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ASSESSMENT OF VEGETATIVE AND REPRODUCTIVE TRAITS IN BOTTLE GOURD CULTIVARS

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ABSTRACT

Low yield of bottle gourd (*Lagenaria siceraria* L.) in Pakistan can be attributed to number of factors, however, cultivation of low-yielding cultivars is a serious and an important issue. Yield in bottle gourd can be improved by using adaptable high-yielding cultivars. The present investigation was carried out with ten cultivars of bottle gourd to evaluate their performance for various horticultural attributes. Cultivars grown under agro-climatic conditions of Faisalabad exhibited significant variation in number of horticultural attributes. The genotype G_6 (Akash Green gold) was found to possess maximum internodal length (3.61 cm) while, G_2 (Arya 187 F_1) recorded maximum leaf area (89.29 cm^2). The cultivar G_4 (Akash F_1 hybrid) and G_8 (Kohli Long hybrid) was noted for higher fruit diameter (11.96 cm) and fruit length (13.23 cm), respectively. The cultivar G_2 (Arya 187 F_1) was found to be superior and promising for more fruit weight, higher number of fruits per vine and elevated fruit yield, thus it can be recommended to farmers for commercial cultivation. Moreover, outcome of this bottle gourd characterization exhibiting significant variations can be organized in accordance to their usefulness for identification of morphological traits, fruit characters and seed attributes.

Keywords: assessment, bottle gourd, cultivars, vegetative, yield

INTRODUCTION

Cucurbits, a group of vine vegetables belonging to family Cucurbitaceae is distinct lineage primarily comprised of about 118 genera having 825 species. Even though many of these have its origin from Old World whereas, many other species too originate in New World particularly seven genera from both northern and southern parts. Well there is immense genomic variability among this family as its adaptability range varies from tropical and subtropical areas, arid zone and temperate regions. There is a presence of high genetic diversity regarding both vegetative and reproductive characters with substantial variation in the chromosome number (x) viz. including *Cucumis sativus* having 7, melons, gourds, squashes, chayote and cucumerina with 11, Indian squash (Tinda), wax gourd and ivy gourd having 12 and luffa species with 13 chromosomes (Thakur *et al*., 2016).

Bottle gourd (*Lagenaria siceraria* L.) is a popular summer vegetable in Pakistan commonly known as lauki or ghia (Ilyas *et al*., 2017). Being a good source of carbohydrates, minerals, vitamins and amino acids, its fruit provides significant quantities of vitamin B and C, pectic substances and soluble fibers (Modgil *et al*., 2004). It has beneficial effects on heart activity and digestive system, further it can also be used as diuretic, cooling, analgesic, anti-pyretic and anti-ulcer agent (Milind and Satbir, 2011).

Bottle gourd is a monoecious, highly cross-pollinated annual vine having a branching growth habit. It has variable, alternate, hairy leaves accompanied by the presence of tendrils. Male and female flowers are present at different axils of plant, particularly male flowers having long peduncles while female bearing short peduncles. This presence of both male and female flowers at same plant enhances extent of cross pollination up to 60 to 80% (Sirohi and Choudhury, 1979). Fruit having many shapes (elongated to narrow neck) and sizes (small to large) is fleshy and multi seeded (Milind and Satbir, 2011).

Cultivars with superior genetic makeup are fundamental constituent among approaches adapted for agricultural sustainability. Whereas

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concept of agricultural sustainability has been shifted repeatedly with passage of time as Hayes *et al.* (1955) concluded "main purpose of germplasm selection/evaluation is to explore genetic potential and phenotypic exhibition that are efficient in response to plant nutrient application, yield high quality products with increased return per acre or unit area in accordance to actual cost consumed with ease of production well adapted to prerequisites of grower and consumer. It is therefore of immense significance to explore available germplasm with high potential against adverse environmental conditions (Kutka, 2011).

