

COMPARATIVE GERMPLASM EVALUATION OF BOTTLE GOURD (LAGENARIA SICERARIA L.) HYBRIDS AND VARIETIES FOR YIELD AND ADAPTIVE TRAITS UNDER FAISALABAD AGRO-CLIMATIC CONDITIONS

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Abstract

Bottle gourd (*Lagenaria siceraria*) is an important cucurbitaceous vegetable crop widely cultivated in Pakistan for its nutritional, culinary, and economic value. Continuous introduction and evaluation of improved hybrids and varieties is essential to identify genotypes with superior germination, fruiting, and yield potential suited to local agro-climatic conditions. The present study was conducted in an open field at the Vegetable Research Institute (VRI), Faisalabad during Kharif 2025 to evaluate the adaptability and comparative yield performance of fourteen bottle gourd hybrids/varieties, including a local check (Faisalabad Round), received from different seed companies. The trial was laid out in a randomized complete block design (RCBD) with three replications, a plot size of 5 × 3 m², and a plant to plant spacing of 50 cm. Seed was sown on March 11, 2025, poor initial germination in some entries necessitated re sowing after seven days to ensure a uniform stand. Fruit picking commenced on May 5, 2025 and continued through August 12, 2025, comprising a total of nineteen pickings. Data on germination percentage, number of fruits per plant, and fruit yield (t/ha) were recorded and analyzed statistically. Five hybrids produced significantly higher yield than the check. The hybrid HBO-246 F1 gave the highest yield (35 t/ha) with 85% germination and 5 fruits per plant, followed by Ujala F1 (34 t/ha) and VIP-66 F1 (32 t/ha), all of which markedly outyielded the local check, Faisalabad Round (15 t/ha). The lowest yield was recorded in ICS-BO-1251 (10 t/ha).

Introduction

Bottle gourd (*Lagenaria siceraria* L.), belonging to the family Cucurbitaceae, is one of the oldest domesticated vegetable crops and is cultivated extensively throughout the tropical and subtropical regions of the world, including South Asia. In Pakistan, it occupies an important place

among summer (kharif) vegetables owing to its wide adaptability, high yield potential, and multiple culinary and nutraceutical uses. The fruit is valued as a low calorie, high fiber vegetable rich in vitamins, minerals, and antioxidants, and various parts of the plant have also been reported to possess pharmacological

properties, including hepatoprotective, antidiabetic, and anti-inflammatory activities.

Bottle gourd is a monoecious, highly cross-pollinated crop with a diploid chromosome number of $2n = 22$, which offers considerable scope for the development of high-yielding hybrids through exploitation of heterosis. In recent years, several public and private seed companies in Pakistan have introduced new hybrids and open-pollinated varieties claiming superior yield and quality attributes. However, the performance of any genotype is strongly influenced by genotype environment interaction, and materials that perform well in one agro-ecological zone may not necessarily perform equally well in another. It is therefore essential to subject newly introduced entries to systematic, replicated adaptability trials under local field conditions before their recommendation to growers.

Yield-attributing traits such as germination percentage, number of fruits per plant, and fruit yield per unit area are commonly used criteria for the preliminary screening of cucurbit germplasm. Several earlier studies on bottle gourd have reported wide genotypic variability for these traits, underscoring the importance of continuous evaluation and selection to identify genotypes best suited to specific growing regions. Keeping this in view, the present adaptability trial was undertaken during Kharif 2025 at the Vegetable Research Institute, Faisalabad, with the objective of evaluating and comparing the germination, fruiting behavior, and yield performance of fourteen bottle gourd hybrids/varieties received from various seed companies against a standard local check (Faisalabad Round), in order to identify superior entries for further evaluation and possible recommendation to farmers in the Faisalabad region.

Materials and Methods

Experimental site, season, and design

The present study was conducted during Kharif 2025 in an open field at the experimental farm of the Vegetable Research Institute (VRI), Ayub Agricultural Research Institute, Faisalabad,

Punjab, Pakistan. Faisalabad lies in the semi-arid plains of central Punjab and represents a major vegetable-growing zone with hot, humid summers, making it well suited for evaluating the field performance and adaptability of cucurbitaceous crops such as bottle gourd. The trial was laid out according to a randomized complete block design (RCBD) with three replications.

