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Morpho-pomological evaluation of elite Persian walnut (*Juglans regia* L.) selections from Kashmir Valley

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Abstract

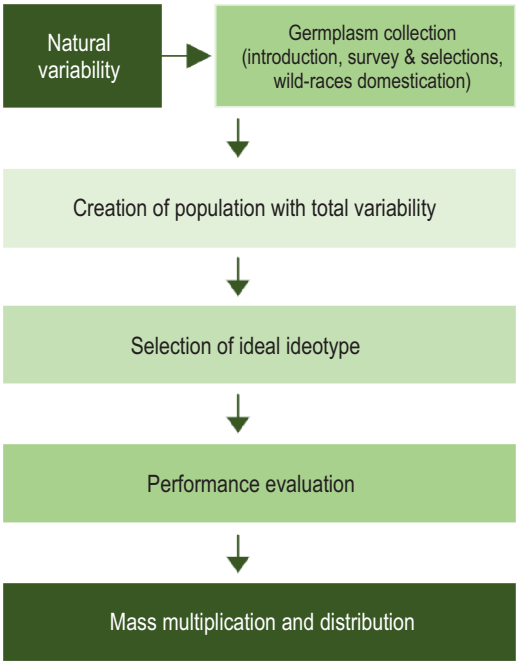
Aim: Identification of superior walnut genotypes from the existing germplasm collection at the SKUAST-Kashmir, Shalimar campus (Srinagar) based on key morphological traits intended for selecting promising parental lines to conduct walnut breeding programmes.

Methodology: Eighty genotypes were evaluated and data on various metric and non-metric traits of walnut were recorded with five replications. Mean values were computed and used to assess the performance of individual traits, enabling comparison of the selected elite genotypes with the currently cultivated walnut varieties.

Results: Among eighty genotypes, five superior genotypes (SKAU-W-24, SKAU-W-28, SKAU-W-34, SKAU-W-41, and SKAU-W-42) were identified based on nut and kernel characters. The maximum nut and kernel weight was recorded in genotype SKAU-W- 41 (14.44 g and 7.60 g). Kernel percentage was notably high across these genotypes, with SKAU-W-28 exhibiting the highest value (60.71%) followed by SKAU-W-34 (59.56%). The estimated kernel protein and kernel fat content were highest in SKAU-W-34 (17.35 % and 59.84 %).

Interpretation: Genotypes SKAU-W-24, SKAU-W-28, SKAU-W-34, SKAU-W-41 and SKAU-W-42 exhibited superior nut and kernel traits compared to many commercial varieties. These promising genotypes warrant further evaluation and multiplication for use in future improvement programmes aimed to develop high-yielding walnut cultivars.

Key words: Elite walnut genotypes, *Juglans regia*, Kashmir valley, Kernel traits



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Introduction

Hybridization in walnuts is time-consuming and laborious, but it is necessary to plan for hybridization between parents with desired traits to introduce new high-quality cultivars. Morphological characterization provides a fundamental basis for assessing, documenting and utilizing phenotypic diversity in perennial fruit trees (Einollahi and Khadivi, 2024). In walnut, characterization of indigenous populations becomes crucial for the conservation and effective utilization of native genetic resources. The genetic diversity in native walnut populations offers good opportunities to identify elite genotypes with superior nut-kernel quality for direct selection and use as potential parents (Chehade *et al*., 2025). Persian walnut is a monoecious species where male and female flowers emerge at different position on same plant and favours hetero-dichogamous behaviour as both mature at different times. Walnut has gained much attention because of its nutritious kernel having much impact on human health alongside; each plant part has multiple nutritional, medicinal and ethno-medicinal properties. Multiple plant parts contain phytochemicals with therapeutic properties like flavonoids, alkaloids and polyphenolic compounds rich in calories, Vitamin E and multiple essential fatty acids, including Omega-3 (Mulani *et al*., 2025).

The North-Western Himalayan region, especially Kashmir valley is one of the richest and most diverse gene pool of the cultivated walnuts. Interestingly, the major share of walnut production comes from the trees of age-old seedling origin considerably having wide range of genetic diversity (Lone, 2017; Wani *et al.,* 2021). Furthermore, the collection, evaluation and identification of superior genotypes from existing populations are prerequisites in any walnut-breeding programme (Botu *et al.,* 2010). Selection is the predominant method of breeding practiced worldwide for selecting elite genotypes with the desired agronomic characteristics, within a short span and easily practicable approach in walnut (Sen *et al.,* 2018). An ideal walnut selection must have late leafing, both terminal and lateral bearing, low incidence of pistillate flower abscission, high yielding nuts (>6 MT ha^{-1}) with jumbo size nut, relatively smooth, >50 per cent kernel recovery, plump and light-colored kernel and at least moderately resistant to pest and diseases (Botu *et al.,* 2010; Cosmulescu *et al.,* 2010; McGranahan and Leslie, 2012).

