**Morphological characterisation of Ash gourd [*Benincasa hispida* (Thumb.) cogn.] genotypes**

**Abstract:**

The experimental site for the present investigation is situated at the College of Horticulture, Bengaluru. Which is located in the southern part of India, at a latitude of approximately 12°58'N and longitude of 77°35'E, with an altitude of around 920 meters above mean sea level. The general climatic conditions of Bengaluru are classified as eastern dry zone. The city experiences a moderate climate throughout the year, with a mean annual precipitation of approximately 970 mm, with the majority of rainfall occurring during the monsoon season from June to September.

The experimental was carried out using randomized block design with 30 genotypes of ash gourd and two replications for the study of variability and diversity. The overall mean performance for the genotypes showed considerable variability across traits. RP-1 was the best parent for vine length, while Pusa Ujwal had the shortest. IIHR AG 1 exhibited the highest Number of primary branches per plant, while Kashi Surbhi had the lowest. Pusa Urmi had the longest internodal length, and IC596993 had the shortest. For flowering traits, Pusa Urmi showed the earliest days to first female flowering, and Kashi Surbhi had the highest number of seeds per fruit. KA-4, IIHRAG-3 and RP-3 has highest average fruit weight. RP-1, Surbhi and RP-3 recorded the highest fruit yields, underscoring their superior productivity.

**Keywords:** Onion, genotypes,Characterised, Sterile,

**Introduction:**

Ash gourd (*Benincasa hispida Thunb.*) is a member of the Cucurbitaceae family, widely cultivated for its nutritional, medicinal and industrial value. This monotypic genus, *Benincasa*, includes only one cultivated species. The crop is known by various names across cultures, including “Koosh manda” in Sanskrit, “Pazadaba” in Persian, “Chinese preserving melon,” “hairy melon,” “wax gourd,” “winter melon,” “ash gourd,” “white ash gourd,” and “petha kaddoo” in Hindi. Ash gourd is predominantly grown in the old tropics, particularly in countries like India, Myanmar, Sri Lanka, and China. Its diversity in Southern China suggests its origin in this region (Yang and Walter, 1992). Globally, the major producers of ash gourd include India, followed by China, Indonesia, Thailand and Bangladesh.

In India, ash gourd is extensively cultivated in the plains of Uttar Pradesh, where it is primarily used for making the renowned sweet delicacy “petha” on a commercial scale. Additionally, it is used to prepare “bari” at the household level. The fame of “Agra petha” has spread across India, making ash gourd a culturally and economically important crop. Its ability to thrive in diverse climatic conditions, particularly in the North-Western Indian plains, allows it to grow successfully during both the spring-summer and rainy seasons. This adaptability, combined with its tolerance to high temperatures, makes ash gourd a robust crop for cultivation in tropical and subtropical regions

**Material and Methods:**

The materials and methods used in the current study titled **“Genetic plasticity and recombination superiority studies in ash gourd [*Benincasa hispida* (Thumb.) cogn]”** are explained in detail in this chapter.

**Experimental details**

The experiment including 30 genotypes of ash gourd was conducted during summer 2023 in the month of March 2023 to June 2023 with two replications using a randomized block design. All the recommended cultivation practices were followed to raise a good crop. The observation regarding yield and its components was recorded. The experimental details are listed in Table 1.

Table 1 : Experimental details

|  |  |
| --- | --- |
| Crop | Ash gourd |
| Season | Summer 2023 (March-June) |
| Statistical design | Randomized block design |
| Total number of genotypes | 30 |
| Number of replications | 2 |
| Spacing | 3m × 1.5m |
| Number of plants per row | 10 |

**Result:**

The analysis of variance for thirteen traits under the study, namely vine length, number of primary branches per plant, internodal length, days to first fruit harvest, days to first male flower appearance, days to first female flowering, days to 50% flowering, fruit diameter, average fruit weight, number of fruits per vine, total soluble solids, number of seeds per fruit, yield per plant at the 5 percent significance level.