Plant material

Fourteen bottle gourd entries, comprising commercial F1 hybrids and open-pollinated varieties received from different seed companies, were evaluated alongside a locally grown check variety, Faisalabad Round. The entries evaluated were: HBO-246 F1, Ujala F1, VIP-66 F1, AABO-111, Savera F1, BG-60 F1, HBO-273G, Quest-1, Quest-2, HBO-373C, PK-5322, AABO-222, ICS-BO-1251, and Faisalabad Round (check).

Sowing, crop stand, and cultural practices

Seed of all entries was sown on March 11, 2025 in plots measuring 5×3 m², with a plant-to-plant spacing of 50 cm maintained within rows to ensure uniform stand establishment. Germination of some entries was found to be poor following the initial sowing; to secure a satisfactory plant population, re-sowing of the affected entries was carried out seven days after the first sowing. Standard cultural practices recommended for bottle gourd cultivation in the region, including irrigation, fertilizer application, weeding/hoeing, and plant protection measures against insect pests and diseases, were applied uniformly to all entries throughout the crop season, so that differences among entries could be attributed primarily to genotype rather than to management.

Fruit picking and data recorded

Fruit picking began on May 5, 2025 and continued at regular intervals until August 12, 2025, during which a total of nineteen pickings were taken from the trial. Observations were recorded on the following parameters for each entry: (i) germination percentage, calculated as the proportion of seeds that produced viable

seedlings relative to the total number of seeds sown; (ii) number of fruits per plant, recorded as the mean number of marketable fruits harvested per plant, cumulated over all nineteen pickings; and (iii) total fruit yield, expressed in tonnes per hectare (t/ha), calculated from the cumulative marketable fruit weight harvested from each entry across all pickings and converted to a per-hectare basis.

Statistical analysis

Data recorded for fruit number and fruit yield were analyzed statistically following the analysis of variance (ANOVA) procedure appropriate to the randomized complete block design, and treatment means were compared using the Least Significant Difference (LSD) test at the 5% probability level to determine statistically significant differences among the tested entries. In addition, Pearson correlation coefficients were computed between germination percentage, number of fruits per plant, and fruit yield across the fourteen entries to examine the strength of association between these traits. All statistical computations and graphical outputs (Figures 1–3) were generated in the R statistical computing environment (R Core Team) using the ggplot2 and ggrepel packages.

Results and Discussion

The performance of the fourteen bottle gourd entries with respect to germination percentage, number of fruits per plant, and fruit yield is summarized in Table 1 and Figure 1. As shown, five hybrids (HBO-246 F1, Ujala F1, VIP-66 F1,

AABO-111, and Savera F1) produced significantly higher yield than the local check, Faisalabad Round. The highest yield was obtained from HBO-246 F1 (35 t/ha), which also recorded the highest germination percentage (85%) and the highest number of fruits per plant (5) among all entries tested. Ujala F1 (34 t/ha, 84% germination) and VIP-66 F1 (32 t/ha, 80% germination) followed closely, while the local check, Faisalabad Round, yielded only 15 t/ha despite a comparable germination percentage (80%), indicating that yield superiority in the top hybrids was driven mainly by greater fruit-bearing capacity rather than germination alone.