This situation is particularly hastened by continuous shift of climate over a period of time which has greatly affected growth and productivity of available germplasm (Raza *et al*., 2019). This led to selection of open pollinated (OP) and hybrid cultivars for cultivation. Whereas OP cultivars are mostly used by farmers for the sake of recycling their own farm seed which having low hetrosis, heterozygous in nature with reduced genetic capability against biotic and abiotic stresses (Karutz and Dierauer, 2005). In comparison, hybrids develop from cross between inbred lines have high heterosis level for various horticultural traits (Joshi and Tandon, 1976), uniformity in reproductive characteristics thus by reducing number of plants per unit area to achieve similar or even higher produce as compared to OP cultivars do. Environmental conditions, selection of appropriate genotypes, nutrient application and management practices greatly influence the growth, flowering and sex expression of bottle gourd (Ilyas *et al*., 2017). However, among these factors, selection of appropriate genotypes is of crucial importance as it sustains and optimizes all other factors. Every genotype has a particular growth behaviour, flowering sequence and maturity timings (Haque *et al.,* 2014). In view of the above facts and figure, a characterization trial of bottle gourd cultivars was conducted to evaluate inherent potential of cultivar to exhibit different horticultural traits under agro-climatic conditions of Faisalabad, Pakistan.

MATERIALS AND METHODS

Research trial was conducted at Vegetable farm, Institute of Horticultural Sciences, University of Agriculture, Faisalabad. Healthy and disease-free seeds of ten bottle gourd cultivars viz. G_1 (Faisalabad round- Check), G_2 (Arya 187 F_1), G_3 (Round Gourd), G_4 (Akash F_1 hybrid), G_5 (Long green F_1), G_6 (Akash Green gold), G_7 (China variety), G_8 (Kohli Long hybrid), G_9 (Bulb hybrid) and G_{10} (Akash India) were gathered from government and private sources. Following ploughing and harrowing, raised bed with a dimension of 6x4 feet with 3 feet apart from each other were prepared on finely pulverized soil. Later on seed of all varieties was sown by dibbling method at depth of 2 cm with plant x plant distance of 2 feet on one-sided bed. Few days after sowing, emergence of seedlings was observed on regular basis and re-transplanting was done in case of any dead, weak/injured seedlings. Experiment was laid down in RCBD design having three replications of each genotype whereas least significant difference (LSD) test was used to compare differences of mean between variables at 95 % confidence level (Chase and Brown, 1997). Vegetative growth expressed as internodal length and leaf area (cm^2) was assessed following the method of Abdel- Mawgoud *et al*. (2010). Reproductive traits i.e. number of flowers per plant, number of fruits per plant, number of marketable fruit per plant, average single fruit weight, fruit length and diameter, yield per plant, plot and hectare were calculated after harvest.

RESULTS AND DISCUSSION

Internodal length is one of the important characters of plants, generally associated with the exhibition of growth and vigour of crop plant. Results showed that G_6 depicted maximum internodal length (3.61 cm), followed by G_1 (3.36 cm), G_2 (3.28 cm) and G_{10} (3.21 cm) while least internodal length was recorded in G_9 (1.88 cm) cultivar (Figure 1a). Internodal elongation is based on ability of plants to perform cell division and cell elongation (Anandan *et al*., 2012) enhancing stem radial growth via radial cell division (Cronquist, 2018) in particular this elongation could be ascribed to role played by genotype internal auxins and gibberellins level (Amooaghaie, 2009) allowing the plant to extend itself and better compete for sunlight thus enhancing photosynthetic potential and maximizing crop yield (Ullah *et al*., 2018). Moreover, environmental conditions *viz*. temperature at specific growth stages also affects internodal spacing as low temperature results in shorter internodes whereas high light levels will lead to photo destruction of auxin, thus producing shorter internodes and smaller plant height (Rauscher, 2017).

