	Semi erect	Light green	Round	Round	Juicy	Round	Slightly depressed	Determinate	Small	Dark red
HRA 20 X HRD 1	Drooping	Light green	Round	Oval	Salad	Irregular	Slightly depressed	Indeterminate	Large	Dark red
Srijana	Horizontal	Green	Pointed	Oval	Juicy	Round	Slightly depressed	Indeterminate	Large	Dark red

Table 2: Fruit yield characters of tomato hybrids, Khumaltar, Lalitpur

Hybrids	pH	Yield /plant (gm)	(Ton/ha) Yield
HRA 13× HRD 7	4.190 ^{bcd} e	2826 ^a	78.50 ^a
HRA 14× HRD 7	4.280 ^{abc}	2910 ^a	80.83 ^a
HRA 15× HRD 6	4.060 ^e	1652 ^c	45.89 ^c
HRA 16× HRD 1	4.260 ^{abcd}	2327 ^{abc}	64.64 ^{abc}
HRA 16× HRD 4	4.260 ^{abcd}	2163 ^{abc}	60.08 ^{abc}
HRA 17× HRD 1	4.270 ^{abcd}	1958 ^{bc}	54.39 ^{bc}
HRA 18× HRD 2	4.180 ^{bcd} e	2225 ^{abc}	61.81 ^{abc}
HRA 20× HRD 2	4.130 ^{cde}	2536 ^{ab}	70.44 ^{ab}
HRA 20× HRD 4	4.340 ^{ab}	2202 ^{abc}	61.17 ^{abc}
HRA 20× HRD 6	4.110 ^{cde}	2474 ^{ab}	68.72 ^{ab}
HRA 20× HRD 1	4.090 ^{de}	2655 ^{ab}	73.75 ^{ab}
Srijana	4.380 ^a	2244 ^{abc}	62.33 ^{abc}
Grand mean	4.213	2347.667	65.213
LSD	0.1606 ^{**}	712.6 [*]	19.80 [*]
SEM	0.0539	242.979	6.7494
CV (%)	2.22	17.93	17.93

pH of the Fruits

pH value of fruit juice from different hybrids showed significant variation. The maximum pH value (4.38) was recorded in Srijana followed by HRA 20× HRD 4 (4.34) whereas HRA 15× HRD 6 showed minimum pH value (4.06) while testing in laboratory (Table 2).

Yield of Tested Hybrids

Tested tomato hybrids showed significant variation on yield characteristic. The maximum fruit yield per plant was found in HRA 14× HRD 7 (2910 gm) which was statistically at par with all other hybrids except HRA 17× HRD 1 and HRA 15× HRD 6 whereas minimum yield per plant was observed in HRA 15× HRD 6 (1652 gm) which is at par with HRA 16 × HRD 1, Srijana, HRA 18× HRD 2, HRA 20× HRD 4, HRA 16× HRD 4, HRA 17× HRD 1 and HRA 15× HRD 6 in decreasing order (Table 2). The total fruit yield per hectare ranged

from 80.83 ton/ha (HRA 14× HRD 7) to 45.89 ton/ha (HRA 15× HRD 6). Yield of hybrids HRA 13× HRD 7, HRA 13× HRD 7, HRA 20× HRD 1, HRA 20× HRD 2, HRA 20× HRD 6 and HRA 16× HRD 1 had 78.50 ton/ha, 73.75 ton/ha, 70.44 ton/ha, 68.72 ton/ha, 64.64 ton/ha respectively which were superior to Srijana (62.33 ton/ha) (Table 2).

Discussion

In Nepal, farmers are growing tomato in seasonal as well as off season vegetable (Chapagain *et al.*, 2011). Plastic house cultivation of tomato is increasing rapidly as off season technology (Ghimire *et al.*, 2017; Timsina *et al.*, 2016; Pokharel and Thakur, 2012). Hybrids HRA 13× HRD 7, HRA 14× HRD 7, HRA 17× HRD 1, HRA 17× HRD 1, HRA 20× HRD 4, HRA 20× HRD 1 and Srijana which have long productive life and indeterminate in nature will suitable for this proposes (Magar *et al.*, 2016b). Whereas indeterminate type of varieties HRA 15× HRD 6, HRA 16× HRD 1, HRA 16× HRD 4 and HRA 20× HRD 6 might be the choice of the farmers who are growing tomato as seasonal crop under open field condition. Tomato is occasionally used as salad crop in hotels and functional celebration although it is not quite common in Nepal in comparison with cucumber, onion, carrot, radish and other vegetables etc. So, consumer preference might be less in hybrids HRA 16× HRD 4, HRA 17× HRD 1, HRA 16× HRD 1 and HRA 20× HRD 1 in compare with all other hybrids which yield Juicy type of fruits. Product from Juicy fruit yielding varieties also has secure markets in agro based enterprise which can also help to reduce the import of tomatoes as raw materials for the industries. Consumer preference to the other fruit characteristics like color, shape, cross section of fruits etc. might vary for individuals so scope of hybrids having all these characteristics are equally important. This study revealed that hybrids HRA 14× HRD 7, HRA 13× HRD 7, HRA 20× HRD 1 and HRA 20× HRD 6 could perform better than existing popular variety Srijana. However, result of study conducted by Chapagain *et al.* (2014) showed that 53.5 gm of fruit weight of Srijana) in a trial conducted in Lumle, Kaski. In a study conducted in Regional Agriculture Research Station (RARS), Parwanipur of Nepal Agriculture Research Council (NARC), 1697 gm of fruit yield per plant was observed from Srijana hybrid (Shrestha and Shah, 2014).

Conclusion

Nepal Agriculture Research Council is trying to develop new tomato hybrids to increase the gross domestic yield of tomato. Varietal improvement of

existing hybrids and evaluation and characterization of newly developed hybrids are necessary to promote hybrids in commercial scale. In this study different hybrids were shown variation on fruit quality parameters as well as overall plant growth parameter. Hybrids showing indeterminate and semi determinate growth pattern should be promoted for offseason production in plastic house condition while determinate type of hybrids could be recommended for open field cultivation. While observing quality parameters of fruits, consumer might prefer varieties yielding juicy type of fruit more than that of Salad type due to food habit of Nepalese consumers. Preference of other hybrids on the basis of other fruit quality parameter like color, shape, size etc. may vary according to situation and choice of individual. Based on overall qualitative as well as yield performance, hybrids HRA 14× HRD 7, HRA 13× HRD 7, HRA 20× HRD 1 and HRA 20× HRD 6 were observed as better performers than existing popular variety Srijana. Further multiyear multi location study and study of consumer preferences is recommended before registration and promotion of hybrids in Nepal.

Acknowledgment

We thank the Horticulture Research Division, Nepal Agriculture Research Council and Institute of Agriculture and Animal Science for providing support to this study.

Author's Contributions

Sudip Devkota: Data collected, analysed and interpreted, Prepared the draft manuscript and manuscript approved.

Surendra Lal Shrestha: Prepared research proposal, analysed data and supervised the overall research.

Amita Pandey: Data collected, reviewed literature and assisted on field activities.

Ethics

This article contain unpublished material and it is original research. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved.

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