Research Article

Evaluation of Bottle Gourd Genotypes for Yield and Quality Traits

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Abstract | Nine exotic bottle gourd (*Lagenaria siceraria* Mol. Standley) genotypes were evaluated for their fruit physico-chemical characteristics and yield behavior at Faculty of Agriculture, Gomal University, D.I. Khan (Pakistan) during 2013 and 2014. The genotypes of bottle gourd were Hazarvi, Anmol, Amber, King, Advanta-205, Surbhi, Royal, Nobel, Sharmic and Louki (local check variety). The experiment was laid-out in randomized complete block design having ten treatments (including 9 exotics plus 1 local genotype) and three replications. The results showed that there were significant variations in all the parameters except moisture content that was found to be non-significant in 2013. The comparative assessment of the exotic germplasms investigated in this study displayed better performance over the local check in both the study years. The maximum germination (84.1 % and 85.4 %), number of fruits (25.4 and 23.9), fruit length (52.8 and 51.5 cm), fruit width (16.7 and 17.1 cm), fruit weight (1283.8 and 1330.2 g), yield (48.1 and 50.1 tons ha^{-1}), TSS (7.1 and 6.9 %) and Vitamin C (16.1 and 16.1 mg/100g) were recorded in cv. Anmol. On the basis of overall performance and highest yield, genotype Anmol is recommended for large-scale cultivation under the agro-climatic conditions of Dera Ismail Khan.

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Introduction

Bottle gourd (*Lagenaria siceraria*) is widely grown cucurbit of the world (Hidayatullah et al., 2012). The plants are annual viny, creeper and can be grown on the ground like most of other members of pumpkin family and die at the end of each growing season. The stem is deeply grooved, angular and 1 cm thick and having 5-6 branches. The leaves are prostrate or branching having two tendrils on the base of the leaf stalk. The plant has wide and spreading root system having color from white to pale cream. The taproot penetrates down from 60-80 cm. Flowers are monoecious in nature white solitary male and female flowers found on different axes of the same plant thus cross-pollination is highly favorable (Ilyas et al., 2017). The large white flowers open at night. Female flowers are short-stalked. Fruit is of many forms, shape, and varieties. Each variety produces different shaped, sized fruit from round to large some elongated with narrow neck (Anonymous, 2016). It is one of the most important species in plant kingdom due to the diversity of fruit shapes, color, sizes, and way to use and is largely grown in tropics and subtropics for its edible fruits. Tender fruits are used as a vegetable and also for the preparation of

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sweets and pickle especially in the hills (Sherma and Sengupta, 2012). Fruit have a moderately hard rind, with a thick edible flesh below, and a central cavity. There are numerous seeds in a fruit. Most seeds are plump and tan or soft white. They all are covered with a testa or seed coat. Seeds are flat, more or less rectangular to narrow trapezoidal, whitish to dark brown. The fruit is rich in proteins, minerals, amino acids and fixed oils (Hegazy and El-Kinawy, 2011). Fruits of the plant are directly or indirectly useful to cure different diseases like asthma, pain, ulcer, constipation and bronchial disorders (Gorasiya et al., 2012). Bottle gourd is commonly grown twice a year during February-March and June-July. Seed sown in February-March are harvested in May-June. Seed sown in June–July is harvested in September-October. It requires loose, fertile, well drained and neutral soil for growth. Local variety, Louki, is cultivated on a large scale in our country that produces a lower yield compared to many exotic varieties. Several factors are responsible for this lower yield such as biotic and abiotic stresses and loss of yield potential of Louki variety with the passage of time. Lack of high yielding varieties is one of the most important factors that limit bottle gourd productivity. All the cultivars cannot be grown successfully in each region. Some cultivars are successfully adapted to a region while others show poor performance in the same region (Rehman et al., 1990). Therefore, very high yielding exotic varieties need careful investigation before growing on a large scale for lack of knowledge of their adaptation with local conditions. In a field study, Samadia (2002) investigated yield potential of twenty genotypes of bottle gourd and found cultivar Pusa Naveen having earliness ability and maximum fruit yield in adverse environmental conditions especially in high-temperature stress under hot arid environment. Considerable variability was displayed in the qualitative traits particularly blossom, shape and ridges of bottle gourd whereas significant differences were also recorded for quantitative characters like fruit length, fruit width and fruit circumference (Sivaraj and Pandravada, 2005; Singh et al., 2006; Vaniya et al., 2008). Pandit et al. (2009) observed genetic variability in 15 genotypes of bottle gourd and recorded useful variations for all yield and yield contributing traits. Harika et al. (2012) did a comparative assessment of 25 bottle gourd genotypes for various horticultural characters and found the genotype Gaja bearing a large number of fruits per plant and higher fruit yield. Arvind et al. (2012) reported significant variations in 24 bottle gourd genotypes for days to germination, fruit diameter, fruit length, vine length and the number of branches plant^{-1}.

