

## Original Research Article

### PHYSICO-CHEMICAL STUDIES OF SOME LOCAL WOOD APPLE

Comment [JSR1]: DELETE SPACE

#### (*Feronia limonia* L.) GENOTYPES UNDER AWADH REGION OF UTTAR PRADESH

**ABSTRACT:** India is blessed with varied agro-climatic conditions which have paved a way to grow variety of fruits in different seasons of the year. The agro-climatic conditions of Awadh region of Uttar Pradesh are highly suitable for the cultivation of minor fruit crop wood apple. In

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Wood apple the existing variability is low due to the problem of unexploitation and lack of awareness. Considering the wide genetic diversity in wood apple (*Feronia limonia* L.) in terms of qualitative characters, an extensive survey of diversity rich area of Awadh region of Uttar Pradesh was done and twenty nine genotypes in the form of fruits were collected from the different locations during 2021-23 to identify elite genotypes having desirable horticultural traits. The experimental design employed in this study was Complete Randomized Block Design. The results revealed rich genetic variations with respect to individual fruit length (5.33-9.49 cm), fruit width (5.57-9.54 cm), fruit weight (113.26-263.45 g), shell thickness (0.14-0.43 mm), seed length (4.04-8.46 mm), seed width (1.95-4.17 mm), seed thickness (1.34-1.69 mm), seed weight per fruit (25.25-31.06 g), number of seeds per fruit (134.50-456.0), among different genotypes. The different genotypes also exhibited wide range of variability in qualitative characters, viz. total soluble solids (10.22-18.14 °Brix), acidity (2.12-6.09 %), TSS/acidity ratio (1.67-8.71),

reducing sugars (0.85-1.30 %), non reducing sugars (0.67-1.06 %), total Sugars(1.55-2.40 %), Vitamin C (15.16-27.95 mg/ per 100 g) and pectin content (1.03-2.09 %) among all 29 genotypes studied for their qualitative characters.

**Key words:** Wood apple, genotype, unexploited, genetic and diversity.

## INTRODUCTION

Wood apple (*Feronia limonia* L.) is a monotypic species, having chromosome number  $2n=18$  (Mazumder *et al.*, 2006) belongs to the family *Rutaceae*, sub-family *Aurantioideae*; tribe-*Citreae*; sub-tribe-*Balsamocitrineae*, which comes under hard shelled citroid fruit tree group (Raut *et al.*, 2023). It is an acidic fruit in unripe condition but gives pleasant flavor when ripe (Das and Das, 2003). In India, it is known by different vernacular names viz., in Tamil (Vilam Pazham), Hindi (Kaitha, Kath bel), Sanskrit (Kapitha), Assamese (Bal, Bael), Bengali (Koth bael), Gujarati (Kothu), Kannada (Belada hannu), Malayalam (Vilam kai), Marathi (Kavath), Oriya (Kaitha or Kainth) and Telugu (Vellaga pandu) (Rajangam and Sankar, 2022). Globally, wood apple grows in Thailand, Malasiya, Cambodia and other parts of Southeast Asia. In India, it is found all over the plains of southern Maharashtra, West Bengal, Uttar Pradesh, Chhattisgarh and Madhya Pradesh.

Wood apple is a potential fruit crop for drought, semi arid tropics, dry forest and suitable for problem soils particularly saline soil (Rajangam *et al.*, 2021). The wood apple is not under regular orcharding, however, along the border of fields, roads, railway lines and as a roadside tree, near villages and banks of the river are the common places where the plants can be found as stray plant. Wood apple is a small to moderate size, deciduous, glabrous tree with thorny

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branches reaching to a height of 10 meters with 0.6 meters to 1.6 meters girth (Kumar and Deen, 2017).

The wood apple fruit can be consumed raw, added to an array of drinks and sweets or canned as jam. The pulp of *Limonia acidissima* is extracted and consumed raw, either with or without sugar. The fruits are consumed as a good source of juice during its harvesting season due to their low cost and thirst quenching ability. A homemade drink popularly known as “Sarbat” is prepared from the wood apple fruits. The pulp is used in savory chutneys in India. Fruit bars, jam, jelly, chutney and ready-to-serve beverages are all made from fruit pulp (Sharma *et al.*, 2024).

