Research Article

Varietal Comparison of Fig (*Ficus carica* L.) under Climatic Conditions of Soan Valley

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Abstract | The present research was conducted to explore the performance of three fig varieties namely Black Ball, Gilgit Selection and Swat Local under the climatic conditions of Soan Valley, District Khushab; Punjab Pakistan during two consecutive years (2017 and 2018). Flowering in studied cultivars started from the end of March to mid-April. Maturity timing in all three cultivars ranged from early June to late June. Fruit of Black Ball cultivar matured earlier (first week of June) as compared to Gilgit Selection and Swat Local fig cultivars (end June). During both years of study, evaluated quantitative parameters revealed that Black Ball variety had maximum fruit weight and firmness (35.27g and 2.4 $N.mm^{-1}$) followed by Gilgit Selection (28.95g and 2.0 $N.mm^{-1}$), and Swat Local (24.72g and 1.8 $N.mm^{-1}$). Fruit size varied from 11.37cm^2 to 14.35cm^2 for Swat Local, and Black Ball Fig cultivars, respectively. Results displayed that maximum yield per plant (15.20 kg) was fetched by Black Ball cultivar in contrast to Swat Local cultivar (9.37Kg). Results of biochemical parameters declared Black Ball as a superior cultivar owing to the maximum value of TSS (15.55%), total sugars (10.85%), antioxidant activity (75.75%) and minimum value of titratable acidity (0.15%). The results suggested that among studied fig cultivars, Black Ball is a premium fig cultivar having superior physical and chemical features which can be used in future breeding programs and establishment of commercial orchards in Soan Valley area of Punjab, Pakistan.

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Introduction

Fig (*Ficus carica* L.) is a primordial crop belonging to mulberry family (Moraceae), is indigenous to Southwest Asia and the Eastern Mediterranean region (Duenas *et al.*, 2008). In Moraceae family, *Ficus* is one of the largest genera of angiosperms having more than 800 species (Soni *et al.*, 2014). This ancient fruit has been known to mankind for more than 5000 years (Owino *et al.*, 2006; Hossain and Boyce, 2009). Turkey, Egypt, Morocco, Algeria and Iran are prominent fig-producing countries in the Mediterranean region (Ferraz et al., 2020). In the world, Turkey is the largest fig producing

country having 306,499 tons of total yields from 51,389 hectares (FAO, 2018). Some other countries like Spain, Syria, Afghanistan, Brazil and the United States of America have a momentous share in the fig production of the world. Fig fruit is destined to use in both forms i.e. fresh and dried (Lama *et al.*, 2019). Worldwide overall consumption of figs in dried form is greater as compared to fresh as it does not keep well after picking and during transportation. It is a good source of minerals, amino acids, phenol-compounds and has a nutritive index of 11, as against 9 for apple and 6 for raisin (Pereira *et al.*, 2017). A huge quantity of fiber and polyphenols are present in both dried and fresh figs both (Vinson *et al.*, 2005). In addition to fruit, assorted plant parts including leaves, bark, latex, shoots tender and seeds of fig are used in the treatment of different ailments (Joseph and Raj, 2011). Dried figs are used as natural sweet and food supplements by diabetics (Veberic *et al.*, 2008). A mixture of fig juice and honey can be used to cure hemorrhage. Its fruit can be used as an expectorant, diuretic, and laxative element (Solomon *et al.*, 2006). Fig fruit is reported as free of cholesterol and fats (Guarrera, 2005; Slantar *et al.*, 2011)

Fig is a sub-tropical fruit requiring 15.5 to 21°C optimum temperature for its growth. Best quality figs are produced in dry climates, especially during fruit growth and development stage. Among fruit trees, fig can bear drought spells and thrive well in saline-sodic soils (Abdolahipour *et al.*, 2019). Fig trees are ideal for shallow soils due to their shallow root system.