Testing diverse genetic material of any crop species in any locality with favorable agro-climatic conditions usually, display variability in different characters due to their genetic makeup and adaptability behavior. This provides an easy way to enhance the gene pool of vegetable crops and exploit genetic variability for food and better agriculture. This technique has been adopted successfully around the globe for several decades particularly for vegetables. The growers need an early maturing and high yielding bottle gourd variety. Therefore, the aim of this study was to evaluate growth, yield and chemical composition of exotic bottle gourd genotypes under the agro-climatic conditions of Dera Ismail Khan.

Materials and Methods

The study was conducted at Faculty of Agriculture, Gomal University, D. I. Khan during 2013 and 2014. The soil of the experimental plot was clay loam in texture. The soil of the study area is hyperthermic, and Typic Torrifluvents, saline, less fertile and requires irrigation for crop production (Soil Survey Staff, 2009). Soil physicochemical characteristics were determined before sowing. The detail is given in Table 1. Weather conditions during both years of study were almost the same (Table 2).

Table 1: *Soil analysis of the experimental area before sowing.*

S. No	Parameter	Unit	Value
1.	pH	-----	8.0
2.	Electrical Conductivity	dSm^{-1}	0.650
3.	Ca + Mg	Meq/L	6.40
4.	CO_3	Meq/L	Nil
5.	HCO_3	Meq/L	1.48
6.	C1	Meq/L	2.38
7.	Organic matter	g/kg	6.5
8.	Nitrogen (N)	g/kg	0.32
9.	Phosphorus (P)	mg/ kg	7.2
10.	Potash (K)	Mg/kg	189
11.	Gypsum requirement	T ac^{-1}	Nil
12.	Lime ($CaCo_3$eq)	%	9.62
13.	Textural class	------	Clay loam

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Table 2: *Meteorological data for 2013 and 2014 bottle gourd growing seasons.*

Date	Temperature ^{O}C Maxi - Mini (2013)	Temperature ^{O}C Maxi-Mini (2014)	Rainfall (mm) (2013)	Rainfall (mm) (2014)
July	40 - 29	38 - 28	22	91.50
August	37 - 27	38 - 27	-	9
September	37 - 25	37 - 25	16	9
October	33 - 21	32 - 19	5.50	4.3

Source: *Arid Zone Research Institute, PARC, D. I. Khan.*

The experiment was laid out in randomized complete block design having 10 treatments including genotypes [Hazarvi, King, Amber, Anmol, Surbhi, Advanta 205, Nobel, Royal, Sharmic, and Louki (a local standard variety used as a check)] and three replications. The genotypes were purchased from Punjab Seed Company, Seed Merchant and Importers, Lahore, Pakistan. The detail about origin and source of local and exotic cultivars is given in Table 3. The field was plowed to a fine tilth and plotting was made according to the experimental treatments. Field was irrigated before dibbling the seeds and thereafter once a week. The soaked seeds were sown on 22nd and 24th July in 2013 and 2014, respectively in well prepared seed bed at a depth of 1 cm. Row to row and plant to plant distance was kept as 2 m and 1.5 m, respectively. Recommended doses of farm yard manure (20 t ha^{-1}) and NPK (200:100:100 kg NPK/ha) fertilizers were also applied. FYM (N = 12.23 g kg^{-1}, P = 7.24 g kg^{-1}, and K = 86. mg kg^{-1}), phosphorus, and potash were applied at sowing while nitrogen was given in three equal splits that is at sowing, one month after sowing, and at flower initiation stage. Irrigation source was canal water. Unifor irrigation at a depth of 7.5 cm was given to all the experimental plots. First irrigation was given immediately after sowing while subsequent irrigations were given with two weeks interval. Total of seven irrigations were given as per detail in Table 4. Last irrigation was given two days before first picking. First picking was done on 16 and 18 October in 2013 and 2014, respectively while second and third pickings were done on weekly basis in both years. Weeds were controlled manually. Red pumpkin beetles, fruit flies, and caterpillars were controlled by spraying Malathion 50 EC (1 ml/lit) before one month of harvesting.