**Table 2 Analysis of variance for yield and component traits in ash gourd**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sl.  No.** | **Source** | **Mean Sum of Squares (MSS)** | | |
| **Replication** | **Treatment** | **Error** |
| **Degrees of freedom** | 1 | 29 | 29 |
| 1 | **Vine length (cm)** | 28.773 | 56664.782\*\* | 871.150 |
| 2 | **Number of primary branches per plant** | 0.301 | 12.36\*\* | 0.340 |
| 3 | **Internodal length (cm)** | 1.549 | 11.84\*\* | 0.550 |
| 4 | **Days to first male flower appearance** | 2.731 | 187.702\*\* | 26.000 |
| 5 | **Days to first female flowering** | 12.899 | 247.346\*\* | 18.580 |
| 6 | **Days to 50% flowering** | 1.630 | 244.898\*\* | 26.370 |
| 7 | **Days to first fruit harvest** | 28.538 | 34.667\*\* | 14.300 |
| 8 | **Fruit diameter (cm)** | 1.088 | 428.794\*\* | 21.660 |
| 9 | **Average fruit weight (kg)** | 0.002 | 2.93\*\* | 0.290 |
| 10 | **Number of fruits per vine** | 0.015 | 1.831\*\* | 0.110 |
| 11 | **TSS (° Brix)** | 0.001 | 0.119\*\* | 0.050 |
| 12 | **Number of seeds per fruit** | 1072.982 | 46971.214\*\* | 1125.460 |
| 14 | **Yield per plant (kg)** | 0.079 | 17.737\*\* | 0.420 |

**Mean performance of ash gourd genotypes for yield and component traits**

The table 3 represents the mean performance of 30 genotypes for different quantitate traits.

**4.2.1. Vine length (cm)**

The genotype with the longest vine length was RP-1 (729.67 cm) followed by, KA-1 (716.61 cm), and KA-2 (637.67 cm). These genotypes exhibited robust and long-growing vines, suggesting that they may be more vigorous and capable of supporting greater numbers of branches and fruits. On the other hand, Kashi Ujwal (172.49 cm) and IIHRAG-1 (174.99 cm) had the shortest vine lengths, reflecting a more compact growth pattern that may be suitable for limited space or high-density planting.

**4.2.2. Number of primary branches per plant**

The genotypes with the highest number of primary branches per plant was IIHRAG-3 (12.87) followed by, IC392313 (11.62), IC596988 (11.28), These genotypes showed a strong branching ability, indicating their potential for higher fruit production due to increased surface area for flowering and fruiting. In contrast, IC596989 (4.81) followed by Surabhi (5.07) and IC61452 (5.17) had the fewer primary branches, suggesting that these genotypes may have a more concentrated growth form.

**4.2.3. Internodal length (cm)**

Genotypes with the longest internodal length, such as KA-1 (15.00 cm) followed by IIHRAG-4 (14.72 cm), RP-3 (14.40 cm) and IIHRAG-2 (14.22 cm), exhibited greater spacing between nodes, which can be advantageous for better airflow and light penetration, potentially reducing disease risks. Conversely, IC596993 (6.80 cm) followed by IC596988 (6.95 cm) had shorter internodal length, indicating more compact growth, which could result in denser canopy structures.

**4.2.4. Days to first male flower appearance**

The earliest male flower appearance was observed in KA-4 (35 days), IC613451 (40 days) and IIHRAG-1 (46 days) all of which flowered relatively early. Early flowering can be advantageous in shortening the growth cycle, allowing for earlier harvests. However, RP-4 (77 days) followed by KA-1 (75 days) and RP-2 (73 days) had later male flowering, which could delay the fruiting cycle.

**4.2.5. Days to first female flowering**

The genotypes that produced earliest first female flowering were KA-4 (40 days) followed by IC613451 (46 days) and IIHRAG-1 (53 days) these genotypes exhibited quicker female flowering, which can help in achieving earlier fruit sets. The genotypes with the latest first female flowering were IIHRAG-2 (86 days) followed by RP-4 (85 days) and KA-1 (84 days), which may indicate a longer vegetative growth phase before reproductive development begins.

**4.2.6. Days to fifty *per cent* flowering**

The genotypes that reached 50% flowering the earliest were IC596994 (60 days) followed by IC596990 (64 days), IC596993 (67 days) and IC613450 (68 days) These genotypes exhibited relatively fast progression towards significant fifty per cent female flowering. The genotypes with the longest period to 50% flowering were RP-4 (106 days) and KA-3 (103 days), which may result in slightly delayed fruit production.

**4.2.7. Days to first fruit harvest**

The earliest fruit harvest was recorded in IC596993 (123 days) followed by RP-3 and RP-4 with 125 days showing these genotypes quicker transition from flowering to fruit-bearing. On the other hand, IIHRAG-3 (139 days) followed by IC596989 (137 days) had the latest harvest times, which could be due to a longer fruit maturation period or slower flowering.

**4.2.8. Fruit diameter (cm)**

The genotypes with the largest fruit diameter were IIHRAG-4 (99.04), RP-3 (91.94 cm) RP-1 (88.73 cm). Larger fruit diameters often indicate higher marketability, but they may also demand greater energy for growth. In contrast, the smallest fruit diameters were recorded in IC613450 (46.17 cm) followed by Surabhi (46.33 cm) and IC596993 (49.16 cm) suggesting smaller, potentially more compact fruit sizes.