The Soan Valley of the Pothwar tract is located in the North West of District Khushab and covers an area of 780 km^2. The cultivable plains are about 700 m above sea level while the hilly area may exceed 1000 m altitudes. In recent years the maximum temperature recorded in the hottest months exceeds 40°C but the average temperature remains around 35°C during summer while minimum temperature rarely falls below -2.5°C in winter (Figure 1). Annual rainfall is less than 600 mm and is mostly received during the monsoon season (Figure 2). The valley is semi-arid in nature and drought-tolerant crops are well adopted in the area. Figs can be grown in the Pothwar region in pockets with water availability. They are less labor intensive, heavy bearers and needs less water as compared to other fruit crops. Figs produce twice a year, 1st fruit bears on one year old branches known as "Breba figs" and 2nd fruit bears on fresh growth of the season. In Pakistan the breba crop is of commercial importance and is generally consumed fresh. Being highly perishable, slightly unripe fruits are harvested for far-away markets. Storage of fully ripe fresh figs is differ in cultivars and can be kept only for one to four weeks at 0 °C to 2 °C (Crisosto and Kader, 2014).

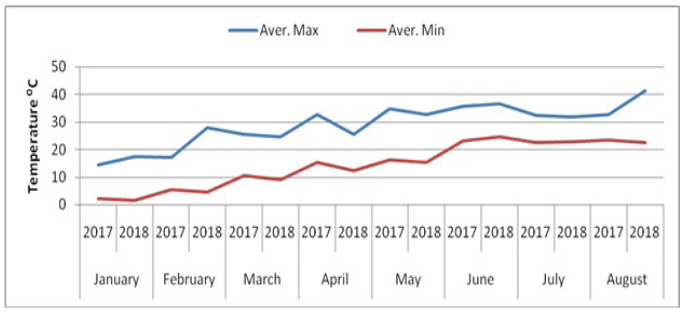

Figure 1: *Average minimum and maximum temperatures during the growing season.*

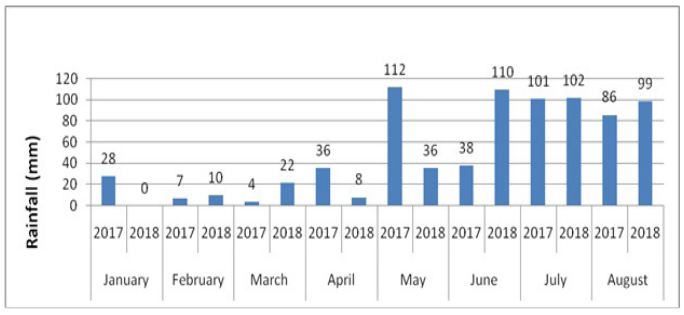

Figure 2: *Rainfall received during the growing season.*

In Pakistan the area of cultivation and production of fig has decreased during the past few years and figs are mainly being imported to cater to the need of the country. According to Fruit, Vegetables and Condiments in 2017-18, the total area under Fig cultivation is 77 hectare with 254 tons of production (fresh fruit). Figs are mainly imported from Turkey, Iran and Afghanistan.

No previous study has been done regarding the traits of fig in this area, keeping in view the nutritional status and wide adaptability of fig, a research was executed to find out the agronomic behavior and quality traits of Black Mission fig varieties at the research station and selection of suitable varieties to suit the needs of the local community based on maturity time and market need.

Materials and Methods

The present research work was carried out on three fig varieties (Black Ball, Gilgit Selection and Swat Local) at the Horticultural Research Station, Nowshera (Soan Valley) of District Khushab (32°33'52.7"N,

72°08'27.8"E) at an elevation of 813 m above sea level during 2017 and 2018 consecutively. Plants of uniform size and vigor were selected for research purposes. Fruits were harvested at commercial maturity. All recommended regular management practices were carried out.

Mature figs were harvested from selected trees during the sunny morning of June in 2017-18 and after that yield per plant was recorded. Ten representative figs of uniform shape and size were randomly collected from each treatment. Harvested figs were washed, rinsed with distilled water, and air-dried. After drying, the samples were kept at room temperature in cardboard cartons, for data collection of different parameters.