Present study effectively addresses existing research gaps through a comprehensive characterization of a diverse walnut germplasm pool, leading to the identification of elite genotypes. The novelty of this investigation lies in the integrated evaluation based on morphological, yield, floral and biochemical attributes, enabling a robust and holistic assessment of genetic potential. Notably, the identified genotypes exhibited superior kernel recovery and quality traits, surpassing several established national and international cultivars, while also representing seedling-origin, locally adapted genetic resources with consistent field performance under minimal management inputs. During the course of investigation, five promising genotypes were selected from a population of eighty genotypes based on studied parameters. The study provides detailed morphological descriptions of these elite genotypes, thereby contributing valuable baseline information for germplasm utilization. These genotypes hold significant potential for further multi-location evaluation, clonal multiplication, and large-scale dissemination, ultimately supporting the development of high-quality planting material and enhancing walnut productivity in the Union Territory of Jammu and Kashmir and similar agro-ecological regions.

Materials and Methods

Over the past two-three decades, SKUAST-Kashmir has conducted extensive field surveys across the walnut-growing areas of the Kashmir Valley, to identify superior seedling-origin walnut genotypes. These selected genotypes were maintained in the germplasm repository located at the Experimental field of Division of Fruit Science, Faculty of Horticulture, Shalimar campus (SKUAST-K). The germplasm was maintained on seedling rootstocks consisting more than 150 genotypes having 7 to 25 years of age, along with released selections and exotic introductions. For the present study, eighty walnut bearing genotypes were marked and evaluated during the year 2023-24 to identify elite ones on the basis of tree, yield, foliage, floral, nut and kernel parameters. Out of eighty genotypes, five genotypes were identified as elite ones based on their overall performance, according to the descriptor lists developed by IPGRI (1994) and UPOV (1999).

These elite genotypes were characterized on the basis of morphological characters viz. age (years), plant height (m), trunk girth (cm), trunk cross-sectional area (TCSA) (cm^2), plant growth habit, shoot pubescence, shoot colour, yield (kg $plant^{-1}$), yield efficiency (kg cm^{-2}) and harvest time; foliage characters viz. leafing time (50% bud burst), leaf length (cm), leaf width (cm), numbers of leaflets, leaflet length (cm), leaflet width (cm), leaf area, (cm^2), leaf colour, leaf shape, leaf margin and time of leaf fall, floral parameters viz. bearing habit, type of dichogamy, time and duration of male flowering, time and duration of female flowering, number of catkins (per shoot), length of catkins (cm), number of pistillate flowers (per shoot) and degree of dichogamy (%). Nut parameters were recorded as: nut shape (perpendicular to suture and through suture), shell texture, shell colour, shell seal, nut diameter (mm) (perpendicular to suture and through suture), nut length (mm) and nut weight (g), whereas kernel parameters such as: kernel colour, kernel weight (g), kernel percentage (%), kernel protein content (%) and kernel fat content (%). Kernel protein (%) was estimated as per Kanwar and Chopra (1967) and kernel crude fat (%) content following the method of Folch *et al.* (1957). All metric characters were recorded with five replications and mean values were computed. The comparison of identified elite genotypes with other standard released varieties (both Indian and global) were discussed based on the values available in secondary literature and international descriptors.

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Results and Discussion

Among the selected genotypes, spreading growth habit was observed in genotype SKAU-W-24 and SKAU-W-41 similar to walnut cvs. Gustine, Payne and Vina (UPOV, 1999) whereas other three genotypes, SKAU-W-28, SKAU-W-34 and SKAU-W-42 showed semi-erect growth habit similar to Franquette, Hartley, Marbot (UPOV, 1999). Angmo *et al.* (2014) found spreading behaviour more common than semi-erect during his course of investigation in walnut.

