



A comparison of apple varieties based on yield and production efficiency under north western plain zones of Uttar Pradesh

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ABSTRACT

Apple is largely cultivated in India's northwestern Himalayan area, which also encompasses the nation's mountainous north-eastern regions as well as the union territory of Jammu and Kashmir, Himachal Pradesh, Uttarakhand and Uttar Pradesh. This research was conducted during 2019-2020 and 2020-21 at Horticultural Research Centre, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut. The experiment was laid out in Randomized Block Design (RBD) and the number of treatments was 3, each replicated 4 times. Each treatment consists of one plant. Total 12 plants were selected for study. The plants were planted at spacing of 5x5 m. The obtained results showed that the no. of fruits per plant (176.62), no. of branches per plant (28.5) was found to be significant. On the other side canopy spread (4.84 m), stem girth (33.87 cm), plant height (4.06 m), number of flowers (1020.75), fruit size (length) (57.12 mm), fruit size (width) (52.61 mm), fruit weight per fruit (76.62 gm), fruit weight (5 fruits) (383.12) were found to be non-significant. The results of present study indicate that the basis of their vegetative behavior, Dorsett Golden appeared to be superior variety in terms of tree morphology and other as moderate. Further, it can be concluded that variety Dorsett Golden had more productivity and the fruits of ANNA and HRMN-99 were having more marketable fruit traits. The current study revealed the diversity of the apple cultivars analyzed in this experiment, highlighting the significance of safeguarding these precious genetic resources and pursuing additional study to ensure their conservation, exchange, and utilization in upcoming breeding initiatives for the development of novel, improved apple varieties.

Introduction

Apple is one of the finest table fruit of the world and has been under cultivation since time immemorial. Apple trees are believed to have originated in South Eastern Europe and the Tien Shan Mountains of Kazakhstan in Asia [Gasteir, 2000], where enormous forests of untamed apple trees still remain. The top ten apple-producing

nations, which together produce 63 million tonnes of apples annually, are the USA, China, France, Italy, Turkey, Argentina, West Germany, Spain, Japan, and the former USSR [Snowdon, 1990]. With an annual production and productivity of 2890.6 thousand metric tonnes and 11 metric tonnes per hectare, respectively, apple is primarily

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grown in India's northwestern Himalayan region, which includes the union territory of Jammu and Kashmir, Himachal Pradesh, and Uttarakhand in addition to the north-eastern hilly states of the nation on an average area of 320 thousand hectares [Anonymous, 2017].

In case of Uttar Pradesh, horticulture is one of the critical sectors in the economy. The horticulture crops are grown in around 30 lakh hectares area which accounts 12% of the total cultivated area of the State (State Horticultural Mission Report, 2013). Expansion of area horticulture can promote economic diversification and thus create additional employment opportunities in the state. Fruits, vegetables, tuber crops, mushrooms, floriculture, medicinal and aromatic plants, spices, food processing, and beekeeping are all included in the broad category of horticulture crops. Uttar Pradesh is being covered by 9 agro climatic zones mainly, Bhabar and terai, Bundelkhand, central, Eastern plain, Mid-Western plain, North Eastern plain, South west semi-arid, Vindhya, Western plain. Because of the diverse agro-climate of U.P., a number of crops may be grown all year long, ensuring year-round availability. The state holds a vast potential for the development of various horticulture crops as it has diverse climatic conditions for growing different categories of fruits and off-season vegetables in its different agro zones [Nomita *et al.*, 2020]. Agriculture, horticulture, and related industries make up the majority of the state's workforce. Fruits from the temperate to subtropical zones can be grown in a hospitable environment due to topographical changes and altitudinal variances [Basannagari *et al.*, 2013].

The cultivated apple (*Malus X domestica* Borkh) belonging to family Rosaceae, sub-family Pomoideae, order Rosales, is considered as one of the most important and widely grown fruit in temperate zones of the world with regard to its acreage, production, economic returns, nutritive value and popularity. Apple is believed to have originated in the temperate regions of Western Asia between Black and Caspian Sea [Beceanu, 2002]. The high value of apple cultivation is a result of the fruit's nutritional, preventative, and therapeutic benefits as well as the biological and technological characteristics of apple trees and value-added cropping. In the diet of the modern human, apples are one of the staple foods. They can be found all

year round as a raw produce and are processed in various ways. The apple tree being one of the most important species of trees in temperate regions of the world, holds a prominent position in the production of fruit [Braniste and Uncheasu 2011]. Apple storage capacity is crucial for the new varieties that have been introduced to the market, and a typical biochemical and sensory examination should be included in an impartial assessment of their commercial value [Stănică *et al.*, 2008]. Achieving a good level of quality that is comparable to the susceptible variety for the scab resistant cultivars is a key objective. This study contains findings from numerous scab-resistant cultivars [Stănică *et al.*, 2010], focusing on the fruit's properties and how they evolve during storage.