Flowering

Fig does not produce typical blooming flowers as in other fruit trees rather they produce specialized inflorescence hollow structure known as Synconia in which flowers are lined internally. The date of appearance of Synconia was considered as a flowering date.

Fruit diameter (cm)

Fruit diameter is of prime importance to determine the quantitative characters of any fruit. 10 fruits were taken at random and their diameter was determined with a digital verniercaliper and mean diameter was taken.

Fruit weight (g)

Single fruit weight is the baseline to proceed towards the final plant yield calculation. The weight of ten representative fruits was measured by using an electric weighing balance and expressed as an average weight (g).

Fruit firmness

Fruit firmness was measured by taking 10 fruit samples from each treatment with Fruit Firmness meter; outfitted with an 8 mm plunger tip. Unit of firmness is kilogram-force (Kg.f).

Yield (kg)

Quantitative character of yield for the experimental units was calculated by harvesting a sample of 10 ripened fruits to access the average fruit weight with the help of a weighing balance. It helped to calculate the yield per plant as average fruit weight was multiplied with the total no. of fruits on each treatment which were counted at the time of harvesting.

Biochemical parameters

TSS (°Brix): TSS was determined with the help of a digital refractometer (ATAGO, Japan). 10 fruits of each variety were taken as a sample and their juice was extracted. Juice drop was put on refractometer prism and reading of refractometer was noted and expressed as ^{0}Brix.

Acidity (%): For acidity percentage, 10 ml extracted juice was titrated against 0.1N NaOH. Moreover, 2-3 drops of phenolphthalein as an indicator were added until the achievement of pink colored endpoint. Acidity was calculated with the help of the following equation:

$$\text{Acidity (\%)} = \frac{\text{0.1N NaOH} \times 0.0064}{\text{ml of juice used}} \times 100$$

Vitamin C (mg/100g): Procedure described by Ruck (1961) was followed to determine vitamin C contents present in investigated fruit samples. 10 ml juice poured in 100 ml volumetric flask. After this, oxalic acid solution (0.4%) was added in it to make the volume up to the mark. A prepared aliquot (5ml) titrated against 2-6-dichlorophenol Indophenol dye till the appearance of light pink endpoint, which lasted for 15 seconds, and vitamin C was estimated by:

$$\text{Vitamin C (mg/100ml)} = \frac{1 \times R1 \times V \times 100}{R \times W \times V1}$$

Where; R_1 = ml dye used in titration; R= ml dye used in titration of 0.1% ascorbic acid + 0.4% oxalic acid; V_1= ml of juice; V= Volume of aliquot; W= ml of aliquot.

Sugars (%): Sugars percentage was calculated by a method as stated by (Hortwitz, 1960). 10 ml juice transferred in 250 ml volumetric flask followed by 100 ml distilled water, then 25% lead acetate (25 ml) and 20 percent potassium-oxalate (10 ml) also added. The distilled water was added up to the mark and then filtered. It was utilized in the calculation of reducing, non-reducing and total sugars.

Total sugars (%): To estimate total sugars percentage, aliquot (25 ml) was added in a volumetric flask (100ml) along with distilled water (20 ml) and concentrated hydrochloric acid (5 ml). This solution was retained for overnight so that the hydrolysis process may occur for the conversion of non-reducing into reducing sugars. While the next day, 0.1 N sodium hydroxide

was added in it to neutralize the solution in addition to phenolphthalein indicator and then distilled water added up to the mark. This was transferred into the burette and titrated against 10 ml Fehling solution (5ml Fehling solution A and 10ml Fehling solution Beach prepared separately) for calculation of total sugars. By using the following equation, the total sugars were estimated;

$$\text{Percent Total sugars} = 25 \times \frac{X}{Z}$$

Where; X = standard sugar used against 10 ml of Fehling solution; Z = sample aliquot titrated against 10 ml of Fehling solution.

pH: A pH meter was used to measure juice pH. 200 µl juice was used to determine its pH by the method illustrated by Moing et al. (1998).