Data were recorded on the following parameters.

Growth characters

Days to germination: Days were counted from the date of seeding till completion of 50% germination and mean was calculated.

Germination (%): Germination %age was calculated by counting the total number of plants emerged in each treatment and % germination was calculated with the formula.

$$Germination\ \%age = \frac{\text{Number of seeds germinated}}{\text{Number of seeds planted}} \times 100$$

Days to male/ female flowering: The number of days was counted from the date of germination to appearance of 50% flowers and the mean was calculated.

Fruit physicochemical characters were recorded in second picking on October 23 and 25, 2013 and 2014, respectively.

Fruit length and width (cm): Ten fruits were selected randomly from each treatment and the length and width of fruit were measured with measuring scale and mean was calculated in centimeters.

Fruit weight (g): The weight of 10 fruits selected randomly from each treatment and weighed in grams with a digital balance and their mean was determined.

Fruits per plant: Three plants were selected randomly from each treatment at every picking. The total number of fruits picked were counted and then averaged to number of fruits plant^{-1}.

Fruit yield (tons ha^{-1}): Total weight of all the harvested fruits from each picking was weighed and fruit yield per hectare was calculated.

Chemical characters

Moisture (%): The moisture content in fruits was determined by the direct heating method as recommended by AOAC (1997).

Total soluble solids (°Brix): It was determined by using hand refractometer.

Ascorbic acid (Vitamin-C): It was determined by the titration method of reduction of 2, 6-dichlorophenol-indophenol dye (Munir et al., 2013).

Table 3: *Origin and source of cultivars.*

Serial No.	Cultivars	Origin	Source
1	Local (Louki, control)	Pakistan	Local market
2	Hazarvi	Thailand	Rashid seeds, Gujranwala-Pakistan. www.rashidseeds.com
3	King	India	Agroimpex corporation. 142, Indra market, old subzimandi, Delhi-110007 (India). Agroimpex2001@yahoo.com
4	Amber	India	Durga seed farm. 172 Industrial area, Phase-1 Chandigarh India. www.durgaseed-farm.com
5	Anmol	Thailand	East-west seed international LTD. Importers: Haji sons. 65/13 kewlery ground Lahore. www.hajisons.pk
6	Surbhi	India	Global seeds. 4656, Roshnara Road, Delhi-110007. Globalseedsco@rediffmail.com
7	Advanta 205	India	Advanta seeds international. Marketed by ICI Pakistan Limited, 5 west wharf-Karachi. www.icipakistan.com
8	Nobel	India	Rachna crop sciences (Pvt.) Ltd. Mini stadium, SKP Road, Gujranwala-Pakistan. www.rachnaseed.com
9	Royal	India	Rachna crop sciences (Pvt.) Ltd. Mini stadium, SKP Road, Gujranwala-Pakistan. www.rachnaseed.com
10	Sharmic	India	Imported by: Green gold Agri seeds-Pakistan. www.greengoldagriseeds.com

Table 4: *Irrigation schedule during 2013 and 2014 bottle gourd growing season.*

Irrigation number	Date of irrigation	
	2013	2014
First irrigation	22 July, 2013	24 July
Second irrigation	5 August	7 August
Third irrigation	19 August	21 August
Fourth irrigation	2 September	4 September
Fifth irrigation	16 September	18 September
Sixth irrigation	30 September	2 October
Seventh irrigation	14 October	16 October

Statistical analysis

The data collected were analyzed statistically using computer software MSTATC. The analysis of variance (ANOVA) technique as appropriate to RCBD was applied and means were compared through least significant difference (LSD) test (Steel et al., 1997).

Results and Discussion

Days to germination

The number of days to germination in bottle gourds displayed significant differences amongst genotypes. Maximum days to germination (7.0 to 6.8 and 6.3 to 6.4) were taken by Hazarvi and King in both years of study (Table 5). Contrary to this Anmol and Amber took minimum days to germination (4.0 to 4.1 and 4.0 to 4.3). All other genotypes took days to germination in the range of 4.3 to 5.3 which is an intermediate range compared to maximum and minimum values.

