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YIELD AND QUALITY ASSESSMENT OF GRAPEVINE CULTIVAR SULTNINA AT DIFFERENT GEOGRAPHIC LOCATIONS OF PUNJAB, PAKISTAN

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ABSTRACT

The yield potential of Grape is heavily dependent on climatic and various other edaphic factors. The present study is focused on the adaptability of Spanish grapes variety Sultanina in comparison with commercial cultivar Abassin in different regions of Punjab for further recommendation to local farmers to get better yield and profitability. Propagation material as cuttings of Sultanina was imported from Spain in 2012. Vines of Sultanina and Abbasin were planted at a distance of 6×10 feet during the year 2013 at six locations in different regions of Punjab to evaluate adaptability and yield potential. The present study aims at evaluating the performance of the new variety Sultanina against Abbasin based on berry physical and quality traits. Sultanina performed better in the highlands of Punjab with average cluster weight (292.46g), appearance (7.1) average fruit yield (11.67 kg/Plant), shelf life (92.34 Hr) and acidity (0.30%) were highest in Chakwal Region (CHK-I and II), while TSS (20.04%) were observed higher in hotter regions of RYK and BWP. Sultanina is better adapted in highlands of Punjab such as Chakwal and Attock regions and hence it is recommended for better yield and quality.

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INTRODUCTION

Grape is the oldest and most important perennial fruit crop around the globe. It belongs to the genus Vitis and consists of around 60 species; however, most commercial varieties are derived from Vitis vinifera (Kausar, 2017). A grape is consumed in fresh juices, fermented wine, prepared raisins, cupped jellies and bottle jams. This delicious fruit is important for its nutritional and medicinal benefits. The latest research shows that it helps in strengthening cardiac muscles and reduces cholesterol in the blood (Ruel and Walker, 2006). It also helps to develop immunity against various diseases in the human body. Grapes are cultivated throughout subtropical and tropical areas around the globe. Spain (14%), China (11%), France (10%), Italy (9%) and Turkey (7%) are the leading producers of grapes (Anonymous, 2017). In Pakistan, 66.98 thousand tons. of grapes are produced on an area of 15.72

thousand hectares, Baluchistan is the largest with 66.21 thousand tons. on an area of 15.59 thousand ha. The climate of Baluchistan is the most suitable for grapes production due to the lack of humidity in the fruiting season. Fresh grapes are also exported to Afghanistan of volume 190 tons during 2018 of worth Rs. 11.34 M (Anonymous, 2018). Grape's production faces the challenges of lacking standardized production technology, undesirable bunch compactness, the occurrence of fungal diseases and seediness in elite table varieties. The seedless varieties of grapes are the wonder of nature; however, new processed and table grapes cultivars are the result of triploid formation by hybridization (Anjum, 2020). There are various potential grapes growing pockets in Pakistan that are not explored including deserted districts of Punjab and Sindh where an excellent irrigation system is existed linked with the mighty Indus River. Grapes growing areas of Baluchistan and Punjab produce fewer yields compared with potential yield due to lack of skilled labour, lack of support of government and high yielding commercial varieties. The private sector, extension services, and government can play an important role to enhance grape production with the provision of certified plants to farmers. The provision of the high yielding potential plant is the most important step in high commercial yield in Pakistan. In Pakistan, several varieties of fresh and processed grapes are used for seven decades such as Manakkah, Sundarkhani and Chaman angoor. Early maturing varieties are suitable for cultivation in Agro-climatic conditions of Peshawar valley (Rehman *et al.*, 2018). Cultivated varieties of grapes fulfil local demand for grapes for many years, while there is a need of introducing new genotypes or cultivars for better returns and further breeding programs in grapes through induced mutation and hybridization as well. The introduction of exotic varieties is one of the prime aspects of breeding. The introduced varieties directly play role in the fulfilment of the food requirement of different commodities of agriculture on an immediate basis. The adaptability studies of exotic varieties before being included in national germplasm is the most critical step. The morphological characters and yield potential is entirely dependent on climatic and various edaphic factors. Climate is a key factor to observe and highlight the plant characteristics regarding the survival, yield potential in the local environment (Rasmann and Pellissier, 2015; Urban *et al.*, 2016). Plant species adaptive potential requires studying populations spread correlation among species with rising elevation (Pellissier *et al.*, 2016), latitude (Anstett *et al.*, 2016), and species distribution can show promising systems for studying adaptation to various biotic pressures (Helsen *et al.*, 2005). The present study is focused on the adaptability of Spanish grapes variety Sultanina along with adapted Abbasin in different regions of Punjab for further recommendation to local farmers for better yield and profitability.