Leaf area regulates light perceiving ability of a crop and is therefore used as a character of high value for determining plant growth behaviour in germplasm evaluation. Results observed varied between 19.63 to 89.29 cm^2 with higher leaf area (89.29 cm^2) recorded in G_2, with least (19.63 cm^2) in G_7 (Figure 1b). Leaf area is mostly governed by both cultivars and prevailing environmental conditions, and an interaction of both these factors. Leaf area and internodal length are positively correlated with each other particularly on main stem of plant (Reddy *et al*., 1995). Linkage between leaf area and plant growth depends on how carbon that has been fixed in photosynthesis is distributed between leaf and other plant organs which has been delineated by using mass-based relative growth rates (RGR_M), depicts photo-synthetically fixed C has been attributed in various plant growth processes viz. root and leaf development, respiration, exudation, and reproduction (Weraduwage, 2015). Thus, it can be concluded that leaf area being an index of crop green area indicates photosynthetic efficiency which in turn enhances crop yield. Similar results were also reported by Rani (2014), that leaf area index differs in various genotypes of a crop.

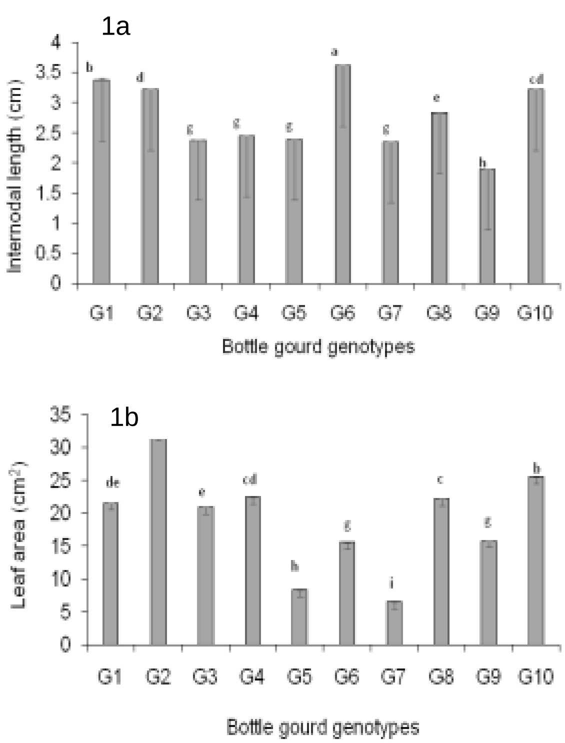


Figure 1. Performance of various vegetative characters of bottle gourd genotypes. Different letters indicate significant differences at $P \leq 0.05$. Vertical bars represent ± SE of means

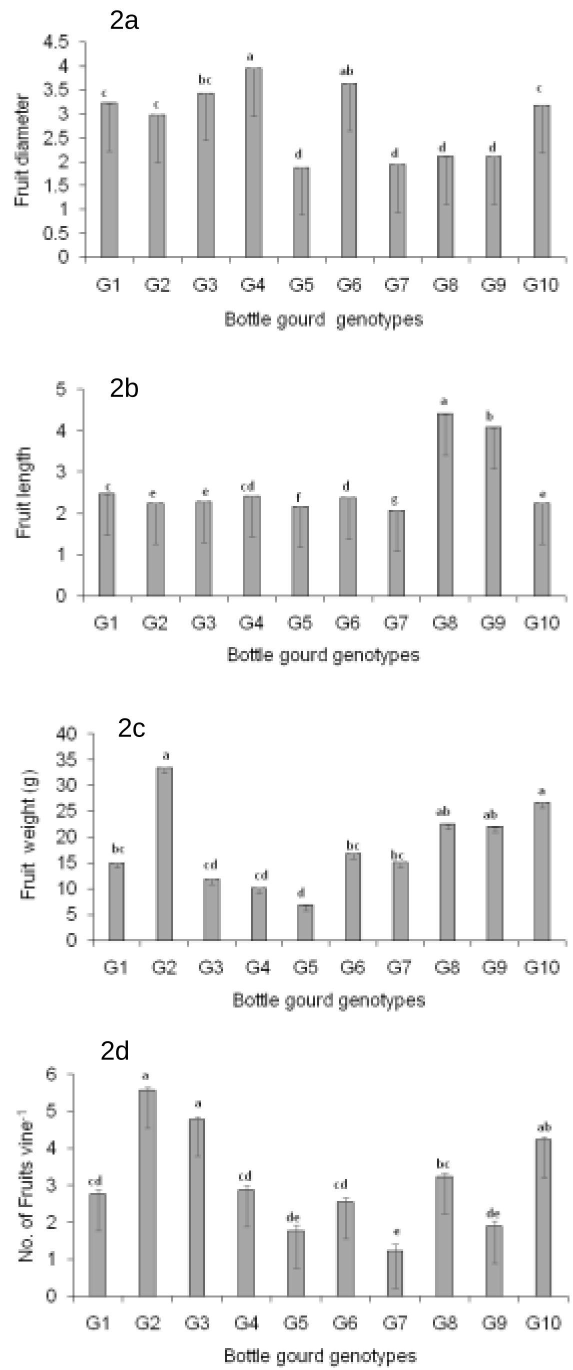
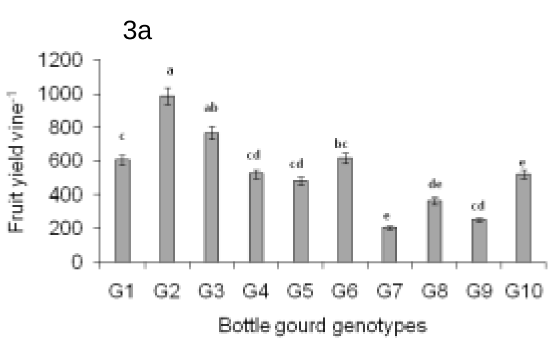