Germination percentage

The germination percentage observed in bottle gourd genotypes was significant. The highest germination was recorded in cv. Anmol during 2013 (84.3%) and 2014 (85.3%) while it was lowest in genotype Louki both in year 1 (Y1) (70.3%) and in year 2 (Y2) (65.8%) (Table 5).

Days to male flowering

The variations observed in the number of days taken to male flowering were found to be significant in the genotypes under study. The cultivar Amber took minimum days to flowering in Y1(40.7) and Y2(39.8) followed by cultivar King and Anmol (42.0 to 41.8 and 45.0 to 44.5) (Table 5). The maximum days to male flowering were recorded in Local check and Sharmic.

Days to female flowering

Female flower emergence remained variable among genotypes and differences observed were statistically significant. Days to female flowering ranged from 44.0 to 65.8 days (Table 5). The cultivar Anmol took minimum days (44.0 to 46.1) while Local check took maximum days (61.3 to 65.8) female flowering, the results being consistent over years. The results obtained are in conformity with the observations of Harika et al. (2012) and Shaikh et al. (2012) who reported days to female flowering in our prescribed range for stable genotype NDBG-104 x DBG-5 of bottle gourd. The difference in flowering time in bottle gourd genotypes is also reported by Kappal et al. (2015).

Table 5: *Days to germination, germination (%), days to male flowering, and days to female flowering observed in bottle gourd genotypes during 2013 and 2014.*

Genotypes↓	Days to germination		Germination (%)		Days to male flowering		Days to female flowering	
Years→	2013	2014	2013	2014	2013	2014	2013	2014
Louki (control)	4.3cd	5.0bc	70.3j	65.8e	52.0a	53.2a	61.3a	65.8a
Hazarvi	7.0a	6.8a	73.3i	75.1d	46.0 cd	45.1d	55.0b	53.1bc
King	6.3a	6.4a	78.2g	75.2de	42.0de	42.8d	47.0cd	48.0de
Amber	4.0d	4.3b-d	80.1d	80.4b	40.7e	39.8e	58.0ab	53.1bc
Anmol	4.0d	4.1d	84.1a	85.3a	45.0cd	44.5d	44.0d	46.1e
Surbhi	4.3cd	4.6b-d	79.1f	78.1bc	51.0ab	50.1bc	55.0b	56.2b
Adventa-205	5.0bc	4.3b-d	81.1b	80.2b	49.0ac	48.0c	50.0c	50.7cd
Nobel	4.7bd	4.6b-d	80.7c	83.1a	51.0ab	51.5ab	45.0d	46.5e
Royal	5.0bc	5.3b	74.8h	76.4cd	47.0 bc	48.2c	50.0c	50.5cd
Sharmic	5.3bc	6.1a	79.7e	80.1b	52.0a	52.1ab	46.7cd	47.2e
$LSD_{0.05}$	0.7	0.7	0.3	2.3	4.2	2.4	3.5	3.2

Means followed by similar letter(s) in each column are non-significantly different at P≤ 0.05

Table 6: *Fruit length (cm), fruit width (cm), fruit weight, and number of fruits per plant observed in bottle gourd genotypes during 2013 and 2014.*

Genotypes↓	Fruit length (cm)		Fruit width (cm)		Fruit weight (g)		No. of fruits /plant	
Years→	2013	2014	2013	2014	2013	2014	2013	2014
Louki (control)	33.2i	31.1g	14.8f	11.5g	926.1g	920.4e	4.5e	6.5g
Hazarvi	36.9h	36.1f	15.0ef	14.2f	998.2f	1050.3d	8.5de	7.1g
King	46.5c	46.4c	15.7cd	14.8ef	1044.1e	1114.9c	11.4e	10.2f
Amber	41.2e	40.1e	16.0bc	15.2de	937.2g	925.1e	11.9c-e	12.2e
Anmol	52.8a	51.5a	16.7a	17.1a	1283.8a	1330.2a	25.4a	23.8a
Surbhi	39.0g	40.1e	15.0ef	15.1de	933.4g	1018.1d	11.8c-e	11.3ef
Adventa-205	44.2d	45.2d	16.1b	16.2b	1030 .1e	1168.8b	14.3a-c	15.2d
Nobel	52.2b	48.2b	15.1c	15.1de	1153.1b	1145.1bc	19.1a-c	21.5b
Royal	40.5f	40.2e	15.7d	15.5cd	1073.6d	1014.5d	17.2a-c	17.6c
Sharmic	46.3c	46.1cd	16.1b	16.0bc	1112.1c	1108.5c	20.2ab	22.1b
$LSD_{0.05}$	0.6	1.2	0.3	0.6	27.2	43.7	3.9	1.2

Means followed by similar letter(s) are non-significantly different at P≤ 0.05.