The wood apple pulp is a rich source of beta carotene, a precursor of vitamin-A which also contains significant amount of vitamins B such as riboflavin and thiamine and it had small quantities of ascorbic acid content (Poongodi *et al.*, 2013). Wood apple is a nutrient-rich fruit that contains a surprisingly high amount of protein (10%) and also shows good amount of phenolic content (38.67 mg (GAE)/ g DW) and which corresponds to a good source of antioxidants in dried powder (Sonawane and Arya, 2013). Additionally, the pectin content of the fruit pulp is 3–8% (Kerkar *et al.*, 2020). The fruit contains flavonoids, phytosterols, glycosides, saponins, tannins, carbohydrates, triterpenoids, vitamins and amino acids as its chemical constituents (Mahour *et al.*, 2008). There are reports that some coumarins and tyramine derivatives were also isolated from the fruits of *Limonia acidissima* (Ilango and Chitra, 2009).



Wide

also isolated from the  
*acidissima* (Ilango and  
genetic variability exists

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in wood apple with desirable characters among accessions and its advantages towards the crop improvement program to identify superior genotypes for commercial cultivation. Through intensive survey, collection, conservation, characterization and evaluation there is a chance to derive a promising varieties in wood apple. Moreover, there are limited studies available in basic evaluation program. In this view, an experiment has been conducted in the wood apple field gene bank and the results were furnished for future research perspective.

**Fig 1:** Selected districts from Awadh region in Uttar Pradesh, India.

## **MATERIALS AND METHODS**

The present experiment was carried out at the Department of Horticultural, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University, Lucknow, India. The diversity rich districts of wood apple was explored and fruits of 29 different genotypes (denoted as G1-G29) were collected from different region such as Barabanki, Lucknow, Bahraich, Ayodhya and Gonda. Wood apple fruit were randomly selected from all the direction of marked genotypes and the bulk of sample of all the selected trees from each site collected into bags and tagged by the number and subjected to biochemical analysis in the departmental

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laboratory. Qualitative characters in terms of total soluble solids (TSS), titratable acidity, reducing sugars, non reducing sugars, total sugars, ascorbic acid and pectin content of wood apple fruits were analyzed and recorded as per the method given by Rangana. The total soluble solid content of fruit was determined with the help of hand refractometer (ERMA) of 0-32 percent, calibrated at 20°C. Total acidity was determined by titrating the diluted fruit juice against 0.1 N NaOH solution using phenolphthalein as an indicator and the results were expressed as percentage fresh weight of fruit. The reducing sugar content was determined by titrating the diluted juice against Fehling 'A' and Fehling 'B' solutions by using methylene blue as an indicator. The total sugars content was determined by titrating the diluted fruit juice after hydrolysis with hydrochloric acid against Fehling 'A' and Fehling 'B' solutions in presence of methylene blue as an indicator. Ascorbic acid content of the fruit was estimated by using 2, 6-dichlorophenol indophenol dye titration method as described in AOAC (1995). Pectin content were analyzed by the methods outlined in AOAC (1980). The result was expressed in per cent calcium pectate. The experimental design employed in this study was Complete Randomized Block Design and data were statistically analyzed as per method outlined by Panse and Sukhatme (1967).

## **RESULTS AND DISCUSSION**

Among the samples considered in our study shows a wide significance variation in fruit size. The highest fruit length was found in G14 (9.49 cm) among the genotypes while the lowest fruit length was recorded in G28 (5.33 cm) as shown in fig 2. The maximum fruit width was recorded in G14 (9.54 cm) which was at par with G15 (9.43 cm) among the genotypes, minimum fruit width was recorded in G28 (5.57 cm) as presented in fig 3. Fig. 4 shows that the maximum fruit weight was observed in G14 (263.45 gm) followed by G15 (245.59 gm) while the minimum

fruit weight was recorded in G28 (113.26 gm). Findings were supported by the results of Pandey *et al.* (2013), Sharma *et al.* (2014), Shyamala and Kulkarni (2018), Khan *et al.* (2019) and Mani *et al.* (2020),

The data on maximum shell thickness was noticed in G10 (0.43mm) followed by G11 (0.41 mm) while the minimum shell thickness was found in G18 (0.14 mm) as represented in fig 5. Similar results were also found by Singh *et.al.* (2016) and Kumar *et.al.* (2021) in wood apple.