Antioxidant activity

It was estimated by taking methanolic extract to which TRIS buffer and DPPH (1, 1– diphenyl–2-picrylhydrazyl) reagents were added. The absorbance of sample noted at 517 nm (Harzallah *et al.*, 2016). Following equation was used to estimate percent inhibition activity.

$$\text{Inhibition activity (\%)} = \frac{\text{control} - \text{sample}}{(\text{Per 100 g sample}) \text{ control}} \times 100$$

Statistical analysis

The treatments were arranged according to Randomized Complete Block Design. Data were treated by analysis of variance (ANOVA) using "Statistix 8.1" software. Means were compared by the least significant difference (LSD) test, at a probability level $p>0.05$ in two experimental seasons.

Results and Discussion

Flowering emergence and maturity

Data regarding flowering emergence and fruit maturity was recorded. Flowering of Gilgit Selection fig variety started earlier compared to the other two varieties (Table 1). Black ball var. started flowering in the first week of April while Swat local var. started flowering in mid-April. Black ball attained maturity earlier i.e. early June as compared to both of Gilgit selection and Swat local fig varieties maturing at the end of June. Early maturity is an important character because late maturing varieties are adversely affected by rainfalls and fruit produced is of poor quality (Ammar *et al.*, 2020) and excessively cracked; therefore, fruit can be harvested before the onset of rains.

Fruit weight and size

Fruit weight of three different fig cultivars was noted and analyzed statistically. Black ball var. attained the highest fruit weight (33.92 and 35.27g) compared with Gilgit selection (28.55 and 28.95g) and Swat local (24.0 and 24.72g) vars. during both years 2017 and 2018, respectively.

Fruit size of three fig cultivars was noted and statistically analyzed. Results depicted a significant difference in fruit size of studied fig cultivars. During both years, Black ball showed maximum fruit size (14.35 and 14.32cm^2) followed by Gilgit selection (13.14 and 13.21cm^2) and Swat Local (11.37 and 11.81cm^2), respectively. Fruit weight and size are important commercial parameters (Khadivi and Mirheidari, 2022) since large sized fruit fetch a good market price and get more popular among consumers (Lama *et al.*, 2019). Both characters are dependent on the variety concerned. A variation in both fruit weight and size was observed among varieties in this study.

Fruit firmness

Data regarding fruit firmness of studied fig cultivars were recorded. Fruit firmness ranged between 1.8 to 2.4 N.mm^{-1} depicted by Swat local and Black ball *cultivars* respectively (Table 1). Fruit firmness is an important character to determine the fruit quality and ripeness (Lama *et al.*, 2019) as it is directly linked to shelf life which determines its export to local as well as international markets. Fresh Figs are highly perishable with a shelf life of only 2-3 days (Khan *et al.*, 2011).

Tree yield

Analysis of variance revealed a significant difference in tree yield of studied fig cultivars. Highest fruit yield (15.20 and 15.20 kg) was recorded in Black ball followed by Gilgit selection (11.97 and 12.17 kg) and Swat local (9.37 and 9.52kg) during both years 2017 and 2018, respectively (Table 1). Yield variability is dependent on age, cultural practices, nutrition status abiotic and biotic stress (Joshi *et al.*, 2015) however in our study this can be attributed to the lesser fruit weight of Swat local var. compared to the other two

Table 1: *Phenological characteristics of Black ball, Gilgit selection and Swat local fig.*