Growth habit of a tree is a crucial parameter that determines yield or yield efficiency. The spreading behaviour of walnut tree increases the bearing potential by increasing the laterals or sub-terminal or terminal leafy shoots (Chand *et al.,* 2017). Plant height, plant spread (EW and NS), trunk girth and TCSA recorded for genotype SKAU-W-24 was 5.6 m, 6.0 m and 4.0 m, 40.3 cm and 129.31 cm^2 with yield capacity of 32.0 kg $plant^{-1}$ and yield efficiency of 0.2475 kg cm^{-2} whereas genotype SKAU-W-28 registered 7.2 m, 4.6 m and 4.2 m, 49.5 cm, 195.08 cm^2 values for plant height, plant spread (EW and NS), trunk girth and TCSA with yield capacity of 37.0 kg $plant^{-1}$ and yield efficiency of 0.1897 kg cm^{-2} (Table 1). SKAU-W-34 registered 7.0 m, 4.8 m, 3.5 m, 59.2 cm and 279.03 cm^2 values for plant height, plant spread (EW and NS), trunk girth and TCSA, with yield capacity of 33.0 kg $plant^{-1}$ and yield efficiency 0.1183 kg cm^{-2}, however SKAU-W-41 recorded 5.2 m, 4.9 m and 4.3 m, 54.1 cm and 233.03 cm^2 values for plant height, plant spread (EW and NS), trunk girth and TCSA, having yield of 30 kg $plant^{-1}$ and yield efficiency of 0.1287 kg cm^{-2}. Plant height, plant spread (EW and NS), trunk girth and TCSA of SKAU-W-42 genotype was 4.2 m, 5.5 m and 6.0 m, 36.0 cm and 103.18 cm2, respectively with yield of 38 kg $plant^{-1}$ and yield efficiency 0.2256 kg cm^{-2}, respectively (Table 1).

Pandey and Tomar (2012) studied tree height and trunk girth of nine cultivars ranged from 24.64 to 51.10 cm, 12.31 to 37.39 cm, however yield ranged from 0.65 to 2.15 kg $plant^{-1}$. Kumar (2016) recorded yield efficiency in various accessions ranged from 0.0106 kg cm^2 to 0.0204 kg cm^2. Similar tree characters were described by multiple researchers across world as fundamental step and basic approach for promising selection (Botu *et al.,* 2007; Karadag and Akca, 2011). These elite genotypes used for planting material in recent years, are widely distributed in local areas. All the identified elite genotypes are terminal bearers, and their use for budwood collection caused reduction in fruiting laterals, which resulted in fewer female flowers, ultimately causing lower fruit set and a decline in yield and yield efficiency of these elite plants. Furthermore, age of tree, flowering phenology, pollinizers and agro-ecology of area impart larger impact on productivity (Soveili and Khadivi, 2023).

Meanwhile, the observed shoots of all studied genotypes were green brown in colour with slightly pubescent nature. Slightly pubescent shoot with green brown in colour were exhibited by all the elite genotypes similar to Franquette cultivar (UPOV, 1999). However, it also varied from greenish brown, black to pale brown (Sharma and Kumar, 2005). While the harvest period was observed during second week of September for all genotypes, *i.e.,* just after the rainy season is over that makes the post-harvest operations like drying, transportation and storage easy, particularly in areas where winter onset is early (Rana *et al.,* 2007). Early leafing (2nd week of March) time, *i.e.,* 50 per cent bud burst stage was noticed in genotypes SKAU-W-24 and SKAU-W-34 whereas, mid leafing (3rd week of March) time was observed in genotypes SKAU-W-28, SKAU-W-41 and SKAU-W-42 (Table 2).

Late leafing is considered an ideal character in walnuts to escape the spring frost injury even though cultivars such as Serr, Ashley, Chico, Payne and Vina grouped as early leafing (UPOV, 1999) and late leafing varieties were 'Ashley' and 'Sunland' (Barone *et al.,* 1990). Despite early and mid-leafing character of these elite genotypes also proved resistant against frost injury. Arzani *et al.* (2010) reported that out of 58 walnut genotypes, 46 were early leafing and eleven were mid-leafing genotypes in Iran. The colour of fully expanded leaves was green in genotypes SKAU-W-24, SKAU-W-28 and SKAU-W-42 whereas light green in genotypes SKAU-W-34 and SKAU-W-41 meanwhile, Sharma *et al.* (2014) selected elite clone exhibited broad elliptic leaflets of