Figure 2. Performance of various reproductive characters of bottle gourd genotypes. Different letters indicate significant differences at $P \leq 0.05$. Vertical bars represent ± SE of means

Genetic and environmental factors are being mainly involved in determining fruit shape (diameter and length) in various crops (Monforte *et al.*, 2014). Results have depicted that maximum (11.96 cm) and minimum fruit diameter (5.65 cm) was recorded for G_4 and G_5, respectively (Figure 2a). Fruit length ranged from 6.22 to 13.23 cm, higher fruit length (13.23 cm) was yielded by genotype G_8 whereas, comparatively G_7 produced lowest (6.22 cm) fruit length (Figure 2b). Fruit growth in particular is completed in four separate growth stages expressing a double-sigmoid growth pattern, where growth and development is mostly expressed as fruit diameter (Coombe, 1976). The S_1 and S_3 are faster growth stages that are being interspersed with S_2 and S_4 stages of slower increases in fruit diameter (Zanchin *et al*., 1994). Time taken to complete each of development stage depends upon genotype (Yamaguchi *et al*., 2002) where early maturing genotypes have resulted in lower cell division rate, so it could yield small size fruits.

Fruit weight an index of crop health and productivity is an important parameter which differs among genotypes. Results depicted significant differences among fruit weight which varies from 20.46 to 83.91g, particularly 83.91 g as maximum fruit weight observed in G_2 whereas least (20.46 g) in G_5 (Figure 2c). Fruit weight a quantitatively inherited character is an important yield determining trait is particularly influenced by genotype as it is controlled by various genetic loci, some of them having major role while others with a small effect. Likewise, in tomato genotypes evaluation, quantitative trait loci (QTL) responsible for influencing fruit weight was characterized on chromosome 2 with a function of regulating cell division thus influencing number of cells per unit size (Frary *et al*., 2000) moreover cell size and ploidy level is also positively correlated to higher fruit mass (Cheniclet *et al*., 2005).

Results of number of fruits vine^{-1} showed significant differences among bottle gourd genotypes. The G_2 recorded maximum number (14.66) of fruits vine^{-1} in comparison of G_7 which yield lowest (3.66) number of fruits vine^{-1} (Figure 2d). This trend may be due to the variation in the genetic makeup of the genotype.