	Flowering		Maturity		Fruit weight (g)		Fruit size (cm^2)		Firmness ($N.mm^{-1}$)		Yield	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Black ball	1st week of April	1st week of April	1st week of June	1st week of June	33.95a	35.27a	14.35a	14.32a	2.4a	2.4a	15.12a	15.20a
Gilgit selection	End March	End March	End June	End June	28.55b	28.95b	13.14b	13.21b	2.0b	2.0b	11.97b	12.17b
Swat local	Mid April	Mid April	End June	End June	24.0c	24.72c	11.37c	11.80c	1.8b	1.8b	9.37c	9.52c
SE	-	-	-	-	0.77	0.79	0.08	0.30	0.07	0.13	0.14	0.24

Table 2: *Chemical characteristics of Black ball, Gilgit selection and Swat local fig.*

	TSS (%)		Total sugars (%)		pH		TA (%)		AO (%)		Vitamin C ($mg.100^{-1}g$)	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Black ball	15.55a	15.30a	10.85a	10.57a	5.52a	5.45a	0.16c	0.15c	75.75a	72.02a	24.15a	23.87a
Gilgit selection	14.07b	14.20b	9.25b	9.07b	5.20a	5.07b	0.21b	0.21b	68.90b	68.12b	21.32b	21.07b
Swat local	13.37c	13.22c	8.37c	8.05c	5.10a	5.00b	0.24a	022a	66.47c	64.80c	16.60c	18.10c
SE	0.13	0.18	0.20	0.31	0.14	0.09	0.004	0.005	0.68	1.01	0.47	0.99

varieties. As the premium quality fruit and optimum yield resulted in a higher profit gain for the growers (Ahmed et al., 2006).

Total soluble solids (TSS)

Data regarding TSS of three studied cultivars showed significant differences during both years as shown in Table 2. Maximum value of TSS was noted in Black ball (15.55%) in contrary to Swat local (13.22%) cultivar. Total soluble solids (TSS) determine the quality of fruit as the sugars are meant for energy provision (Shireen *et al.*, 2018). Higher TSS can be attributed to the higher concentrations of total sugars in these varieties as evident in Table 2.

Total sugars

Analysis of variance depicted significant variation in total sugars of three fig cultivars during both years of study. Black ball cultivar exhibited a maximum amount of total sugars (10.85 and 10.57%). On the other hand, minimum total sugars were recorded in Swat local cultivar (8.37 and 8.05%). Total sugars in Gilgit selection (9.25 and 9.07%) were significantly higher compared to Swat local during both years. Higher total sugars can be correlated to the higher TSS in both varieties. Sensory attributes of figs are directly linked to sugar and acid content which is an important criterion of ripeness at harvest time (Crisosto *et al.*, 2010). Since sugars do not increase in fruit after harvest therefore proper ripeness at the time of harvest is of vital importance for good flavor and quality (Hong *et al.*, 2016).

pH

Data regarding pH of three fig cultivars were recorded which depicted no significant difference amongst the investigated fig cultivars during both years of study (Table 2). Analysis of variance showed that pH value of the three studied cultivars was statistically similar. Maximum value of pH was noted in Black ball cultivar (5.45) in contrast to Swat local (5.4). pH is important in the storage life of a fruit since lower pH values tend to decrease the activity of microorganisms compared to higher pH. Polat and Caliskan (2008) have reported a pH range of 4.8 to 5.3 which is in accordance with our study (Khadivi *et al.*, 2018).

Titratable acidity (%)

A significant difference in Titratable acidity (TA) of three fig cultivars was recorded. Results indicated maximum value of titratable acidity in Black ball (0.24 and 0.22%) cultivar followed by the value in both Black ball (0.24 and 0.22%) and Gilgit selection (0.22 and 0.21%). Swat local had significantly lower TA (0.16 and 0.15%). According to Crisosto *et al.* (2010), Figs with lower TA content are susceptible to physical damage and may affect storage life. Furthermore, TA may vary in different varieties under different soil and climatic conditions (Lama *et al.*, 2019).