Fruit length (cm): The variability in bottle gourd genotypes for fruit length remained significant. The highest fruit length (52.8 to 51.5) was found in Anmol followed by Noble and King (52.2 to 48.2 and 46.5 to 46.6) as compared to local check, Louki that produced lowest fruit length (33.2 to 31.1) (Figure 1 and Table 6).

Fruit width (cm): The analysis of variance for fruit width of bottle gourd was found significant. The genotype Anmol gave maximum fruit width (16.7 to 17.1) followed by genotype Adventa-205 and Sharmic (16.1to 16.2 and 16.1to 16.0) (Table 6). Local variety, Louki gave lowest fruit width (14.8 to 11.5).

Fruit weight (g): The fruit weight of different genotypes was significantly different from each other. The genotype, Anmol exhibited the highest fruit weight of 1112 to 1108 (g) among all other genotypes (Table 6). The local cultivar Louki had the lowest fruit weight (926 to 920).

Number of fruits per plant: The number of fruits plant^{-1} varied significantly among the bottle gourd genotypes. The genotype Anmol produced highest (25.4 to 23.8) number of fruits/plant followed by Nobel and Sharmic (20.2 to 22.1 and 19.1 to 21.1) (Table 6). Minimum (4.5 to 6.5) number of fruits/plant was recorded in local cv. Louki (check) which was statistically at par with Amber and Surbhi.

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Table 7: *Fruit yield (ton/ha), moisture (%), fruit TSS (%), and vitamin C (mg/100g) observed in bottle gourd genotypes during 2013 and 2014.*

Genotypes↓	Yield (ton/ha)		Moisture (%)		Fruit TSS (°Brix)		Vitamin C (mg/100g)	
Years→	2013	2014	2013	2014	2013	2014	2013	2014
Louki (control)	20.2i	21.2j	89.9	89.1c	7.1a	7.1a	14.8c	14.8c
Hazarvi	27.3h	27.8i	91.1	91.3a	4.3 e	3.6f	13.2d	13.3f
King	38.2e	37.5e	91.0	90.1b	6.0 c	4.8e	14.1c	14.1e
Amber	27.2h	24.2h	90.6	90.2b	5.2d	5.2d	15.8b	15.2b
Anmol	48.1a	50.1a	88.3	85.4f	7.0a	6.9ab	16.1a	16.1a
Surbhi	30.3g	30.2g	87.0	87.8e	6.4b	6.7b	14.1c	14.2e
Adventa-205	37.9f	35.1f	87.7	88.8cd	5.2 d	6.0c	15.1b	15.2b
Nobel	40.6b	41.1b	88.3	88.1e	5.1d	5.2d	14.9b	14.5d
Royal	40.2c	40.5c	88.8	90.6b	6.0 c	6.1c	13.2d	13.4f
Sharmic	39.2d	39.8d	91.0	90.8ab	5.0 d	5.1de	14.2c	14.1e
$LSD_{0.05}$	0.02	0.55	ns*	0.72	0.25	0.28	0.45	0.27

Means followed by similar letter(s) are non-significantly different at P≤ 0.05. ns stands for non significant.*

Figure 1: *Pictures of nine exotic bottle gourd genotypes along with local (Control).*

Yield (tons/ha): The study revealed significant differences for yield in different bottle gourd genotypes. Anmol had the highest fruit yield both in Y1(48.8) and in Y2(50.1) followed by Nobel(40.6 to 41.1) (Table 7). The lowest (20.2 to 20.2) fruit yield was recorded in local check variety Louki. The genotype Hazarvi and Amber gave statistically identical fruit yield(27.2 to 24.2) . The rest of the genotypes like Royal, Sharmic, King, and Adventa-205 also gave higher fruit yield than check variety.

Fruit moisture contents (%): Fruit moisture contents observed in various genotypes was not significant in 2013, however, the results were found to be significant in 2014. The genotype Hazrvi displayed maximum moisture contents of 91.1 to 91.3 %, respectively in 2013 and 2014 (Table 7). The genotype Surbhi produced the lowest moisture contents (87.0 to 87.8%).