Material and Methods

The Horticulture Research Center of the Sardar Vallabhbhai Patel University of Agriculture & Technology, Modipuram, Meerut, Uttar Pradesh, conducted the investigation titled "To Find the Suitable Variety of Apple for North Western Plain Zones of Uttar Pradesh" during the years 2019–2020 and 2020–21. At a height of 237.75 metres above mean sea level, the experimental field is located at 29°04 North latitude and 77°42 East longitude. In order to avoid pruning during the experiment, all 12 apple trees that were chosen as the experimental material were subjected to the same cultural practises. Using a Randomized Block Design (RBD) layout, the experiment was conducted on a five-year-old apple orchard, and its parameters were recorded. There were three different varieties, each replicated four times.

The three apple cultivars studied were HRMN-99, Dorsett Golden, and ANNA. The cultivars were taken into consideration as a factor, and each plant under study served as a replication. The dates of the first flowering and the full bloom, which occurred in February and March, respectively, were determined by daily observations (Table 1). By calculating the number of days it took the plant to go from the anthesis of the first flower to the last, the Date to First Flowering and the Date to Full Bloom durations emerged. In terms of the overall number of flowers per plant, the number of flowers produced by each apple variety replication was recorded.

Throughout the trial period, the number of branches per plant was manually tallied. The average value of each branch was then computed by dividing the total number of branches by the number of plants in each replication of apple types. Measurements of the canopy spread were made in the North-South and East-West directions, and the diameter was calculated using the mean diameter (m). A height of 50 cm was used to gauge the mature tree's trunk girth (cm). By using a long, straight, measured, and marked stick, we were able to assess plant height by measuring the distance between the tree's base and the topmost shoot.

Their measurements were given in metres. Each Apple variety replication's fruit production was measured in terms of the total quantity of fruits produced by each plant. The length, breadth (in mm), weight per fruit (gm), and total weight of five fruits from each cultivar were measured from each replication (gm). To determine the length of the fruit in each replication, Vernier callipers were used to measure the average length of five fruits from their base to their tip. Each replication's fruit width was measured using Vernier callipers, with the average width of five fruits being measured at their widest point.

To measure the fruit weight per fruit using a digital balance, five randomly chosen fruits from each marked tree were averaged in each replication. The fruit weight per fruit data were then computed for each replication by dividing the total fruit weight by the total fruit number. To get the total weight of fruit weight (5 fruit), add the weights of the five randomly chosen mango fruits from each marked tree in each replication (5 fruit). The acquired observations were statistically assessed utilising the recommended Panse & Sukhatme (1967) standard technique.

Results and Discussion

The 10 more relevant quantitative characters were measured in plant samples and are summarized in table 2, 3 and 4. Among the three cultivars studied, earliest flower initiation occurred in cv. Dorsett Golden and ANNA (13 February), while the latest flower initiation was also observed in cv. Dorsett Golden (24 February) in the year 2019-20 (table 1). In the year 2020-21, the earliest flower initiation occurred in cv. HRMN-99 (11 February), followed

by ANNA (12 February) and Dorsett Golden (18 February) while the latest flower initiation was observed in cv. Dorsett Golden (23 February) in the year 2020-21. Data further revealed that maximum number of flowers per plant was born in cv. ANNA (911.5) and was followed by HRNM 99 (846.5) and Dorsett Golden (654.5) in the year 2019-20. In the year 2020-21, maximum number of flowers per plant was borne in cv. Dorsett Golden (1283), and was followed by cv. ANNA (1130) and cv. HRMN-99 (1028). Depending on the cultivar's propensity as well as environmental and cultural factors, the flowering date and duration may vary. According to [Mratinic and Aksic 2011], the earliest initial bloom was observed in some apple cultivars on April 22 and persisted until May 6. They also noted a roughly 16-day gap between the earliest and last cultivars' entire bloom dates. Among the three cultivars studied, earliest full blossom was observed in cv. Dorsett Golden (20 February), while the latest full blossom was observed in cv. HRMN-99 (1 Mar) in the year 2019-20 (table 1). In the year 2020-21, the earliest full blossom occurred in cv. ANNA (26 February), while the latest full blossom was observed in both cv. Dorsett Golden and cv. HRMN-99 (6 March) in the year 2020-21.