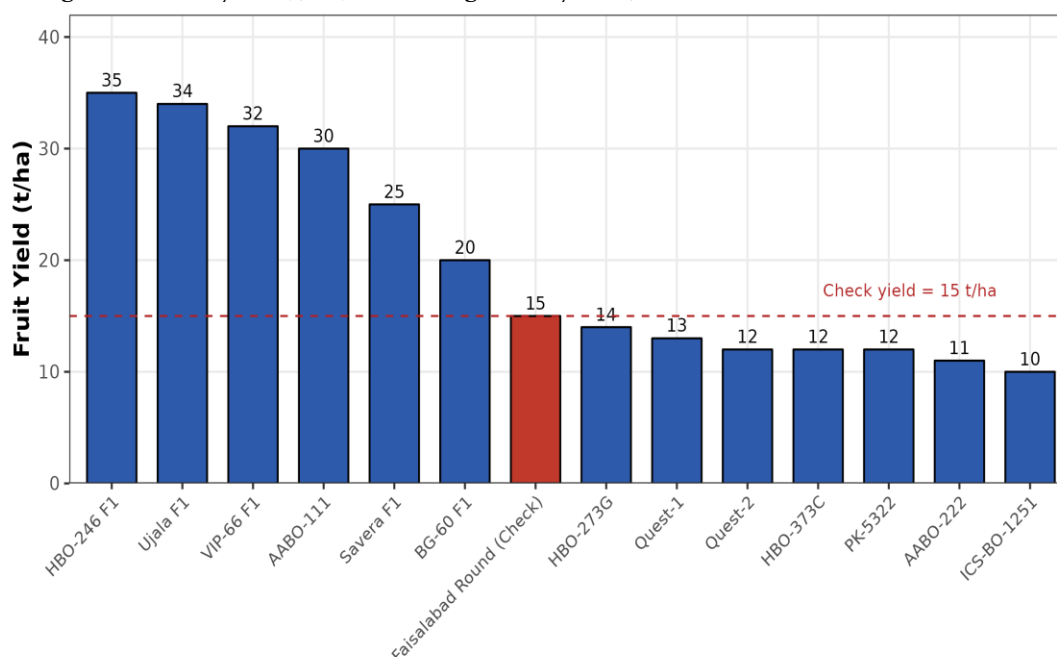
A closer examination of the data reveals a broadly positive association between germination percentage, fruit number per plant, and final yield, though the relationship was not strictly linear. Entries such as BG-60 F1 combined a relatively lower germination percentage (73%) with five fruits per plant to still achieve a respectable 20 t/ha, whereas HBO-273G, despite comparable germination (79%) to several higher-yielding hybrids, produced only four fruits per plant and a correspondingly lower yield (14 t/ha). This suggests that fruit-set and fruit-retention efficiency, rather than germination alone, were the principal drivers of yield differences among the mid- and lower-ranking entries. The bottom four entries (HBO-373C, PK-5322, AABO-222, and ICS-BO-1251) each produced only three to four fruits per plant and yields at or below 12 t/ha, reflecting comparatively weaker adaptability to the open-field conditions at Faisalabad during the Kharif 2025 season.

Table 1. Performance of bottle gourd hybrids/varieties in an adaptability trial at the Vegetable Research Institute, Faisalabad (Kharif 2025)

Hybrid/Variety	Germination (%)	Fruits/Plant (No.)	Yield (t/ha)
HBO-246 F1	85	5	35
Ujala F1	84	5	34
VIP-66 F1	80	5	32
AABO-111	75	5	30
Savera F1	74	4	25

Hybrid/Variety	Germination (%)	Fruits/Plant (No.)	Yield (t/ha)
BG-60 F1	73	5	20
Faisalabad Round (Check)	80	4	15
HBO-273G	79	4	14
Quest-1	76	4	13
Quest-2	75	4	12
HBO-373C	72	4	12
PK-5322	70	3	12
AABO-222	71	3	11
ICS-BO-1251	72	3	10
LSD (5%)	—	5.4	5.4

Figure 1. Fruit yield (t/ha) of bottle gourd hybrids/varieties relative to the local check



The calculated LSD (5%) value of 5.4 for both fruit number and yield indicates that differences of this magnitude or greater between entry means can be considered statistically significant. Applying this threshold, HBO-246 F1, Ujala F1, VIP-66 F1, and AABO-111 were each significantly superior to the check in yield, while the remaining entries, including Savera F1, did

not differ significantly from several of the lower-to mid-ranking entries, even though their yields were numerically higher than the check. This pattern of a small group of clearly superior hybrids separated from a larger cluster of statistically similar entries is consistent with earlier reports of considerable genotypic variability for fruit yield and yield-attributing

traits in bottle gourd (Balat et al., 2021; Bawkar et al., 2015), and mirrors the wide range in fruit number and yield documented across diverse bottle gourd genotypes evaluated under different agro-climatic conditions in India (Devi & Prathyusha, 2020; Kumar et al., 2023).