**4.2.9. Average fruit weight (kg)**

Genotypes with the heaviest fruits included KA-4 (8.81 kg) followed by IIHRAG-3 (8.21 kg) and RP-3 (7.90 kg). These genotypes produced significantly larger fruits, which could result in higher yield per plant. Conversely, IC613451 (3.87 kg) followed by KA-2 (4.28 kg) and IC61452 (4.84 kg) had lighter fruit weights, suggesting that they may not be as productive in terms of fruit size.

**4.2.10. Number of fruits per vine (kg)**

The highest average number of fruits per vine were found in RP-1 (5.50) followed by Dhawal and Surabhi which consist of value 4.50 indicating a high fruit-bearing capacity. In contrast, IC596984, IC548540, KA-1 and KA-3 showed fewer average fruits per vine (2.50), which may limit their total yield potential.

**4.2.11. Total soluble olids (TSS)**

The highest TSS values were recorded in Surabhi (3.33), IIHRAG-1 (3.22), and RP-2 (3.16), reflecting sweeter fruits that are likely to be more preferred for fresh consumption. The lowest TSS values were observed in IC548540 (2.39) and IC596985 (2.49), suggesting that these genotypes may produce fruits with lower sugar content.

**Table 3. Mean performance of ash gourd genotypes for yield and component traits**

| **Sl. No.** | **Genotypes** | **VL  (cm)** | **NPB** | **IL  (cm)** | **DFMF** | **DFFF** | **DFF** | **DFH** | **FD (cm)** | **AFW  (kg)** | **NFV** | **TSS (0B)** | **NSF** | **YPP (kg)** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | **IC596984** | 337.16 | 9.12 | 8.05 | 58.92 | 66.88 | 85.09 | 129.73 | 53.79 | 5.32 | 2.50 | 2.75 | 639.61 | 13.20 |
| 2 | **IC596988** | 403.73 | 11.28 | 6.95 | 55.99 | 62.06 | 91.07 | 134.84 | 51.44 | 5.35 | 3.50 | 2.78 | 500.00 | 8.73 |
| 3 | **IC596991** | 317.05 | 6.30 | 10.16 | 62.22 | 72.82 | 88.78 | 128.10 | 62.29 | 6.15 | 4.50 | 2.77 | 339.00 | 24.67 |
| 4 | **IC392313** | 463.42 | 11.62 | 10.37 | 63.63 | 69.56 | 90.12 | 126.38 | 58.05 | 5.55 | 3.00 | 2.61 | 575.50 | 25.38 |
| 5 | **IC596985** | 259.11 | 5.21 | 13.05 | 60.66 | 68.01 | 70.67 | 129.34 | 67.01 | 5.75 | 4.50 | 2.49 | 423.00 | 30.77 |
| 6 | **IC596989** | 183.86 | 4.81 | 12.12 | 68.10 | 75.98 | 85.83 | 137.28 | 65.79 | 5.28 | 3.00 | 2.79 | 320.50 | 21.67 |
| 7 | **IC596993** | 355.45 | 6.88 | 6.80 | 60.44 | 68.05 | 67.17 | 122.73 | 49.16 | 6.50 | 3.00 | 2.73 | 609.00 | 22.80 |
| 8 | **IC548540** | 463.00 | 5.28 | 9.01 | 63.90 | 74.40 | 88.89 | 130.61 | 54.01 | 5.78 | 2.50 | 2.39 | 447.00 | 14.06 |
| 9 | **IC596987** | 629.00 | 10.83 | 9.16 | 61.77 | 72.89 | 85.67 | 133.79 | 64.95 | 7.85 | 3.50 | 3.07 | 654.00 | 26.77 |
| 10 | **IC596990** | 553.29 | 5.40 | 8.05 | 63.62 | 68.97 | 63.45 | 127.06 | 52.73 | 7.28 | 2.50 | 2.56 | 290.00 | 18.82 |
| 11 | **IC596994** | 346.78 | 5.22 | 13.95 | 55.90 | 66.14 | 60.20 | 133.95 | 68.00 | 6.85 | 4.50 | 2.67 | 469.00 | 15.18 |
| 12 | **IC613444** | 429.78 | 5.75 | 10.82 | 69.57 | 82.06 | 95.51 | 127.60 | 55.95 | 6.78 | 5.00 | 2.65 | 736.00 | 34.55 |
| 13 | **IC613450** | 562.74 | 7.34 | 8.40 | 69.44 | 77.67 | 68.12 | 135.10 | 46.17 | 6.10 | 3.50 | 2.52 | 624.00 | 19.50 |
| 14 | **IC613451** | 616.78 | 7.40 | 9.34 | 40.19 | 45.86 | 94.56 | 129.62 | 62.90 | 3.87 | 1.50 | 2.77 | 665.00 | 11.46 |
| 15 | **IC61452** | 581.56 | 5.17 | 10.17 | 54.78 | 59.02 | 91.58 | 126.12 | 52.17 | 4.84 | 3.50 | 2.79 | 492.50 | 19.33 |
| 16 | **KA-1** | 716.61 | 5.22 | 15.00 | 74.78 | 83.89 | 85.56 | 135.05 | 53.95 | 6.50 | 2.50 | 3.00 | 595.50 | 14.13 |
| 17 | **KA-2** | 637.67 | 6.79 | 10.95 | 71.07 | 78.63 | 95.06 | 130.47 | 61.11 | 4.28 | 3.50 | 3.13 | 461.50 | 25.78 |
| 18 | **KA-3** | 463.94 | 6.89 | 9.34 | 58.41 | 66.45 | 103.00 | 134.11 | 60.33 | 7.16 | 2.50 | 2.95 | 484.00 | 13.15 |