The study reveals that largest number of seeds per fruit was observed in G15 (456.00) followed by G14 (410.00) while the minimum number of seeds per fruit was recorded in G28 (134.50) among all genotypes as shown in fig 6. Similar results was also noticed by Singh *et al.* (2016) in wood apple.

In the present survey, the maximum seed length was recorded in G7 (8.46 mm) followed by G12 (8.27 mm) while the minimum seed length was observed in G28 (4.04 mm) among all genotypes as shown in fig 7. Similarly the largest seed width was noticed in G16 (4.17 mm) which was at par with G9 (4.10 mm) while minimum seed width was recorded in G1 (1.95 mm) as presented in fig 8. The data on highest seed thickness was also noticed in G12 (1.69 mm) which was at par with G22 (1.67 mm) while the lowest seed thickness was recorded in G2 (1.34 mm) as can be seen in fig 9. The maximum seed weight per fruit was observed in G8 (31.06 g) followed by G26 (30.70 g) while the lowest was observed in G21 (25.25 g) as mentioned in fig 10. Similar results were also reported by Ghosh *et. al.* (2012), Singh *et. al.* (2016) and Yadav *et al.* (2018) in wood apple.

Table 1 shows significant variations among the wood apple genotypes with respect to different qualitative parameters. The data pertaining to total soluble solids content of different

wood apple genotypes shows significant difference. The highest value of total soluble solids (18.14<sup>0</sup> Brix) was noticed in G14 was significantly higher than the remaining genotypes. In contrast, lowest value of total soluble solids was recorded in genotype G8 (10.22<sup>0</sup> Brix) among all genotypes. Similar trend of total soluble solid was reported by Sharma *et al.*, (2014), Singh *et al.*(2016), Yadav *et al.* (2018) and Pandey *et al.* (2020) in wood apple fruits.

The data on titratable acidity revealed significant differences among all genotypes undertaken for this study. As shown in Table 1 genotype (G11) had the maximum content of titratable acidity (6.09 %) followed by G8 (5.93 %) among genotypes while the minimum acidity was noticed in G14 (2.12%). Sharma *et al.*, (2014) also found that ripe fruits were less acidic (1.74%) than both unripe (2.92%) and half-ripe fruits (2.40%), respectively in wood apple.

Different genotypes showed significant variation in their TSS/acidity ratio content. The highest TSS/acidity ratio content was found in G14 (8.71) among the genotypes while, lowest TSS/acidity ratio content was recorded in G8 (1.67) as represented in Table-1. Similar finding were also matched with Debbarma and Hazarika (2024) in bael fruits.

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The perusal of data represented in table-1 clearly reveals that all genotypes of wood apple sample showed significance variation in total sugars. The maximum total sugars was recorded in G14 (2.40 %) which was at par with G22 (2.38%) among the genotypes, while the minimum total sugars was noticed in G8 (1.55%). Similar variations in total sugar content of wood apple were reported by Pandey *et al.*, (2013), Singh *et al.*, (2016) and Yadav *et al.* (2018). A significant difference in reducing sugars was found among cultivars undertaken for evaluation. The maximum value of reducing sugars was observed in G14 (1.30 %) among the genotypes while, lowest value of reducing sugars was recorded in G8 (0.85 %) as shown in Table-1. The

data regarding variation in non reducing sugars is presented in Table-1 which clearly reveals that there is significance variation in wood apple genotypes with respect to non reducing sugars. Genotype G20 (1.06%) showed significantly higher levels of non reducing sugars in comparison to other cultivars under study while the lower levels of non reducing sugars were found in G8 (0.67 %) among all 29 genotypes.

The data on vitamin C revealed significant differences among all genotypes undertaken for study. Genotype G15 (27.95 mg/ 100 g) showed significantly higher levels of Vitamin C in comparison to other cultivars under study while the lower levels of Vitamin C were found in G8 (15.16 mg/100 g) among all 29 genotypes as represented in Table 1. Vitamin C content of the fruits was also found similar with the findings of Singh *et al.* (2016) where they observed that it ranged from 7.08 -19.60 mg/100 g.