To further examine the relationships among the recorded traits, germination percentage and number of fruits per plant were each plotted against fruit yield (Figures 2 and 3). Fruit yield showed a moderately strong positive correlation with germination percentage ($r = 0.70$) and a stronger positive correlation with the number of fruits per plant ($r = 0.83$) across the fourteen entries. The steeper and tighter relationship with fruit number, visible in Figure 3, supports the

interpretation that fruit-bearing capacity, rather than germination percentage alone, exerted the dominant influence on final yield ranking. Notably, HBO-246 F1, Ujala F1, VIP-66 F1, and AABO-111 clustered together at both high fruit number (5 fruits/plant) and high germination (75–85%), whereas the local check, Faisalabad Round, fell distinctly below the fitted trend line in Figure 3, producing only four fruits per plant and a lower yield than would be predicted from its germination percentage alone (Figure 2). Such deviation of a standard check below the fitted regression is frequently observed when comparing open-pollinated checks against elite F1 hybrids, and is generally attributed to the absence of heterotic vigor in the check genotype.

Figure 2. Relationship between germination (%) and fruit yield (t/ha)

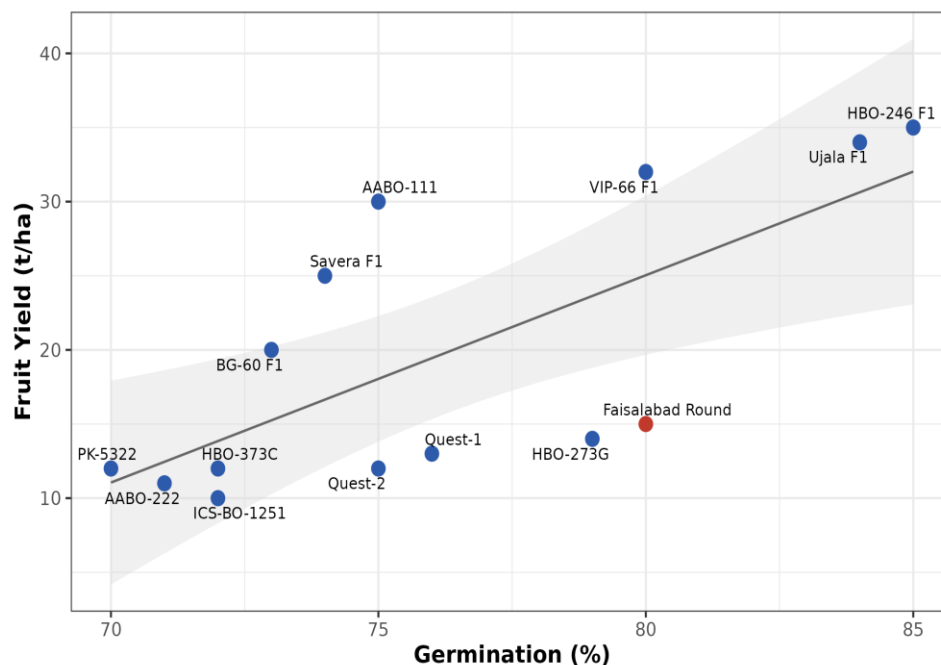
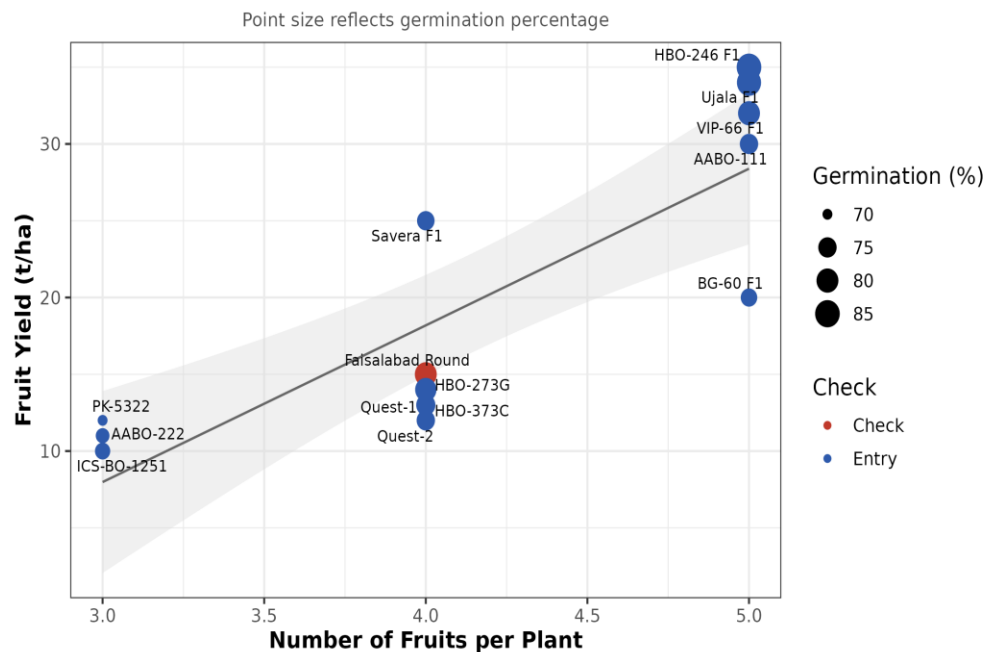