No. of branches per plant were found significantly maximum in HRMN-99 (28) in the year 2019-20 as compared to Dorsett Golden (9) and ANNA (7.750). Whereas, in the year 2020-21 also HRMN-99 (29) was found to be having significantly higher number of branches per plant compared to ANNA (15) and Dorsett Golden (14). Canopy spread of a plant was found to be non-significant in both 2019-20 and 2020-21 years. In the year 2019-20, cv. Dorsett Golden (4.543m) was having maximum area cover under its canopy, followed by ANNA (4.312m) and HRMN-99 (4.198m). In the year 2020-21 also cv. Dorsett Golden (5.15m) was having maximum area cover under its canopy and was followed by ANNA (4.94m) and HRMN-99 (4.37m). Stem girth of HRMN-99 (33cm) was found maximum among all the three cultivars used in the experiment in the year 2019-20. This was followed by ANNA (29.50cm) and Dorsett Golden (29.25cm). In the year 2020-21, cv. Dorsett Golden (35.00cm) was found to have maximum stem girth and was followed by HRMN-99 (34.75cm) and

Table 1: Date of flower initiation and full blossom in the year 2019-20 and 2020-21

SN	Cultivars	Date of flower initiation								Date of Full blossom							
		R1		R2		R3		R4		R1		R2		R3		R4	
		19-20	20-21	19-20	20-21	19-20	20-21	19-20	20-21	19-20	20-21	19-20	20-21	19-20	20-21	19-20	20-21
1	HRMN-99	14 Feb	11 Feb	14 Feb	12 Feb	14 Feb	16 Feb	14 Feb	12 Feb	28 Feb	5 Mar	28 Feb	4 Mar	1 Mar	6 Mar	1 Mar	5 Mar
2	Dorsett Golden	13 Feb	18 Feb	15 Feb	20 Feb	25 Feb	20 Feb	13 Feb	23 Feb	24 Feb	2 Mar	24 Feb	1 Mar	22 Feb	2 Mar	20 Feb	6 Mar
3	ANNA	13 Feb	12 Feb	13 Feb	15 Feb	13 Feb	18 Feb	13 Feb	12 Feb	25 Feb	28 Feb	25 Feb	28 Feb	26 Feb	26 Feb	26 Feb	26 Feb

Table 2: Mean values of different traits of three apple varieties the year 2019-20 and 2020-21

SN	Character	2019-20						2020-21					
		HRMN-99	Dorsett Golden	ANNA	SE Mean	CD	CV	HRMN-99	Dorsett Golden	ANNA	SE Mean	CD	CV
1	No. of flowers	846.5	654.5	911.5	60.02	N.S.	14.93	1028	1283	1130	128.71	N.S.	22.58
2	No. of branches per plant	28	9	7.750	1.41	4.872	18.92	29	14	15	4.97	N.S.	52.83
3	Canopy spread (m)	4.198	4.543	4.312	0.41	N.S.	18.84	4.37	5.15	4.94	0.38	N.S.	15.30
4	Stem Girth (cm)	33.00	29.25	29.50	2.67	N.S.	17.48	34.75	35.00	33.75	2.46	N.S.	13.37
5	Plant Height (m)	3.258	3.220	2.91	0.22	N.S.	13.99	3.66	4.91	4.00	0.42	N.S.	19.97
6	No. of fruits per plant	67.50	92.50	81.25	3.82	13.17	9.50	174.00	288.00	272.00	19.99	68.99	17.38
7	Fruit size (length) (mm)	55.75	54.375	54.243	1.91	N.S.	6.55	55.98	56.11	60.00	1.79	N.S.	6.27
8	Fruit size (width) (mm)	57.583	52.99	52.53	2.52	N.S.	9.25	43.22	47.46	52.69	4.01	N.S.	17.08
9	Fruit weight per fruit (gm)	71.5	71.75	73.25	7.21	N.S.	20.22	80	73	80	4.87	N.S.	12.80
10	Fruit weight (5 fruit) (gm)	357.50	358.75	366.25	36.05	N.S.	19.98	400.00	365.00	400.00	24.32	N.S.	12.94

Table 3: Pool data values of different traits of three apple varieties the year 2019-20 and 2020-21

SN	Character	HRMN-99	Dorsett Golden	ANNA	Mean
1	No. of flowers	937.25	968.75	1020.75	975.58
2	No. of branches per plant	28.5	11.5	11.37	17.12
3	Canopy spread (m)	4.28	4.84	4.62	4.58
4	Stem Girth (cm)	33.87	32.12	31.62	32.53
5	Plant Height (m)	3.45	4.06	3.45	3.65
6	No. of fruits per plant	120.75	190.25	176.62	162.54
7	Fruit size (length) (mm)	55.86	55.24	57.12	56.07
8	Fruit size (width) (mm)	50.40	50.22	52.61	51.07
9	Fruit weight per fruit (gm)	75.75	72.37	76.62	74.91
10	Fruit weight (5 fruit) (gm)	378.75	361.87	383.12	374.58