***Table 3. Contd...***

| **Sl. No.** | **Genotypes** | **VL  (cm)** | **NPB** | **IL  (cm)** | **DFMF** | **DFFF** | **DFF** | **DFH** | **FD (cm)** | **AFW  (kg)** | **NFV** | **TSS (0B)** | **NSF** | **YPP (kg)** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 19 | **KA-4** | 422.50 | 10.95 | 12.68 | 35.28 | 39.83 | 97.04 | 131.92 | 66.40 | 8.81 | 3.00 | 2.96 | 473.50 | 16.59 |
| 20 | **KASHI UJWAL** | 172.49 | 10.49 | 9.60 | 59.06 | 68.95 | 89.89 | 125.18 | 63.21 | 4.41 | 2.50 | 3.09 | 388.00 | 15.02 |
| 21 | **DHAWAL** | 232.34 | 6.15 | 8.72 | 61.70 | 69.50 | 86.23 | 129.98 | 59.98 | 7.40 | 4.50 | 3.12 | 389.50 | 29.31 |
| 22 | **SURBHI** | 205.21 | 5.07 | 13.45 | 55.86 | 61.15 | 90.61 | 127.25 | 46.33 | 5.11 | 4.50 | 3.33 | 497.50 | 44.21 |
| 23 | **IIHRAG-1** | 174.99 | 11.05 | 13.79 | 45.82 | 52.92 | 96.51 | 132.44 | 79.86 | 6.33 | 4.00 | 3.22 | 422.00 | 28.21 |
| 24 | **IIHRAG-2** | 215.47 | 10.79 | 14.22 | 73.28 | 85.85 | 89.28 | 125.16 | 84.17 | 5.73 | 3.00 | 3.10 | 640.00 | 21.15 |
| 25 | **IIHRAG-3** | 545.00 | 12.87 | 10.71 | 65.92 | 76.11 | 93.89 | 139.27 | 88.38 | 8.21 | 4.50 | 2.88 | 399.50 | 22.61 |
| 26 | **IIHRAG-4** | 607.90 | 10.20 | 14.72 | 70.47 | 80.89 | 88.29 | 128.34 | 99.04 | 6.60 | 4.50 | 2.54 | 597.50 | 33.82 |
| 27 | **RP-1** | 729.67 | 9.70 | 11.79 | 68.62 | 79.27 | 87.43 | 134.05 | 88.73 | 5.05 | 5.50 | 2.97 | 948.50 | 48.98 |
| 28 | **RP-2** | 620.78 | 7.12 | 13.01 | 73.62 | 83.00 | 97.17 | 128.19 | 66.33 | 6.25 | 3.50 | 3.16 | 600.00 | 25.58 |
| 29 | **RP-3** | 405.17 | 9.15 | 14.40 | 69.41 | 78.13 | 91.11 | 124.62 | 91.94 | 7.90 | 4.50 | 3.02 | 828.00 | 35.79 |
| 30 | **RP-4** | 407.06 | 7.29 | 13.09 | 76.90 | 85.34 | 106.15 | 124.84 | 89.39 | 5.00 | 4.50 | 3.07 | 750.00 | 13.20 |
| **Mean** | | 435.32 | 7.91 | 11.06 | 62.31 | 70.67 | 87.46 | 130.10 | 65.45 | 6.13 | 3.58 | 2.86 | 541.97 | 23.75 |
| **CV (%)** | | 6.78 | 7.31 | 6.69 | 8.18 | 6.10 | 5.87 | 2.91 | 7.11 | 8.65 | 9.09 | 7.10 | 6.19 | 13.74 |
| **SEm±** | | 20.87 | 0.41 | 0.52 | 3.61 | 3.05 | 3.63 | 2.67 | 3.29 | 0.38 | 0.23 | 0.14 | 23.72 | 2.31 |
| **CD at 5%** | | 60.36 | 1.18 | 1.51 | 10.43 | 8.82 | 10.50 | 7.74 | 9.52 | 1.08 | 0.67 | 0.42 | 68.61 | 6.67 |