A significant difference in pectin content was found among cultivars undertaken for evaluation. As shown in Table 1 which clearly reveals that the highest pectin content was found in G14 (2.09%) among the genotypes while, lowest pectin content was recorded in G10 (1.03%). Similar results were also noticed by Rajangam and Sankar (2022) in wood apple fruit.

### CONCLUSION

Wood apple genotypes demonstrated significantly immense variability in quantitative and qualitative studied characteristics. Among these genotypes, genotype G15, G14, G13, G17, G18 and G20 were screened as promising genotypes as per their quantitative traits. Findings with respect to qualitative characters viz; TSS, acidity, TSS/Acidity ratio, total sugars, reducing sugars, non-reducing sugars, vitamin C content and pectin content, the genotypes G22, G13, G7, G14, G20 and G1 were screened as promising genotypes. These promising genotypes can be



recommended for commercial multiplication, growing at farmer's field, conservation in the field gene bank and formulating an effective breeding program for its genetic improvement or genetic up gradation of this valuable crop.

### **FUTURE PROSPECTS**

Woodapple is an important fruit crop with a high market value in both the Indian and global markets. In India, it is an underutilized fruit. Researchers must conduct genetic diversity research on this species, which could lead to future crop enhancing efforts. Thar Gaurav and Thar Prabha are India's sole recently developed varieties and research institutes are required to explore and advocate for the cultivation of this fruit crop, while also undertaking enhancement initiatives to develop high-yield cultivars with superior fruit quality.

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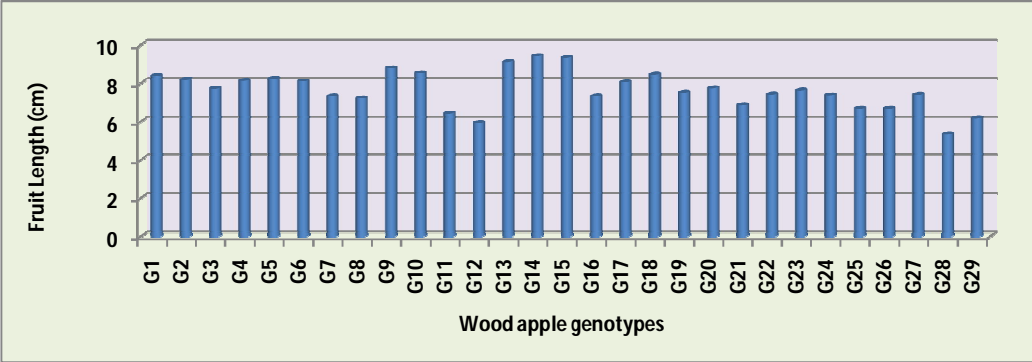
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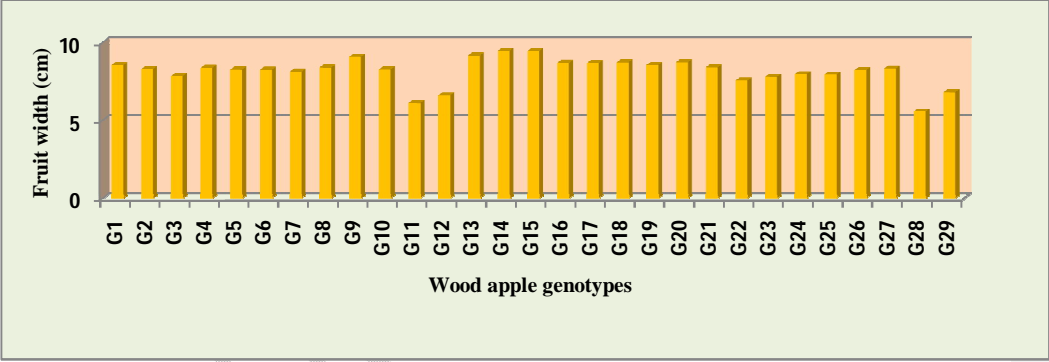
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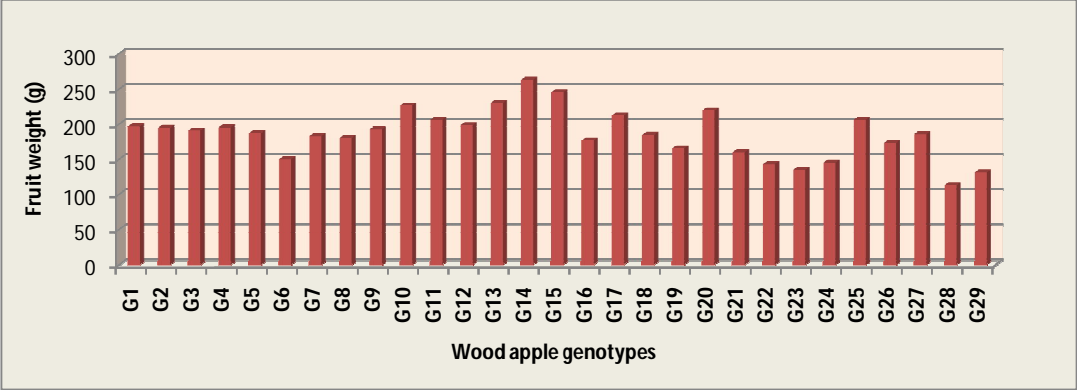
**Fig 2:** Variability in fruit length (cm) of wood apple genotypes