Total soluble solids (°Brix): The variation in total soluble solids (TSS) observed in fruits of exotic bottle gourd genotypes was significant (Table 7). The highest value of TSS (7.1 to 7.1°Brix was recorded in Local cv Louki. The minimum value of TSS (4.3 to 3.6) was recorded in genotype Hazarvi. All other genotypes had TSS value with a bit variation among them.

Vitamin C: The data for vitamin C contents in fruits of different exotic germplasm exhibited significant differences. The cultivar Anmol had the maximum vitamin C contents (16.1 to 16.1 mg/100g) followed by Amber (15.8 and 15.2 mg/100g) (Table 7). The genotype Hazarvi produced minimum vitamin C (13.2 and 13.3 mg/100g).

Nine exotic varieties (Hazarvi, King, Amber, Anmol, Surbhi, Adventa-205, Nobel, Royal, and Sharmic) along with one local variety of bottle gourd (Louki) were tested in Dera Ismail Khan agro-climatic condition for fruit yield and quality traits during 2013-2014. The overall assessment of the genotypes revealed that all exotic varieties showed superiority over local check variety both in fruit yield and quality attributes. This indicates that local variety has lost viability and yield potential and should be replaced with appropriate genotype. Among the exotic varieties, Anmol was the most suitable alternative genotype as it performed better among all other genotypes. It took fewer days to germinate which could be attributed to genetic makeup and seed vigor of the genotype. Earlier germination probably matched more with the existing environmental conditions such as light and temperature and had more seed vigor and viability that contributed to rapid seed germination compared to the genotypes that took more days to germinate (Husna et al., 2011; Mangala et al., 2016). It showed higher germination percentage, earlier maturity, and higher fruit yield. Jan et al. (2000) and Tamilselvi et al. (2017) ascribed higher germination percentage in bottle gourd to more viability and vigorousness of a genotype over others. The genotypes Amber, Anmol, and King had the superiority over other genotypes regarding earlier flowering that resulted in earlier fruit maturity. On the other hand, genotypes, Louki and Sharmic took maximum days to flowering that matured late in the season which might interfere with the growers' scheduled cropping sequence and their choice to fetch a good price on a timely supply of their products to the market. Harika et al. (2012), Shaikh et al. (2012), Kappal et al. (2015) and Priyanka et al. (2017) reported similar point of views. They reported that early maturing and quality-oriented genotype is more economical than late maturing yield oriented genotype. Anmol is attractive both for quality as well as higher fruit yield. Regarding quality attributes, it had higher TSS and Vitamin C values compared to all other genotypes. The higher fruit yield recorded for genotype Anmol indicated its higher yield potential and suitability with the agro-climatic conditions of the study site. The differences in fruit yield of various genotypes may be due to the genetic makeup of the genotypes as well as their comparative response to soil macro- and micro-climates. The higher yield obtained from Anmol was probably due to higher fruit length, fruit width, fruit weight, number of branches and number of fruits per vine since fruit yield is correlated with its yield components as reported by other researchers (Vaniya et al., 2008; Singh and Singh, 2014; Janaranjani and Kanthaswamy, 2015). Bakhsh et al. (2003) reported that bottle gourd production could be enhanced in the country through the allocation of more area, utilization of the available resources more efficiently and development of new genotypes of higher yield potential. The first one is difficult as the area allocated to agricultural crops and vegetables are already saturated. The second one is a continuous process depending upon the growers' resources and skillful management and utilization. The last one is a viable option to screen out genotype of higher yield and quality attributes which is the focus of the present study. The results revealed that genotype Anmol was the best source of vitamin C among all other genotypes. Bottle gourd is an excellent source of essential fatty acids, antioxidants, vitamins (high level of vitamin E, A and C.) and sterols. The study yielded useful information regarding general performance and genotypic differences for yield, yield components and quality traits of the genotypes in the environmental condition of Dera Ismail Khan, Pakistan.

Conclusions and Recommendations

In conclusion, the bottle gourd genotypes had significant variations in fruit yield and quality traits, however, for most of the traits recorded in the present study, the genotype Anmol performed better than rest of the genotypes. This showed the better suitability of this genotype to the region. Moreover, the comparative assessment of the exotic germplasm investigated in this study displayed better performance of exotic genotypes over the local check. Among the genotypes studied, cv. Anmol revealed the highest fruit yield, TSS and Vitamin C values and showed better adaptability to the agro-climatic conditions of D. I. Khan. Keeping in view higher fruit yield and quality, the genotype Anmol is recommended for general cultivation under agro-climatic conditions of D. I. Khan, Pakistan. However, the genotype Anmol may be passed through adaptive research before its mass cultivation in regions other than Dera Ismail Khan.