Table 1: Growth and yield parameters of elite walnut genotypes

Parameters \ Genotypes		SKAU-W-24	SKAU-W-28	SKAU-W-34	SKAU-W-41	SKAU-W-42
Age (years)		22	21	21	21	22
Plant height (m)		5.6	7.2	7.0	5.2	6.8
Plant spread (m)	East-West	6.0	4.6	4.8	4.9	4.5
	North-South	4.0	4.2	3.5	4.3	4.0
Trunk girth (cm)		40.3	49.5	59.2	54.1	46
TCSA (cm^2)		129.31	195.08	279.03	233.03	168.47
Plant growth habit		Spreading	Semi-erect	Semi-erect	Spreading	Semi-erect
Shoot pubescence		Slightly pubescent	Slightly pubescent	Slightly pubescent	Slightly pubescent	Slightly pubescent
Shoot colour		Green brown	Green brown	Green brown	Green brown	Green brown
Yield (kg $plant^{-1}$)		32	37	33	30	38
Yield efficiency (kg cm^{-2})		0.2475	0.1897	0.1183	0.1287	0.2256
Harvesting time		2nd week of Sept	2nd week of Sept	2nd week of Sept	2nd week of Sept	2nd week of Sept

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Table 2: Foliage parameters of elite walnut genotypes

Parameters \ Genotypes	SKAU-W-24	SKAU-W-28	SKAU-W-34	SKAU-W-41	SKAU-W-42
Leafing time (50% bud burst)	Early (15th March)	Mid (16th March)	Early(15th March)	Mid (22nd March)	Mid (16th March)
Leaf length (cm)	52.28	52.32	52.92	41.26	47.2
Leaf width (cm)	36.49	36.82	35.95	33.24	32.99
Numbers of leaflets	6.80	6.60	7.80	5.40	7.00
Leaflet length (cm)	19.82	22.28	22.74	17.62	21.14
Leaflet width (cm)	8.10	10.38	12.36	8.86	11.18
Leaf area (cm^2)	501.33	728.57	897.48	530.14	752.54
Leaf colour	Green	Green	Light green	Light green	Green
Leaf shape	Elliptic	Narrow elliptic	Broad elliptic	Elliptic	Narrow elliptic
Leaf margin	Entire	Entire	Entire	Serrate	Entire
Time of leaf fall	25th Sep. to 15th Oct.	20th Sep. to 15th Oct.	20th Sep. to 15th Oct.	15th Sep. to 5th Oct.	30th Sep. to 15th Oct.

Table 3: Flowering parameters of elite walnut genotypes

Parameters \ Genotypes	SKAU-W-24	SKAU-W-28	SKAU-W-34	SKAU-W-41	SKAU-W-42
Bearing habit	Terminal	Terminal	Terminal	Terminal	Terminal
Type of dichogamy	Protogyny	Protogyny	Protandry	Protandry	Protandry
Duration of male flowering	Late (9 days)	Late (9 days)	Early (10 days)	Mid (7 days)	Mid (6 days)
Duration of Female flowering	Early (13 days)	Early (13 days)	Late (8 days)	Mid (7 days)	Mid (9 days)
Number of catkins (per shoot)	4.33	3.33	4.33	4.00	2.67
Length of catkins (cm)	14.86	14.78	15.62	14.1	15.28
Number of pistillate flowers (per shoot)	2 to 3	2 to 3	2 to 3	2 to 3	2 to 3
Degree of dichogamy (%)	100	100	100	72.43	100

green colour with entire margin. Furthermore, all elite ones had entire leaf margin, except genotypes SKAU-W-41 which showed serrate type. Leaf shape identified as elliptic (SKAU-W-24 and SKAU-W-41) conforming with Corne, Franquette and Marbot (UPOV 1999), narrow elliptic (SKAU-W-28 and SKAU-W-42) conforming with Hartley, Payne and Vina (UPOV, 1999) and broad elliptic (SKAU-W-34) conforming with Adam 10, Chase D 9 (UPOV, 1999), respectively. The estimated values of leaf length, leaf width, number of leaflets, leaflet length, leaflet width and leaf area was 52.28 cm, 36.49 cm, 6.80, 19.82 cm, 8.10 cm and 501.33 cm^2 for SKAU-W-24 genotypes whereas for SKAU-W-28 genotypes the values were 52.32 cm, 36.82 cm, 6.60, 22.28 cm, 10.38 cm and 728.57 cm^2, respectively.