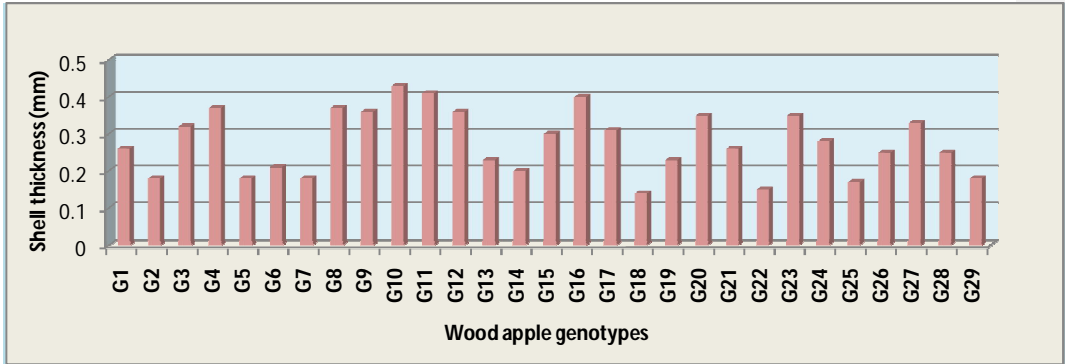
**Fig 3:** Variability in fruit width (cm) of wood apple genotypes



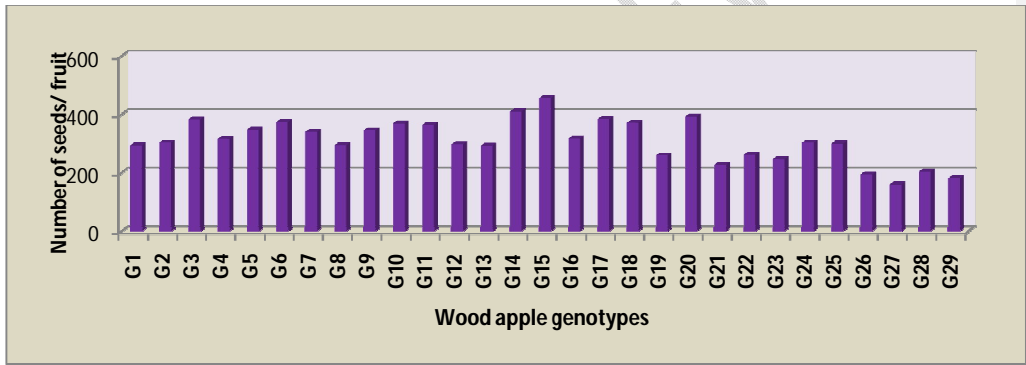
**Fig 4:** Variability in fruit weight (g) of wood apple genotypes