Antioxidant activity (%)

Analysis Antioxidant activity (AO) ranged from 66.47% to 73.42% (Table 2) in all three varieties studied during both years. No significant difference was observed among the varieties. Antioxidants

are known to differ according to soil and climatic conditions as well as extraction methods. Dark-colored figs are known to have higher AO contents compared to light-colored varieties (Alturki, 2013). Viuda-Martos *et al.* (2015) reported 65.57% AO activity while Yang *et al.* (2009) reported 92.60% AO activity in Mission figs.

Vitamin C content (mg.100^{-1}g)

Vitamin C content ranged between 21.15 to 24.15 mg.100^{-1}g among the varieties studied (Table 2). Statistically, the vit. c content was at par in all the tested varieties. Figs are known to be rich in Vitamin C (Doymaz, 2005; Ishurd *et al.*, 2004).

Conclusions and Recommendations

Adaptability studies were conducted by Horticultural Research Station, Nowshera (Soan Valley) District Khushab. The soil and climatic requirements for Fig cultivation var. Black ball is ideal in the Pothwar region and the adjoining plain areas. It starts bearing during the third year of its plantation. Flowering starts in the last week of March and fruit matures in June. Fruit is of medium size and symmetrical shape. The average weight of fruit has been recorded 40-45 g. The average yield of the variety is 35 to 45 kg per plant.

Novelty Statement

Black Ball is a premium fig cultivar having superior physical and chemical features which can be used in future breeding programs and establishment of commercial orchards in Soan Valley area of Punjab, Pakistan

Author's Contribution

Allah Bakhsh: Conceived the idea and overall management of the article.
Attiq Akhtar: Wrote abstract and methodology.
Fiaz Hussain: Data entry and analysis.
Hafiz Wasif Javaad: Data collection, Introduction and references.
Inam ul Haq: Result and discussion and technical input at every step, corresponding author.
Humara Umar: Conclusion and review of literature.

Conflict of interest

The authors have declared no conflict of interest.

References

Abdolahipour, M., A.A.K. Haghighi, A.R. Sepaskhah, S.Z. Parsa, T. Honarj and F. Razzaghi 2019. Time and amount of supplemental irrigation at different distances from tree trunks influence on morphological characteristics and physiological responses of rainfed fig trees under drought conditions. Sci. Hortic., 253: 241-254. https://doi.org/10.1016/j.scienta.2019.04.023

Ahmed, M., T. Hussain, A.H. Sheikh, S.S. Hussain and M.F. Siddiqui 2006. Phytosociology and Structure of Himalayan Forests from Different Climatic Zones of Pakistan. Pak. J. Bot., 38(2): 361-383.

Alturki, S., 2013. Utilization of modiied atmosphere packaging to extend shelf life of fresh igs. Biotechnology, 12(2): 81-86. https://doi.org/10.3923/biotech.2013.81.86

Ammar, A., B. Aissa, Imed, Mars, Messaoud and G. Mohamed. 2020. Seasonal variation of fig tree (*Ficus carica* L.) physiological characteristics reveals its adaptation performance. S. Afr. J. Bot., 132: 30-37. https://doi.org/10.1016/j.sajb.2020.04.020

Crisosto, C.H. and Kader, A.A., 2014. Gigs. In: The commercial storage of fruits, vegetables and florists and nursery stocks (eds. K.C. Gross, C.Y. Wang and M.E. Saltveit). USDA Agricultural Handbook, pp. 66. http://www.ba.ars.usda.gov/hb66/fig.pdf

Crisosto, C.H., Bremar, V., Ferguson, L. and Crisosto, G.M., 2010. Evaluating quality attributes of four fresh figs (*Ficuscarica* L.) cultivars harvested at two maturity stages. HortScience, 45: 707-710. https://doi.org/10.21273/HORTSCI.45.4.707

Doymaz, I., 2005. Sundrying of figs: An experimental study. J. Food Eng., 71: 403-407. https://doi.org/10.1016/j.jfoodeng.2004.11.003

Duenas, M., J.J. Perez-Alonsoa, C. Santos-Buelgaa and T. Escribano-Bailona. 2008. Anthocyanin composition in fig (*Ficuscarica* L.). J. Food Compos. Anal., 21: 107-115. https://doi.org/10.1016/j.jfca.2007.09.002