Genotypes SKAU-W-34 and SKAU-W-41 registered leaf length as 52.92 cm and 41.26 cm, leaf width as 35.95 cm and 33.24 cm, number of leaflets as 7.80 and 5.40, leaflet length as 22.74 cm and 17.62 cm, leaflet width as 12.36 cm and 8.86 cm and leaf area as 897.48 cm^2 and 530.14 cm^2. However, SKAU-W-42 recorded 47.20 cm, 32.99 cm, 7.00, 21.14 cm, 11.18 cm and 752.54 cm^2 values for leaf length, leaf width, number of leaflets, leaflet length, leaflet width and leaf area, respectively. The leaf fall period commenced from 15th September (SKAU-W-41), 20th September (SKAU-W-28 and SKAU-W-34), 25th September (SKAU-W-24) and 30th September (SKAU-W-42) and ended on 15th October in all the genotypes, except for SKAU-W-41 where leaf fall ended on 5th October. Corresponding foliage observations was estimated by Pandey and Tomar (2012) and Sharma *et al.* (2014) as a reliable morphological descriptor in walnut selection.

Terminal bearing habit was observed in all the studied genotypes having two to three number of pistillate flowers borne per shoot, which are in accordance with Kumar (2016) who also observed terminal bearing habit in all evaluated walnut selections. Among five elite genotypes, highly protandrous nature were exhibited by SKAU-W-34, SKAU-W-41 and SKAU-W-42 (Table 3) which was similar to Ashley, Franquette, Marbot, Payne, Hartley, Pedro and Hamdan cultivars (UPOV, 1999; Sounduri *et al.,* 2005; Pandey and Tomar, 2012) whereas, genotypes SKAU-W-24 and SKAU-W-28 were found to be protogynous in nature, similar to Amigo, Chico, Sulaiman' cultivars (UPOV, 1999; Sounduri *et al.,* 2005).

Walnut is hetero-dichogamous species demonstrating protandry, protogyny and homogamy in different cultivars/ selections (Kumar, 2016). Except for SKAU-W-41 (72.43 %) the remaining four elite genotypes exhibited high cent per cent degree of dichogamy, suggesting the requirement of pollinizers

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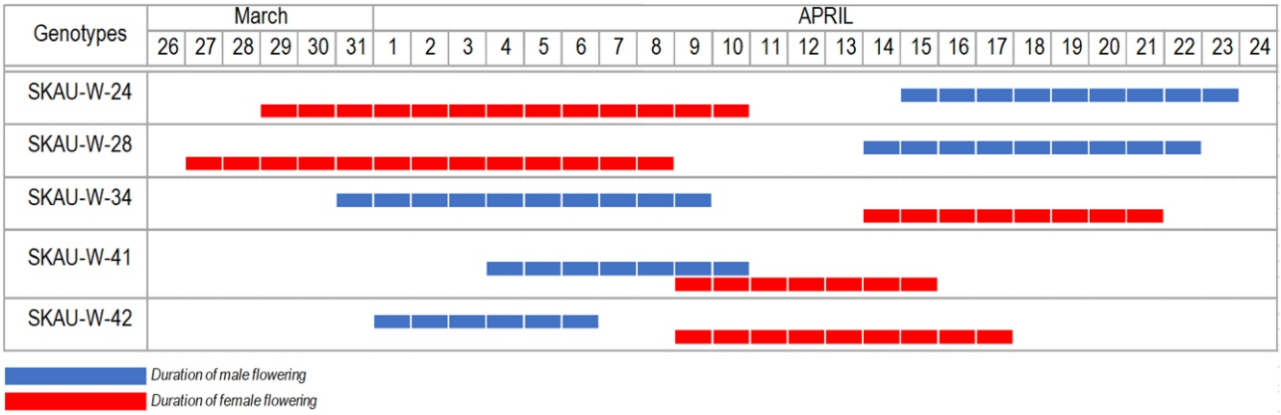


Fig. 1: Time and duration of male and female flowering of elite walnut genotypes.