Author's Contribution

Muhammad Iqbal supervised the research. Khalid Usman set the paper technically and gave final shape for publication. Muhammad Arif conducted field research and collected the data. Shakeel Ahmad Jatoi helped in designing the experiments. Muhammad Munir helped in lab work by analyzing quality test of the fruit. Imran Khan assisted in field work as well as in lab.

References

AOAC. 1997. Assoc. Agric. Chem. Official

methods of anal-ysis. Assoc. Off. Agric. Chem. Washington D.C. USA.
Anonymous. 2016. Production guide line for bottle guord.Department of Agriculture, Forestary and Fisheries of Rebulic of South Africa. P. 1-10
Arvind, K., B. Singh, M. Kumar and R.K. Naresh. 2012. Genetic variability, heritability and genetic advance study for yield and its components in bottle gourd (*Lagenaria siceraria* Mol.). Prog. Hortic. 43: 267-270.
Bakhsh, K., B. Ahmad, S. Hassan and Z.A. Gill. 2003. An analysis of technical efficiency of growing Bitter gourd in Pakistani Punjab. Pak. J. Agri. Sci. 44(2): 350-355.
Gorasiya, S.J., A. Paranjape and K. Murti. 2012. Pharmacognostic and pharmacological profile of *Lagenaria siceraria* (Molina) Standley. Pharm. Newsl. 3: 317-324.
Harika, M., V.D. Gasti, T. Shantappa. R. Mulge. A.M. Shirol. A.B. Mastiholi and M.S. Kulkarni. 2012. Evaluation of bottle gourd genotypes (*Lagenaria siceraria* Mol.) Standl. for various horticultural characters. Karnataka J. Agric. Sci. 25: 241-244.
Hegazy, E.M. and O.S. El-Kinawy, 2011. Characteristics, of pumpkin and bottle gourd in Egypt and potentially their contamination by mycotoxins and mycotoxigenic fungi. J. Am. Sci. 7(9): 615-622.
Hidayatullah., T. Mahmood, M. Farooq, M.A. Khokhar and S.I. Hussain. 2012. Plant growth regulators effecting sex expression of bottle gourd (*Lagenarria siceraria* Molina) plants. Pak. J. Agric. Res. 25: 50-54.
Husna, A., F. Mahmud, M.R. Islam, M.A. Mahmud and M. Ratna. 2011. Genetic variability, correlation and path co-efficient analysis in bottle gourd (*Lagenaria siceraria* L.). Adv. Biol. Res. 5: 323-327.
Ilyas, M., G. Nabi, S. Ali, M.M. Anjum, N. Ali, W. Zaman, S. Jan, I. Samar, M. Sadiq and S. Akbar. 2017. Evaluation of bottle gourd genotypes (*Lagenaria siceraria* Mol.) varieties in Agro climatic conditions of Peshawar Valley. Int. J. Envioron. Sci. Nat. Res. 3(1): 1-3.
Jan, D.J., M. Iqbal, A. Ghafoor, K. Waseem and M.S. Jilani. 2000. Effect of NPK fertilizers and spacing on the yield of bottle gourd (*Lagenaria siceraria* M.). Pak. J. Biol. Sci. 3: 448-449. https://doi.org/10.3923/pjbs.2000.448.449
Janaranjani, K.G. and V. Kanthaswamy. 2015. Correlation studies and path analysis in bottle gourd. J. Hortic. 2(1): 1-4.
Kappal, S.B., B. Chawan, R.H. Rathod and T. Shantappa. 2015. Variability and characters, association studies in ridge gourd (*Luffa acutangula* Robx) reference to yield attributes. J. Glob. Biosci. 4(5): 2332-2342.
Managala, T., J. Mandal and V.K. Dhangrah. 2016. Variation in flowering characters of bottle gourd. Hort. Flora. Res. Spectr. 5 (1): 39-42.
Munir, M., A.K. Baloch, W.A. Baloch, F. Ahmad and M. Jamil. 2013. Development of iodometeric redox method for routine test of ascorbic acid from fresh fruits and vegetables. J. Chem. Soc. Pak. 35 (3): 784-792.
Pandit, M.K., B. Mahato and A. Sarkar. 2009. Genetic variability, heritability and genetic advance for some fruit characters and yield in bottle gourd (*Lagenaria siceraria* Molina Standl.) genotypes. Acta. Hort. 809: 221-226. https://doi.org/10.17660/ActaHortic.2009.809.22
Privanka, V., S.K. Maurya, A. Panchibhaiya and S. Dhyani. 2017. Studies on variability, heritability and genetic advance for yield and yield contributing characters in pointed gourd (*Trichosanthus diocia*-Roxb). J. Pharm. Phytochem. 6(3): 734-738.
Rahman, M.M., S.K. Dey and M. Wazuddin. 1990. Yield components and plant characters of several bitter gourd, ribbed gourd, bottle gourd and sweet gourd genotypes. Proc. workshop Bangladesh Agric. Univ. Res. Prog. Mymensingh (Bangladesh) Vol. 4: 117-127.
Rami, U.K. and E.N. Reddy. 2017. Variability and correlation studies of bottle gourd. Int. J. Pure Appl. BioSci. 5(2): 723-731.
Samadia D.K. 2002. Performance of bottle gourd Genotypes under hot arid environment. India. J. Hort. 59 (2): 167-170.
Samadia, D.K. and R.C. Khandelwal. 2002. Combining ability in bottle gourd. India. J. Hort. 59(4): 402-405.
Shaikh, J.A., K.B. Kathiria and R.R. Acharya. 2012. Heterosis and combining ability for fruit yield and its component traits in bottle gourd (*Lagenaria siceraria* Mol.). Veg. Sci. 38(2): 169-175.
Shermila, V.S., M.N. Supe, M.N. Bhalekar and S.S. Gaikwad. 2016. Combining ability studies in bottle gourd in summer season. Asian. J. Sci.