ANNA (33.75cm). The data was found to be non-significant. HRMN-99 (3.258m) showed highest plant height in the year 2019-20, while ANNA (2.91m) showed shortest plant height in the same year. Dorsett Golden showed vertical plant growth of 3.220m. In the year 2020-21, Dorsett Golden (4.91m) showed highest plant height and was followed by ANNA (4.00m) and HRMN-99 (3.66m). The data was found to be non-significant. In the year 2019-20, maximum number of fruits per plant was produced by Dorsett Golden (92.50) and was followed by ANNA (81.25) and HRMN-99 (67.50). Dorsett Golden in the year 2020-21 produced maximum number of fruits per plant i.e.,

288 and was followed by ANNA (272) and HRMN (67.50). The data was found to be non-significant. The obtained data in this experiment was found to be significant. Fruit size is another crucial factor in the breeding programmes that are used to select the best genotypes [Westwood and Blaney, 1963]. Fruit size in length was measured longest in HRMN-99 (55.75 mm) in the year 2019-20. In the same year, other two cultivars, Dorsett Golden and ANNA showed 54.375 mm and 54.243 mm of fruit size in length, respectively. In the year 2020-21, the cv. ANNA (60.00 mm) produced longest fruit size in length and was followed by Dorsett Golden (56.11 mm) and HRMN-99 (55.98 mm). The data was found to be non-significant. The results were close to results found by [Reim *et al.* 2013] who recorded the fruit size between 1.8-5.1 cm and [Reim *et al.* 2013] also reported that the majority of the trees had fruit size under 3.5cm thus indicating a true type *Malus sylvestris*. Fruit size in width was measured longest in HRMN-99 (57.583 mm) in the year 2019-20. In the same year other two cultivars, Dorsett Golden and ANNA showed 52.99 mm and 52.53 mm of fruit size in length respectively. In the year 2020-21, the cv. ANNA (52.69 mm) produced longest fruit size in length and was followed by Dorsett Golden (47.46 mm) and HRMN-99 (43.22 mm). The obtained data in this experiment was found to be non-significant. Phylogenetic behavior-related genetic variables may be in charge of controlling variation in fruit size and weight [Harda *et al.*, 2005]. Fruit weight per fruit was measured and it revealed that in the year 2019-20, cv. ANNA (73.25 gm) produced the heaviest fruit. This was followed by cv. Dorsett Golden (71.75 gm) and HRMN-99 (71.5 gm) which produced almost similar fruit weight. In the year 2020-21, cv. ANNA and HRMN-99 produced similar and heaviest fruit among the three cultivars used in this experiment and weighed 80 gm, whereas, cv. Dorsett Golden weighed 73 gm and produced lower weight as compared to other two cultivars used in this experiment. It is common knowledge that factors including genetics, environment, and cultural practices all affect fruit weight. Using resources effectively to reach a specific fruit size may represent a genotype's innate ability to produce bigger fruits. The findings of this study were

consistent with those of [Mratinic and Aksic 2011], who noted that several Turkish *Malus* species' fruits ranged in weight from 70.00g to 193.33g and that some wild apples' fruits weighed between 3.828g and 3.668g. Fruit weight (5 fruits were chosen randomly) was measured highest in ANNA showed 366.25 gm in the year 2019-20. The same year other two cultivars, Dorsett Golden and HRMN-99 showed 358.75 gm and 357.50 gm of fruit size in length. In the year 2020-21, the cv. ANNA and HRMN-99 produced highest fruit weight of 400.00 gm and Dorsett Golden (365 gm) produced lowest weight among all the cultivars used in the experiment. The data was found to be non-significant.

Conclusion

All the varieties appeared to be promising under the conditions of North-West plain zone of Uttar Pradesh and can be recommended for further research, mass multiplication and ultimate adoption by orchardists. On the basis of their vegetative behavior, Dorsett Golden appeared to be superior variety in terms of tree morphology and other was found to be moderate. Further, it can be concluded that variety Dorsett Golden had more productivity and the fruits of ANNA and HRMN-99 were having more marketable fruit traits. The current study demonstrated the diversity of the apple cultivars investigated in this experiment, demonstrating the importance of protecting these rare genetic resources and pursuing further research to ensure their conservation, exchange, and utilisation in upcoming breeding programmes for the creation of novel, commercially focused cultivars.

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Conflict of interest

The authors declare that they have no conflict of interest.

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