Table 4: Nut and kernel non-metric parameters of elite walnut genotypes

Parameters	Genotypes	SKAU-W-24	SKAU-W-28	SKAU-W-34	SKAU-W-41	SKAU-W-42
Nut shape	Perpendicular to suture	Broad elliptic	Broad elliptic	Broad elliptic	Broad elliptic	Circular
	Through Suture	Broad elliptic	Broad elliptic	Broad elliptic	Broad elliptic	Circular
Shell texture	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Shell colour	Light	Light	Light	Light	Light	Light
Shell seal	Weak	Intermediate	Weak	Weak	Weak	Weak
Kernel colour	Light	Light	Extra light	Extra light	Extra light	Extra light

for getting higher fruit set among these elite genotypes (Table 3). In contrast to the present findings, Kumar and Sharma (2013) reported less than 25 per cent dichogamy in nine selections and three cultivars. Floral characters, including bearing habit, abundance of male and female flowers and nature of dichogamy, constitutes important traits for characterization and variability studies in walnut (Shah *et al.*, 2021), and are of location, area and cultivar specific traits influenced by agro-ecological condition. Among the selected genotypes, male flowering was initiated earliest in genotype SKAU-W-34 (31st March) taking duration of 10 days, followed by SKAU-W-42 (1st April) and SKAU-W-41 (4th April) taking duration of 6 days and 7 days, respectively. Late male flowering was observed in SKAU-W-28 (14th April) and SKAU-W-24 (15th April) taking duration of 9 days and 8 days, respectively (Fig. 1). The female flowering commenced early in SKAU-W-28 (27th March) and SKAU-W-24 (29th March) taking duration of 13 days each, followed by SKAU-W-41 and SKAU-W-42 as both commenced from 9th April but recorded the duration of 7 days and 9 days, respectively.

Late female flowering was noticed in SKAU-W-34 (14th April) taking duration of 8 days (Fig. 1). Pandey and Tomar (2012) observed male and female flowering in Hartley from 3rd April - 15th April and 6th April to 13th April, whereas in Payne male and female flowering was observed from 23rd March - 6th April and 3rd April to 9th April, respectively. For getting higher fruit set early, mid and late blooming genotypes should be planted with sufficient overlapping period of blooming for effective pollination. The number of catkins per shoot and length of catkins in elite genotypes were SKAU-W-24 (4.33 and 14.86 cm), SKAU-W-28 (3.33 and 14.78 cm), SKAU-W-34 (4.33 and 15.62 cm), SKAU-W-41 (4.00 and 14.10 cm) and SKAU-W-42 (2.67 and 15.28 cm), respectively (Table 3). Kumar (2016) reported maximum number of catkins per bud in RJ-02 (7.50) and catkin length in BS-11 (11.75 cm), during his selection of homogamous walnut trees in South Kashmir region.

Nut and kernel characters decide the superiority of any genotypes in the domestic and international market (Sundouri and Sharma, 2005, Verma *et al.,* 2011) given in Table 4 and Fig. 2. The nut shape at both dimension: at perpendicular to suture and at through suture were identified as circular in genotype SKAU-W-42 aligning with cv. Meylannaise (UPOV, 1999) and broad elliptic in genotypes SKAU-W-24, SKAU-W-28, SKAU-W-34 and SKAU-W-41, which was accordance with cvs. Parisienne and Franquette (UPOV, 1999). All genotypes had nuts with smooth shell texture alongwith light shell colour, similar to Sulaiman and Hamdan (Sofi *et al.,* 2007). Genotype SKAU-W-28 exhibited intermediate shell seal, while the remaining genotypes (SKAU-W-24, SKAU-W-34, SKAU-W-41 and SKAU-W-42) had weak seal. The nut diameter: at perpendicular to suture was 35.08 mm

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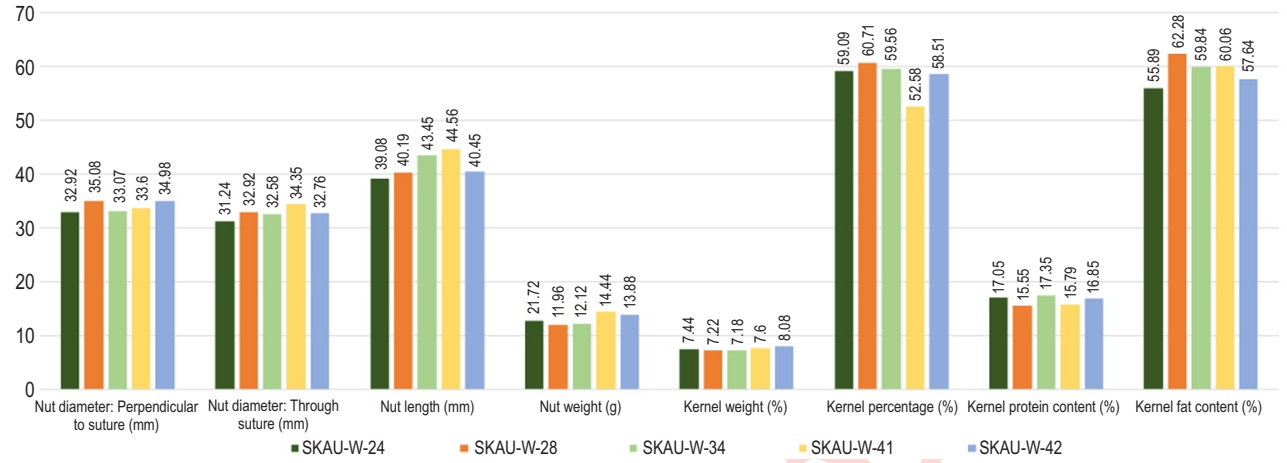


