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Evaluation of Fruit Production Potential of Harar (*Terminalia chebula* Retz.) in Natural Forest and Manmade Plantation

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ABSTRACT: The study was conducted in Hamirpur district (H.P.) to assess the fruit yield potential among the Harar landraces and seedling variety. Observations of fruit yield were recorded on 6 cultivars of Harar. The crowned area varied between 42 to 140 m^2 per tree. The fruit yield of fresh fruit ranged from 23.0 kg/tree to 117.0 kg/tree while it varied from 20.0 kg/tree and 115.0 kg/tree during the year 2018 and 2019, respectively. The highest yield per tree was registered in diameter class V while the lowest was recorded in diameter class I. Tamber outperformed all the landraces having maximum fruit yield per tree i.e. 32.3 kg and 34.3 kg in 2018 and 2019, respectively. The quantities of fruit registered under Kallar and Kothi were 31.0 and 22.0 kg per tree whereas it was the same i.e. 21.0 kg per tree under Pahlu and Paluri. However, there were some hurdles during the collection of fruit rates in the market as the traders did not cooperate and also do not provide exact price tags per kg. Tamber was proved statistically superior over all other landraces including seedling origin tree with regard to fruit yield per tree therefore it should be adopted in the Hamirpur environmental conditions.

Keywords: Landraces, fruit, diameter, yield, seedling, environmental

INTRODUCTION

Terminalia chebula is a marvelous gift from nature to humankind. Harar fruit possesses miraculous healing properties such as astringent, purgative, rejuvenating, antibacterial, antifungal, and laxative. Tannic acid, chebulinic acid, gallic acid, anthraquinone, and sennoside are implicated for this activity. It is used to cure a variety of diseases in India, including urinary, digestive, diabetic, skin, parasite infections, heart issues, fever, flatulence, constipation, ulcers, vomiting, colic pain, and hemorrhoids (Bag *et al.,* 2013). It is a deciduous tree that grows up to 1600 m above mean sea level and is found primarily in Himachal Pradesh, Jammu & Kashmir, Haryana, Uttarakhand, Madhya Pradesh, Maharashtra, North Eastern States, Assam, Kerala, and Karnataka. Ayurveda recognizes seven varieties of Harar (Vijaya, Putana, Rohini, Amrita, Abhaya, Jivanti, and Chetaki), each with unique properties.

India is by far the leading producer of Harar. Harar from Himachal Pradesh and Morni Hills has great demand in Pakistan, Afghanistan, Iran, Iraq, and other Gulf nations. India's dried fruit production is expected to be 100,000 tons, with 20 per cent exported to neighboring nations, Europe, and the United States. (World Agroforestry Centre, 2008). India exported 465,809 kg of Harar fruits generating revenue of 20,738,160 INR (Brinckmann, 2016). Aside from that, farmers confront a slew of issues when it comes to selling their produce. Farmers are being misled by dealers due to a lack of understanding about fruit production by trees of various age/diameter/crown size classifications. Thus, some man-made plantations have been developed, and these can be used as a reference for calculating the age of naturally growing trees with similar diameter/crown area.

MATERIALS AND METHODS

Total five diameter classes (I= <20 cm, II= 20.1-40 cm, III= 40.1-60 cm, IV= 60.1-80 cm, V= >80.1 cm) were made keeping in view the total diameter range of Harar trees available in the natural forest of Hamirpur district (HP). Three trees were chosen at random from each diameter class to record fruit yield and average yield per tree. In the case of man-made plantations, clone-wise fruit production per tree was calculated by randomly picking three trees per clone. There were five

improved clones (Kallar, Tamber, Kothi, Pahlu, and Paluri) and one seedling variety in total.

Harar fruit value was determined using diameter classes in the natural forest of Harar because the age of the trees growing in the forest was unavailable. The crowned area of different diameter class trees was also estimated which varied from 42 m^2 (diameter class I) to 140 m^2 per tree (diameter class V) as shown in Table 1. Fruit production figures from natural forests and man-made plantations were collected during fruit harvesting in November.

RESULTS AND DISCUSSION

The data on fresh fruit yield of different diameter classes of Harar in natural forest is presented in Table 1 and Fig. 1. The fresh fruit yield of different diameter class trees varied from 23.0 kg/tree to 117.0 kg/tree in the year 2018 whereas, it ranged from 20 kg/tree to 115.0 kg/tree in the year 2019. Diameter class I trees revealed the lowest yield whereas, class V trees the highest in both the years. The fruit yield per tree increased consistently with the diameter class I to diameter class V in both the years. The highest average fruit yield (116.0 kg/tree) over the two years was recorded in diameter class V trees followed by class IV (96.5 kg/tree) and minimum in diameter class I (21.5 kg/tree). Overall, low fruit yield per tree was recorded during the year 2019 over 2018 under respective diameter classes except diameter class II where an average increase of 5.0 kg per tree in fruit yield was noticed. The greater output in 2018 compared to 2019 can be attributed to better weather conditions for Harar fruit production. Temperature, humidity, rainfall, sunlight, and drought are all significantly associated with fruit yields in trees. The minimum and maximum temperatures in 2019 were higher than in 2018 during the blooming and initial fruit setting period. The rainfall was also less, only 56 mm (2019) in comparison to 124 mm (2018) which might have resulted in flower fall and low fruit setting in 2019.