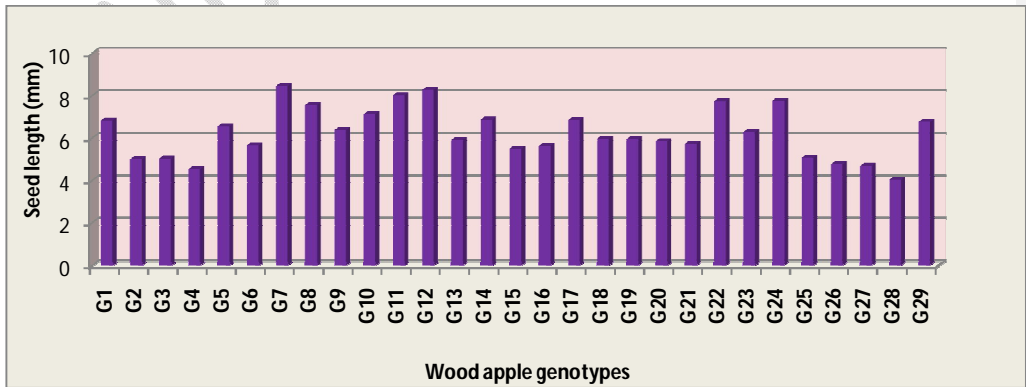
**Fig 5:** Variability in shell thickness (mm) of wood apple genotypes



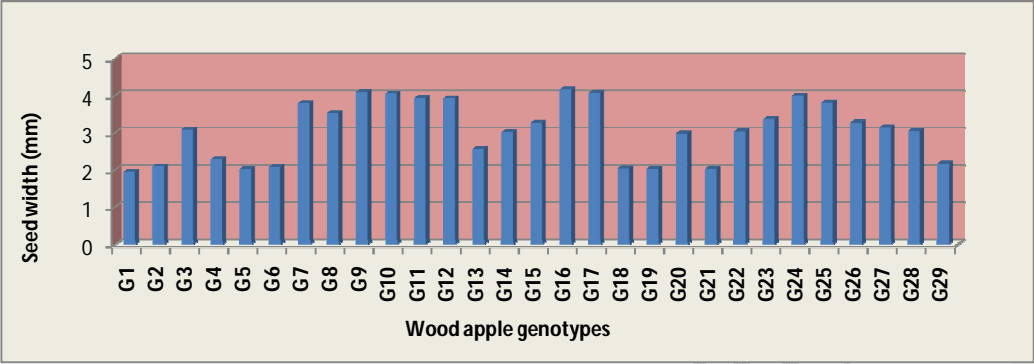
**Fig 6:** Variability in number of seeds per fruit of wood apple genotypes



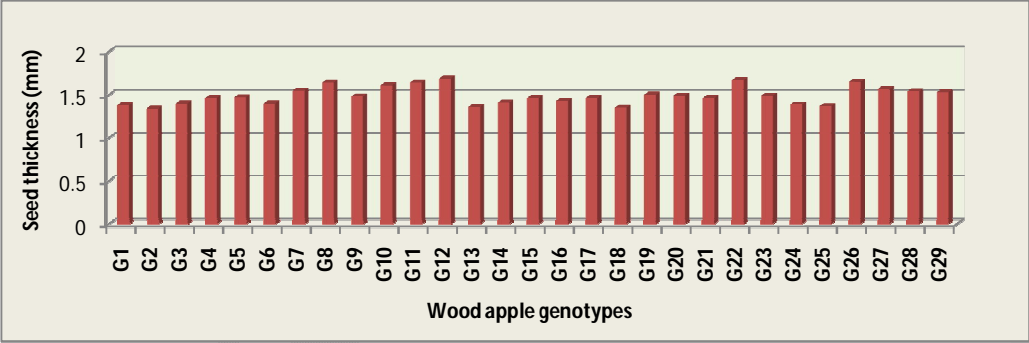
**Fig 7:** Variability in seed length (mm) of wood apple genotypes