Figure 3. Number of fruits per plant versus fruit yield, scaled by germination (%)



The consistently poor performance of the local check, Faisalabad Round, relative to several of the newly introduced F1 hybrids is noteworthy from a breeding and extension standpoint. Open-pollinated, locally maintained varieties such as Faisalabad Round typically lack the heterotic vigor associated with well-combined F1 hybrids, which may explain the roughly two- to three-fold yield advantage observed in the top three hybrids over the check. This finding aligns with the broader trend, reported across multiple bottle gourd hybrid evaluation and diallel studies, of F1 hybrids expressing substantial standard heterosis for fruit yield over open-pollinated checks, with reported magnitudes ranging from roughly 35% to well over 100% above the standard check in some cross combinations (Doloi et al., 2018), and is further supported by evaluation studies documenting F1 hybrids outperforming open-pollinated checks in fruit number, fruit weight, and total yield (Singh et al., 2024; Verma et al., 2024). Genetic studies employing diallel and line $\times$ tester mating designs have similarly reported that non-additive gene action predominates for fruit yield in bottle gourd (Yadav et al., 2025), which is consistent with the pronounced yield advantage of F1 hybrids over the open-pollinated

check observed in the present trial. Taken together, the results support the continued advancement of HBO-246 F1, Ujala F1, and VIP-66 F1 for multi-location testing, while entries in the lower-yielding cluster, particularly ICS-BO-1251 and AABO-222, warrant re-evaluation or exclusion from further trials at this location.

Conclusion

The Kharif 2025 adaptability trial conducted at the Vegetable Research Institute, Faisalabad, demonstrated clear and statistically significant genotypic variation among fourteen bottle gourd hybrids/varieties for germination, fruit number, and fruit yield. HBO-246 F1, Ujala F1, and VIP-66 F1 emerged as the most promising entries, each substantially out yielding the local check, Faisalabad Round, and are recommended for inclusion in multi-location adaptability trials and, subject to consistent performance over additional seasons and locations, for eventual recommendation to growers in Faisalabad and comparable agro-ecological zones of Punjab. Conversely, ICS-BO-1251, AABO-222, and PK-5322 showed the weakest adaptability under the tested conditions and are not recommended for further advancement at this stage. Continued

seasonal and multi-location evaluation, supported by data on fruit quality, disease reaction, and cost-benefit analysis, is recommended to confirm the stability and commercial viability of the superior hybrids identified in this study.

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