Table 1: Fruit yield of Harar growing in natural forest.

Diameter class	Yield (kg/tree)			
	Crown area (m^2)	2018	2019	Mean
I	42	23	20	21.5
II	64	47	52	49.5
III	80	63	62	62.5
IV	120	100	93	96.5
V	140	117	115	116

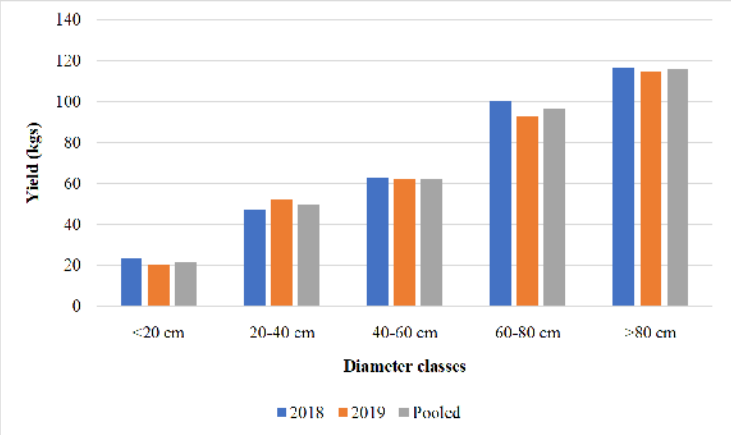

Fig. 1. Fruit yield/tree of different diameter class trees of Harar in natural forest.

Snook *et al.*, (2005) also reported that fruit production inclined with increase in diameter and trees having ≥ 75 cm diameter yielded substantially more fruit per year than smaller diameter trees. Large trees could produce more than 700 fruits per year. Trees with ≥ 75 cm of DBH were also more prolific producers while up to 27 per cent of trees < 75 cm of DBH produced < 1 fruit per year in any given year. At least 93 per cent of bigger trees yielded fruit every year. Over the period of 6 years, trees with ≥ 75 cm diameter produced in total 367 ± 34 fruits compared to 91 ± 8 fruits in trees < 75 cm. Despite, the amount of fruits produced per unit of crown volume did not vary significantly between the two size groups. Larger trees had a stronger capacity to absorb and retain nutrients and carbohydrates (Carbone *et al.*, 2013; Greene & Johnson, 1994; Han *et al.*, 2008) and tend to produce more fruit per tree.

A. Fruit production from manmade plantation of Harar

The perusal of data presented in Table 2 showed that Tamber registered the highest average fruit yield per

tree (32.3 kg) followed by Kallar (29.0 kg) and Paluri (23.0 kg), whereas the lowest (19.3 kg) was recorded in the seedling origin tree in manmade plantation during the year 2018. In the year 2019, Tamber landrace also showed the maximum average fruit yield per tree (34.3 kg) followed by Kallar (31.0 kg) and Kothi (21.7 kg) while, the seedling origin tree had the minimum average fruit yield per tree (18.0 kg). Tamber strain gave the highest average fruit yield per tree during the years, 2018 and 2019. In case of pooled data of both the years, the highest fruit yield per tree i.e. 33.3 was recorded in Tamber strain, followed by Kallar (30.0) and minimum, 18.7 in seedling origin tree. Despite being statistically similar, Tamber and Kallar outperformed all other strains, even seedling trees, in terms of fruit production per tree. All of the improved landraces producing excellent fruit moreover achieved a greater yield than the seedling origin tree.

Table 2: Fruit yield (kg) of improved landraces and seedling origin tree of Harar.