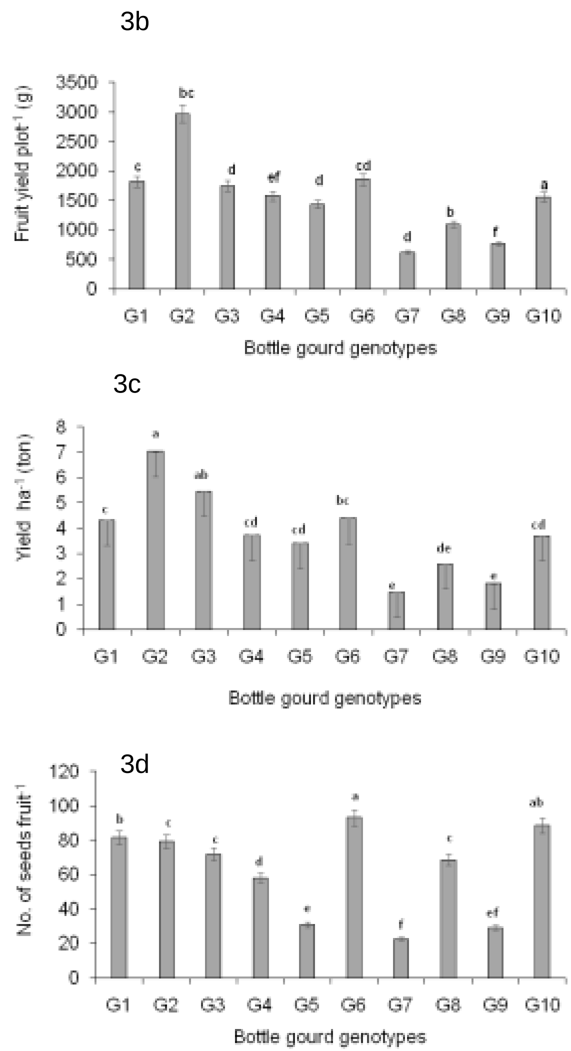


Figure 3. Performance of various yield related characters of bottle gourd genotypes. Different letters indicate significant differences at $P\leq$ 0.05. Vertical bars represent ± SE of means

Fruit yield vine^{-1} determines crop productivity and profitability of crop. It ranged between 620.0 to 2633.4 g vine^{-1} (Figure 3a). Maximum fruit yield per vine (2633.4 g) was produced by G_2, while G_7 produced minimum (620.0 g) fruit yield vine^{-1} (Figure 3a). Whereas, fruit yield per plot fluctuate from 1860.3 to 8012.1 g. Greater yield per plot (8012.2 g) was recorded in G_2 cultivar, whereas G_6 gave lower (1860.3 g) yield per plot (Figure 3b). Maximum yield per hectare (18.72 t ha^{-1}) was recorded in G_2, while minimum yield (4.40 t ha^{-1}) was observed in G_6 (Figure 3c). This higher yield might be due to either differences in genotypes or to the favorable climatic condition and better management of the experiment or both. Fruit yield is usually inherent potential of any genotypes to set fruit, whereas final fruit size is controlled by number of cells and volume of cell layers in fruit pericarp which is governed by rate of cell division and expansion of fertilized ovaries (Renaudin *et al*., 2017).

Significant differences were exhibited among bottle gourd genotypes regarding number of seeds fruit^{-1} (Figure 3d). Number of seeds fruit^{-1} ranged from 67.67 to 279.6. The G_6 recorded maximum (279.6) number of seeds fruit^{-1}; while G_7 recorded least (67.67) number of seeds fruit^{-1} (Figure 3d). Such increment of seed fruit^{-1} can be ascribed to various factors i.e. pollinating agents, number of fruits plant^{-1} and final quality of produce (Harika *et al*., 2012). Whereas, low seed yield may also be due to inconsistent day and night temperatures which lead to drying of ovaries, poor fruit set and desiccation of tender fruits ultimately reducing seed yield (Samadia, 2002).

CONCLUSION

Results depict significant level of variations among bottle gourd genotypes under assessment. Whereas average bottle gourd yield in Pakistan is very low in comparison to developed vegetable growing countries; thus genotypes under current evaluation contribute good indication and opportunities for bottle gourd growers in country to make use of these cultivars for achieving better yield and quality ultimately a significant increment in profit and income generation. Conclusively use of improved luffa cultivars with recommended cultural practices is advised for optimum crop production and sustainable agriculture management.

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