Fig. 2: Nut and kernel metric parameters of elite walnut genotypes.

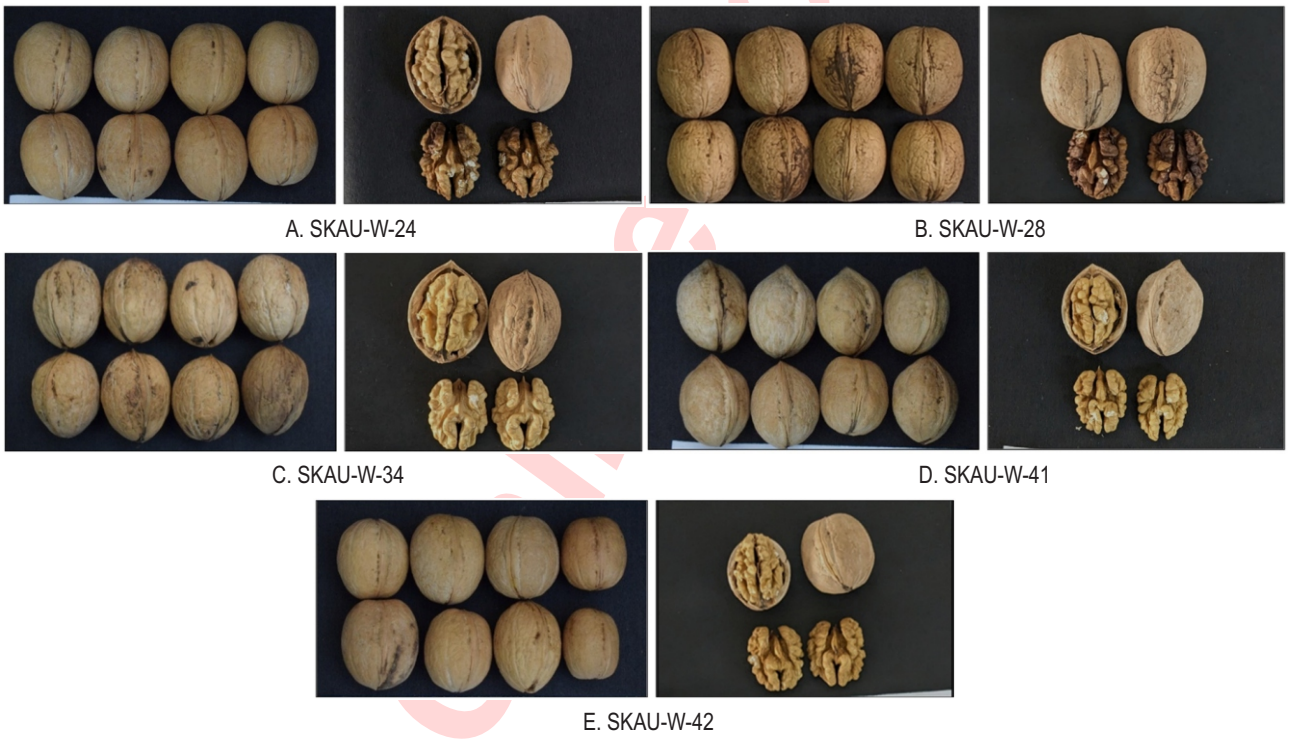


Fig. 3: Nut and kernel sample of elite walnut genotypes.

(SKAU-W-28), 34.98 mm (SKAU-W-42), 33.60 mm (SKAU-W-41), 33.07 mm (SKAU-W-34) and 32.92 mm (SKAU-W-24), however, the nut diameter: at through suture was 34.35 mm (SKAU-W-41), 32.92 mm (SKAU-W-28), 32.76 mm (SKAU-W-42), 32.58 mm (SKAU-W-34) and 31.24 mm (SKAU-W-24), respectively.