Landraces	Yield per tree (kg)		Pooled Mean
	Year 2018	Year 2019	
Kallar	29.0	31.0	30.0
Tamber	32.3	34.3	33.3
Kothi	22.7	21.7	22.2
Pahlu	21.0	20.7	20.8
Paluri	23.0	21.3	22.2
Seedling tree	19.3	18.0	18.7
Mean	24.6	24.5	24.5
CD	L= 4.93, Y= NS and L*Y= NS		

L= Landraces and Y= Years

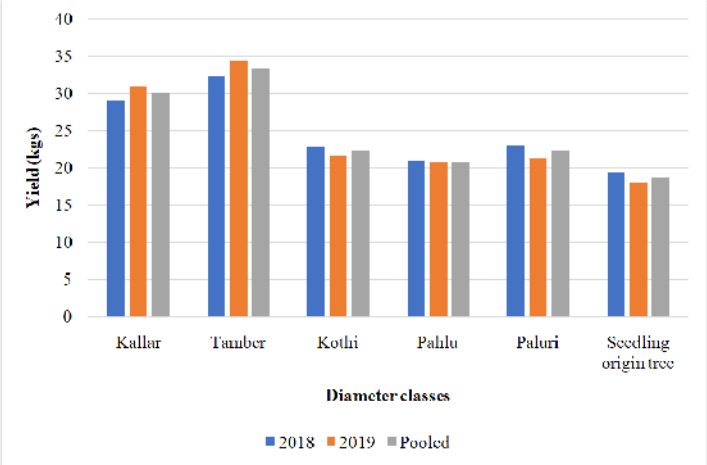

Fig. 2. Fruit yield/tree of improved strains and seedling tree of Harar.

During both years, no significant variation in fruit output was seen between the different Harar landraces, demonstrating their adaptability to the existing environmental conditions. The difference in yield of the multiple Harar landraces is related to the intrinsic capabilities of these landraces and their adaptability potential to the climate conditions prevalent at the plantation site. *Terminalia chebula* is a widely outcrossed species and the considerable diversity predicted as a consequence has resulted in the formation of numerous genotypes with variable production and adaptability capability.

Kumar and Deepika (2018) reported the yield of different cultivars of Jamun (*Syzygium cuminii* Skeels) per tree varied from 10.0 kg plant^{-1} to 54.0 kg plant^{-1} with highest recorded in KJ- 45 followed by KJ- 48 (48.2 kg plant^{-1}), KJ- 47 (46.5 kg plant^{-1}), KJ- 7 (41.6 kg plant^{-1}) and the lowest yield of 10 kg plant^{-1} was registered in KJ- 19. KJ- 45 was noted as superior cultivar due to better qualitative and quantitative characters.

Pandey *et al*., (2016) recorded considerable variation in fruit yield of Indian gooseberry (26.14 to 52.50 kg/tree) from 6 years old trees. Highest fruit yield was recorded in genotype CISH A-31 (52.50 kg/tree) followed by CISH A-3 (48.11 kg/tree) which is highly significant compared to standard check NA-6 (32.90 kg/tree) and NA-7 (35.76 kg/tree).

Pokharkar *et al*., (2016) also reported consequential difference in fruit yield per hectare of different guava groups with highest yield (188.5 q) in large group followed by medium (181.3 q) and small (110.5 q). Kumar and Deepika (2018) revealed the yield of different cultivars of Jamun (*Syzygium cuminii* Skeels) per tree varied from 10.0 kg plant^{-1} to 54.0 kg plant^{-1} with highest recorded in KJ- 45 followed by KJ- 48

(48.2 kg plant^{-1}), KJ- 47 (46.5 kg plant^{-1}), KJ- 7 (41.6 kg plant^{-1}) and the lowest yield of 10 kg plant^{-1} was registered in KJ- 19. KJ- 45 was noted as superior cultivar due to better qualitative and quantitative characters.

Kumar *et al*., (2015) observed that Dashehari cultivar of Mango gave the highest (76.3 kg/tree) fruit yield followed by Langra, Sindhuri, Safeda, Fazli, Chausa and Tamuria resulting in fruit yield of 60.2, 42.7, 41.2, 38.3, 35.4 and 34.9 kg/tree, respectively. Among hybrids, it was noticed that Amarpali was good yielder and most ideal as late season cultivar.

Ghosh *et al.,* (2013) revealed that the cultivars of aonla Neelum and Kanchan at the age of 9 yr, gave highest production of 80 kg plant^{-1} with an average of 56.0 kg tree^{-1} and 60 kg tree^{-1} with an average of 27.7 kg tree^{-1}, respectively. Malshe *et al.,* (2016) reported the maximum annual yield (18.23 kg tree^{-1} & 5.05 ton ha^{-1}) in Kanchan variety of aonla followed by NA-10, NA-7 and Krishna variety.

CONCLUSION

As the demand for Harar fruit has increased tremendously because of its medicinal value but the growers do not get enough profit from the Harar cultivation because of its lower yields and exploited by traders. In natural forest of Harar, diameter class V (>80 cm) gave maximum fruit yield. Whereas, among different landraces, Tamber registered the highest fruit yield and should be given the priority to harness maximum returns per unit area under Hamirpur environmental conditions.

Conflict of interest. Nil.

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