FAO, 2018. Food and agriculture organization. Available online with updates at http://www.fao.org/faostat/en/#data/QC

Ferraz, R.A., S. Leonel, J.M.A. Souza, R.B. Ferreira, J.H. Modesto and L.L Arruda. 2020. Phenology, vegetative growth, and yield performance of fig

in Southeastern Brazil. Pesquisa Agropecuária Brasileira, v.55, e01192. DOI: https://doi.org/10.1590/ S1678-3921.pab2020.v55.01192

Guarrera, P.M., 2005. Traditional phytotherapy in central italy (marche, abruzzo, and latium). Fitoterapia, 76: 1-25. https://doi.org/10.1016/j.fitote.2004.09.006

Harzallah, A., A.M. Bhouri, Z. Amri, H. Soltana and M. Hammami. 2016. Phytochemical content and antioxidant activity of different fruit parts juices of three igs (*Ficuscarica* L.) varieties grown in Tunisia. Ind. Crops Prod., 83: 255-267. https://doi.org/10.1016/j.indcrop.2015.12.043

Hong, G., C. Crisosto and M.I. Cantwell. 2016. Quality and physiology of two cultivars of fresh-cut figs in relation to ripeness, storage temperature and controlled atmosphere. Proc. III Int. Conf. on Fresh Cut Produce: Maintaining quality and safety. Acta Hortic., 1141: 213-219. https://doi.org/10.17660/ActaHortic.2016.1141.25

Horwitz, W., 1960. Official and tentative methods of analysis. 9th edition, Association of Official Agricultural Chemists, Washington D.C. pp. 314-320.

Hossain, A.B.M.S. and A.N. Boyce. 2009. Fig fruit growth and quality development as affected by phloem stress. Bulg. J. Agric. Sci., 15: 189-195.

Ishurd, O., F. Zgheel, A. Kermagi, M. Flefla, M. Elmabruk, W. Yalin, J.F. Kennedy and Y. Pan. 2004. Micribial 1-3D glucans from Libyan figs (*Ficuscarica*). J. Carbohydr. Polym., 58: 181-184. https://doi.org/10.1016/j.carbpol.2004.06.040

Joseph, B. and S.J. Raj. 2011. A comparative study on various properties of five medicinally important plants. Int. J. Pharmacol., 7: 206-211. https://doi.org/10.3923/ijp.2011.206.211

Joshi, V., M. Kumar, M. debnath, S. Pattanashetti, M.T. Variath and S. Khadakabhavi. 2015. Multivariate analysis of colored and white grape grown under semi arid tropical conditions of Peninsular India. Int. J. Agri. Crop Sci., 8: 350-365.

Kahadivi, A. and F. Mirheidari. 2022. Selection of promising fig (*Ficus carica* L.) accessions using fruit-related characters. Food Sci. Nutr., 00: 1-11.

Khadivi, A., R. Anjam and K. Anjam. 2018. Morphological and pomological characterization of edible fig (*Ficus carica* L.) to select the superior trees. Sci. Hortic., 238: 66-74. https://doi.org/10.1016/j.scienta.2018.04.031

Khan, M.N., A. Sarwar, M. Adeel and M.F. Wahab. 2011. Nutritional evaluation of *Ficus carica* indigenous to Pakistan. Afr. J. Food Agric. Nutr. Dev., 11(5): 5188-5202. https://doi.org/10.4314/ajfand.v11i5.70445

Lama, K., A. Modi, R. Peer, Y. Izhaki, M.A. Flaishman. 2019. On-tree ABA application synchronizes fruit ripening and maintains keeping quality of figs (*Ficus carica* L.). Sci. Hortic., 253: 405-411. https://doi.org/10.1016/j.scienta.2019.04.063

Moing, A., L. Svanella, D. Rolin, M. Gaudillera, G.P. Gaudillera and R. Monet. 1998. Compositional Changes during the Fruit Development of Two Peach Cultivars Differing in Juice Acidity. J. Amer. Soc. Hort. Sci. 123(5): 770-775.