Tech. 7(5): 2842-2845.

Sherma, A. and S.A Sengupta. 2012. Evaluation of genetic variability in bottle gourd genotypes. Veg. Sci. 39 (1): 83-85.

Shiviannad, B.K., L. Mukesh, R.C. Jagdeesha, R.C. Vijaykumar, J.J. Ayappa and S. Koulgi. 2015. Genetic variability and correlation among the physiological growth attributing characters in ridge gourd genotypes. Int. J. Adv. Res. 3 (4): 961-971.

Sarvanyadev, G., V. Lakshmanan and N. Robin. 2016. Performance evaluation and correlation analysis in mithipagal genotype (Momordica charantia var mucata). Elect. J. Plan. Bree. 8(2): 652-659.

Singh, A.K., U.B. Pandey and S. Mamta. 2006. Studies on heterosis in bitter gourd (*Momordica charantia* L). J. Veg. Sci. 27(2): 158-161.

Singh. B and S.K. Singh. 2014. Evaluation trial of bottle gourd (*Lagenaria siceraria* Mol.). Asia. J. Hort. 9(1): 116-119.

Sivaraj, N. and S.R. Pandravada. 2005. Morphological diversity for fruit characters in bottle gourd germplasm from tribal pockets of telangang region of Andhra Pradesh, India. Asian Agric. History. 9: 305-310.

Soil Survey Staff. 2009. Keys to soil of NWFP, FATA and northern areas. Nat. Instit. Res. Soils Geomatics, Lahore, Pakistan. p. 76.

Steel, R.G.D., J.H. Torrie and D.A. Dickey. 1997. Principles and practices of statistics, a biometric approach, *3rd ed.* McGraw Hill, Int. book co., Inc. Singapore. Prof. Russell Freed MSTAT Office freed@msu.edu 384C. Plant Soil Sci. Mich. State Univ. East Lansing, MI48824 Fax: 517 353-5174.

Tamilselvi, N.A. and P. Janisravi. 2017. Evaluation of pumpkin (*Cucerbita mosqata*.L*)* genotypes for earliness, yield and quality. Int. Curr. Micrbiol. APP. Sci. 6(3): 1554-1559.

Vaniya, B.D., L.K. Dhaduk and J.H. Vachhani. 2008. Heterosis studies in bottle gourd (*Lagenaria siceraria* Mol.) in relation to diallel crossing system. Int. J. Biosci. 6(1): 131-134.