VL=Vine length (cm), NPB=Number of primary branches per plant, IL=Internodal length (cm), DFMF=Days to first male flower appearance, DFFF=Days to first female flowering, DFF=Days to 50% flowering, DFH=Days to first fruit harvest, FD=Fruit Diameter(cm), AFW=Average fruit weight (Kg), NFV=Number of fruits per vine, TSS=Total soluble solids(OB), NSF=Number of seeds per fruit, YPP=Yield per plant(kg)

**4.2.12. Number of seeds per fruit**

The genotypes with the highest seed numbers per fruit were RP-1 (948.50), RP-3 (828.00), and RP-4 (750.00). These genotypes produced a higher number of seeds, which can be a trait of vigorous fruiting. The lowest seed counts per fruit were found in IC596990 (290 seeds) and IC596989 (320.50), indicating potentially lower seed-setting capacity.

**4.2.13. Yield per Plant (kg)**

The highest yield per plant was recorded in RP-1 (48.98 kg) followed by SURBHI (44.21 kg) and RP-3 (35.79 kg). These genotypes had high productivity, which is crucial for maximizing overall yield in a given area. In contrast, IC596988 (8.73 kg) followed by IC613451 (11.46 kg) and KA-3 (13.15 kg) had the lowest yield per plant, indicating that they may not be the best choices for large-scale production due to their relatively lower yield.

**A close-up of a melon

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**Fig .1 Pictorial representation of high yielding genotypes**

**Discussion:**

The analysis of thirteen traits across 30 genotypes revealed considerable variation in performance, offering valuable insights for breeding programs. RP-1, KA-1, and KA-2 exhibited the longest vine lengths, suggesting robust growth, while KASHI UJWAL and IIHRAG-1 had the shortest vine lengths, making them suitable for compact planting in space-constrained environments. Genotypes like IIHRAG-3, and IC392313 showed the highest branching potential, which can contribute to increased fruit production. In contrast, KA-1, IIHRAG-4, and RP-3 showed the longest internodal lengths, promoting better airflow and reducing the risk of disease. Early flowering was observed in KA-4, IC613451 and IIHRAG-1, which could be advantageous for achieving early yields.

However, IIHRAG-3 and IC596993 exhibited delayed fruit harvest, which may be less desirable for early-season production. RP-1, Surbhi and RP-3 recorded the highest fruit yields, underscoring their superior productivity, while IC596988 and IC613451 and KA-3 yielded the least. Additionally, IIHRAG-4 and RP-3 and RP-1 demonstrated the largest fruit diameter. KA-4, IIHRAG-3 and RP-3 has highest average fruit weight. Surabhi, IIHRAG-1 and RP-2 has highest total soluble solids (TSS), indicating their strong commercial potential. These findings highlight the diversity in traits across the genotypes, providing valuable information for selecting candidates for further breeding and cultivation improvement.

The mean performance of various genotypes in terms of traits such as average fruit weight, fruit length, flowering time, and yield-related characteristics highlighted specific genotypes that showed superior traits. For instance, Pusa Ujjwal was found to be superior to Sunabeda Local and Mahima in terms of Average fruit weight and length, which supports the findings of Thakur *et al*. (2017). In contrast, MAH-1 and Hiramandalam Local exhibited early flowering and harvesting, respectively, demonstrating their potential for early maturity (Ram *et al*., 2007). Other genotypes, such as Raygada Local and Kasi Surbhi, exhibited the best fruit productivity, underscoring the importance of assessing multiple traits to identify high-performing genotypes. The evaluation of fifteen ash gourd genotypes revealed significant variation, suggesting a potential for breeding improved varieties. The similar findings reported by Sharma *et al*. (2018) and Narayan (2011) further support the idea that genetic variation plays a crucial role in determining desirable traits in bottle gourd and related crops.

Overall, the findings underscore the importance of both genetic diversity and mean performance evaluations in identifying promising genotypes for breeding programs, as evidenced by the works of Singh *et al*. (2000), Sundaram (2007), Behera *et al*. (2009), and others.

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