Nut length was recorded as 44.56 mm (SKAU-W-41) followed by 43.45 mm (SKAU-W-34), 40.56 mm (SKAU-W-42), 40.19 mm (SKAU-W-28) and 39.08 mm (SKAU-W-24) (Fig. 2). Based on the grades of elite genotypes, SKAU-W-28, SKAU-W-41 and SKAU-W-42 were categorised in jumbo sized nuts (>34 mm), whereas genotypes SKAU-W- 24 and SKAU-W-34 are categorised in Indian super-sized nuts (32-34 mm). Such jumbo size nuts were earlier reported by Sharma *et al.* (2014) in elite walnut clone. The nut weight and kernel weight among the elite

genotypes were recorded as SKAU-W- 41 (14.44 g and 7.60 g), SKAU-W-42 (13.88 g and 8.08 g), SKAU-W-24 (12.72 g and 7.44 g), SKAU-W-34 (12.12 g and 7.18 g) and SKAU-W-28 (11.96 g and 7.22 g), respectively. Kernel percentage was reported very high viz. SKAU-W-28 (60.71 %), SKAU-W-34 (59.56 %), SKAU-W- 24 (59.09%), SKAU-W-42 (58.51 %) and SKAU-W-41 (52.58 %) eventually improved as compared to other international cultivars like Payne (50%), Hartley (46%), Franquette (45%), Chico (46%), Chandler (50%), Yalova-2 (50.37%) and Bilecik (56%) (McGranahan and Leslie, 1990; Akca, 1999) and Indian walnut selections like CITH-1, 2, 3, 4, 5, 6, 7, 8, 9 and 10, Sulaiman, Hamdan, SKAUW-03 and SKAU-W-14 for which it ranged from 50 to 59 per cent (Sounduri *et al.,* 2005; Sofi *et al.,* 2007; Verma *et al.,* 2011; Kumar *et al*., 2025).

Kernel colour was found to be extra light in genotypes SKAU-W-34, SKAU-W-41 and SKAU-W-42 besides light colour in genotypes SKAU-W-24 and SKAU-W-28, which in accordance with Indian walnut selections-Sulaiman and Hamdan (Sounduri *et al.,* 2005; Sofi *et al.,* 2007). The kernel colour also holds premium price in the market and its light colour is preferred over amber and brown colour (Sharma *et al.,* 2014). Apart from morphological characters, the biochemical characters, particularly protein and lipids also play an important role in deciding the market value. Kernel protein content estimated in elite genotypes was SKAU-W-34 (17.35%), SKAU-W-24 (17.05%), SKAU-W-42 (16.82%), SKAU-W-41 (15.79%) and SKAU-W-28 (15.55%). In the previous studies, Erturk *et al.* (2014) reported protein content of 16.85 percent in cv. Sebin, however, protein content in walnut may vary from 15.00 to 24.00 per cent (Akca and Ozongun, 2004; Ali *et al.,* 2010). Kernel fat content registered by the elite genotypes was SKAU-W-28 (62.28 %), SKAU-W-41 (60.06 %), SKAU-W-34 (59.84 %), SKAU-W-42 (57.64 %) and SKAU-W-24 (55.89 %) whereas Erturk *et al.* (2014) reported fat content of 62.17 percent in cv. Sebin.

These five elite genotypes (SKAU-W-24, SKAU-W-28, SKAU-W-34, SKAU-W-41 and SKAU-W-42), identified from the indigenous seedling population of the Kashmir Valley, demonstrated significant superiority in nut and kernel attributes, including high kernel recovery and favorable biochemical composition, coupled with good adaptability. Due to such desirable traits, these elite ones serve as promising genetic resources and reference material for future walnut improvement programmes (Ahir *et al*., 2025), with scope for cultivar development and increase quality walnut production in UT of Jammu and Kashmir, and other temperate regions of India.

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Authors' contribution: S. Mulani: Conceptualization, execution of field work, data collection, data interpretation and drafting manuscript; **A. Kumar:** Conceptualization and designing of the experimental material, contribution of experimental material; **U. Iqbal** and **F.A. Khan:** Proof reading of manuscript; **B. Dhekale:** Proof reading of manuscript and data analysis; **S. Mufti:** Proof reading of manuscript.

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