Owino, W.O., Y. Manabe, F.M. Mathooko, Y. Kubo and A. Inaba. 2006. Regulatory mechanisms of ethylene biosynthesis in response to various stimuli during maturation and ripening in fig fruit (*Ficuscarica* L.). Plant Physiol. Bio-Chem., 44: 335-342. https://doi.org/10.1016/j.plaphy.2006.03.009

Pereira, C., M.L. Corrales, A. Martin, M.D.C. Villalobos, M.D.G. Cordoba and M.J. Serradilla. 2017. Physiochemical and nutritional characterization of brebas for fresh consumption from nine varieties (*Ficuscarica* L.) grown in Extremadura (Spain). J. Food Qual., 2017: 1-12. https://doi.org/10.1155/2017/6302109

Polat, A.A. and O. Caliskan. 2008. Fruit characteristics of table fig (*Ficus carica* L.) cultivars in subtropical climate conditions of the Mediterranean region. N. Z. J. Crop Hortic. Sci., 36: 107-115. https://doi.org/10.1080/01140670809510226

Ruck, J.A., 1961. Chemical Methods for Analysis of Fruits and Vegetables. No. 1154. Research Station Summerland, Research Branch Canada, Department of Agriculture.

Shireen, F., M.J. Jaskani1, M.A. Nawaz, and F. Hayat. 2018. Exogenous application of naphthalene acetic acid improves fruit size and quality of Kinnow mandarin (C*itrus reticulata*) through regulating fruit load. J. Anim. Plant Sci., 28(4): 1080-1084.

Slatnar, A., U. Klancar, F. Stampar and R. Veberic. 2011. Effect of drying of figs (ficus carica l.) on the contents of sugars, organic acids, and

phenolic compounds. J. Agric. Food Chem., 59: 11696-11702. https://doi.org/10.1021/jf202707y

Solomon, A., S. Golubowicz, Z. Yablowicz, S. Grossman, M. Bergman, H.E. Gottlieb, A. Altman, Z. Kerem and M.A. Flaishman. 2006. Antioxidant activities and anthocyanin content of fresh fruits of common fig (*Ficus carica* L.). J. Agric. Food chem., 54: 7717-7723. https://doi.org/10.1021/jf060497h

Soni, N., S. Mehta, G. Satpathy and R.K. Gupta. 2014. Estimation of nutritional, phytochemical, antioxidant and antibacterial activity of dried fig (*Ficus carica*). J. Pharmacogn. Phytochem., 3(2): 158-165.

Veberic, R., M. Colaric and F. Stampar. 2008. Phenolic acids and flavonoids of fig fruit (*Ficus carica* L.) in the northern mediterranean region. Food Chem., 106: 153-157. https://doi.org/10.1016/j.foodchem.2007.05.061

Vinson, J.A., L. Zubik, P. Bose, N. Samman and J. Proch. 2005. Dried fruits: Excellent *in vitro* and *in vivo* antioxidants. J. Am. Coll. Nutr., 24: 44-50. https://doi.org/10.1080/07315724.2005.10719442

Viuda-Martos, M., X. Barber, J.A. Perez-Alvarez and J. Fernandez-Lopez. 2015. Assessment of chemical, physic-chemical, techno-functional and antioxidant properties of fig (*Ficuscarica* L.) powder co products. Ind. Crops Prod., 69: 474-479. https://doi.org/10.1016/j.indcrop.2015.03.005

Yang, X.M., W. Yu, Z. zp. Ou, W.M. Liu and X.L. Ji. 2009. Antioxidant and immunity activity of water extract and crude polysaccharide from *Ficuscarica* fruit. Plants Food Hum. Nutr., 64: 167-173. https://doi.org/10.1007/s11130-009-0120-5