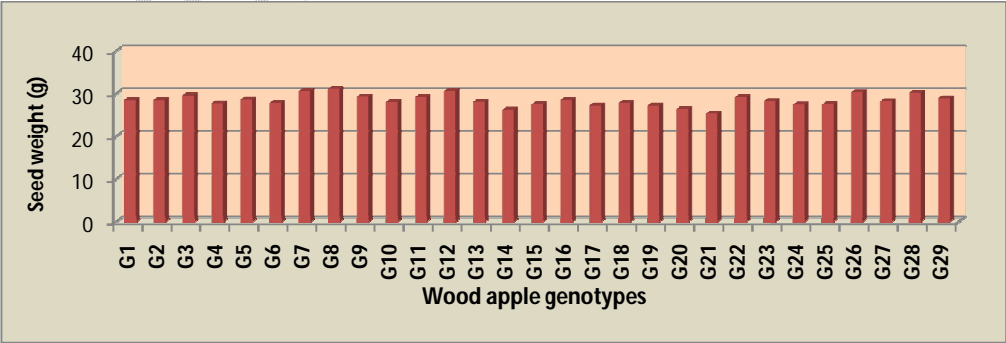
**Fig 8.** Variability in seed width (mm) of wood apple genotypes



**Fig 9:** Variability in seed thickness (mm) of wood apple genotypes



**Fig 10:** Variability in seed weight (g) of wood apple genotypes



**Table 1:** Variation in qualitative characters of fruits of wood apple genotypes from Awadh region of Uttar Pradesh, India (pooled data of two years)

Genotypes	TSS (°Brix)	Acidity (%)	TSS/Acidity Ratio	Total Sugars (%)	Reducing Sugars (%)	Non Reducing sugars (%)	Vitamin C (mg/100g)	Pectin (%)
G1	16.96	2.26	7.00	2.31	1.20	1.05	20.51	1.37
G2	15.30	4.23	4.37	2.17	1.12	1.00	18.40	1.25
G3	15.94	3.68	4.82	2.20	1.17	0.98	25.33	1.96
G4	16.02	3.93	4.97	2.18	1.14	0.99	17.52	1.92
G5	13.07	4.17	2.80	1.99	0.98	0.95	21.63	1.36
G6	13.46	4.43	2.91	2.02	1.03	0.94	26.06	1.82
G7	12.08	4.78	2.42	1.83	0.94	0.85	21.30	2.08
G8	10.22	5.93	1.67	1.55	0.85	0.67	15.16	1.97
G9	11.21	5.14	2.19	1.80	0.90	0.86	17.28	1.55
G10	11.95	5.09	2.35	1.82	0.94	0.84	18.06	1.03
G11	10.30	6.09	1.74	1.78	0.86	0.87	16.29	1.37
G12	10.46	5.03	2.04	1.79	0.87	0.87	16.11	1.48
G13	17.73	2.16	8.25	2.36	1.28	1.03	26.10	2.08
G14	18.14	2.12	8.71	2.40	1.30	1.05	25.81	2.09
G15	17.60	2.55	8.03	2.34	1.27	1.02	27.95	1.98
G16	16.65	2.89	5.60	2.30	1.19	1.05	26.60	2.01
G17	16.07	2.82	5.24	2.22	1.18	0.99	19.35	1.55
G18	14.86	3.03	3.79	2.09	1.08	0.95	24.57	1.15
G19	16.75	2.89	6.03	2.31	1.21	1.05	25.06	1.67
G20	17.29	2.27	7.68	2.33	1.21	1.06	25.51	1.69
G21	17.24	2.78	7.53	2.32	1.21	1.05	27.04	1.65
G22	18.05	2.50	8.50	2.38	1.29	1.04	26.97	1.35
G23	16.41	3.05	5.48	2.28	1.19	1.04	27.81	1.78
G24	13.99	3.53	3.47	2.07	1.06	0.96	27.35	1.90
G25	15.78	3.15	4.51	2.18	1.15	0.98	26.48	1.45
G26	12.71	5.06	2.56	1.85	0.98	0.83	20.40	1.81
G27	14.01	4.19	3.35	2.04	1.06	0.93	21.22	2.03
G28	15.13	3.89	4.01	2.14	1.10	0.99	20.06	2.00
G29	16.24	3.04	5.34	2.25	1.14	1.05	20.99	1.70
SE(m)±	0.34	0.13	0.13	0.02	0.01	0.01	0.27	0.06
C.D. at 5%	0.68	0.26	0.26	0.03	0.03	0.03	0.53	0.13