METHODOLOGY

Propagation material as cuttings of cv. Sultanina was imported from Spain in 2012. Vines were planted apart 6×10 feet during 2013 in CHK-I (BARI), CHK-II (Commercial farm), ATK-I (Commercial farm), ATK-II (Commercial farm), BWP (Commercial farm) and RYK (Commercial farm) to see adaptability and yield potential. Another used cultivar was Abbasin which is already cultivated in the plains of Punjab province. Abbasin is commercially propagated through cuttings and it was also planted along with Sultanina for comparison of yield and berry traits.

The regular cultural operations were continued such as irrigation and fertilizer application at research areas. Four sites are located in Pothwar, while the other two sites are in South Punjab with warmer climatic conditions and less rainfall as shown in Figure 1 (Ahmad et al. 2019). Vines were planted in RCBD experimental statistical design with four treatments and three replications during the year 2012-13. The means response was compared at a 5% level of significance by Statistix 8.1 statistical software. The berries and clusters characters were observed according to the following attributes of chemical and physical nature during 2016-2018.

Physical and Cluster Attributes

The number of berries/cluster, cluster weight (g), individual berry weight (gm) and individual berry size (cm) was measured through vernier calliper at edible maturity. Thirty clusters were selected randomly at harvest to analyze the physical attributes such as cluster weight (g) while nine clusters were harvested for counting the number of berries/clusters. Thirty berries were randomly observed from these nine clusters from different positions of plants to determine the mean berry weight (g) and size.

Biochemical attributes of berries

Total soluble solids (TSS) for sweetness in the juice were observed at harvest through a Digital (RX 5000-ATAGO-Japan) Refractometer. Titratable acidity (%) was determined by Hortwitz methods (Hortwitz 1960). Calculations were done by using the following assumptions for titratable acidity (%).

$$\text{Titratable acidity (\%)} = \frac{\text{0.1 N NaOH used x 0.0064 x 100}}{\text{The volume of sample used}}$$

RESULTS

Average fruit yield (kg/Plant) and average cluster mass (g) at various geographical locations of Punjab

The results revealed (<0.05) that Sultanina performance was variable at different geographical locations for better clusters mass of berries and berries yield (kg/plant) of Punjab compared with Abasin-2000 during the year of 2016 to 2018 (Figure 2-3). The Sultanina cultivar performed at par in CHK-I (298.24) and ATK (297.28) while it produces less mass of berry clusters in other regions of Punjab such as in BWP and RYK during 2016 (Figure 2). This promising table grape cultivar performed better in CHK-I (315.64) and ATK (301.70) in 2017 and 2018, also performed better in geographical locations of CHK-I (324.12). The results showed that Sultanina performed better in Pothwar regions of Punjab compared with the geographical locations of South Punjab of BWP and RYK. Better fruit yield (kg/Plant) was showed BWP during 2016 (16.43), CHK-I (13.67) in 2017 and ATK-I (13.58) during 2018 (Figure 2-3). It is revealed from results that better berry clusters mass (g) and berry yield (kg/Plant) produces in Pothwar geographical regions compared with South Punjab regions of BWP and RYK however in 2016 berry yield (kg/Plant) is better in BWP which may be due to altering the standard fertilizer doses and other changes in production technology schedules.

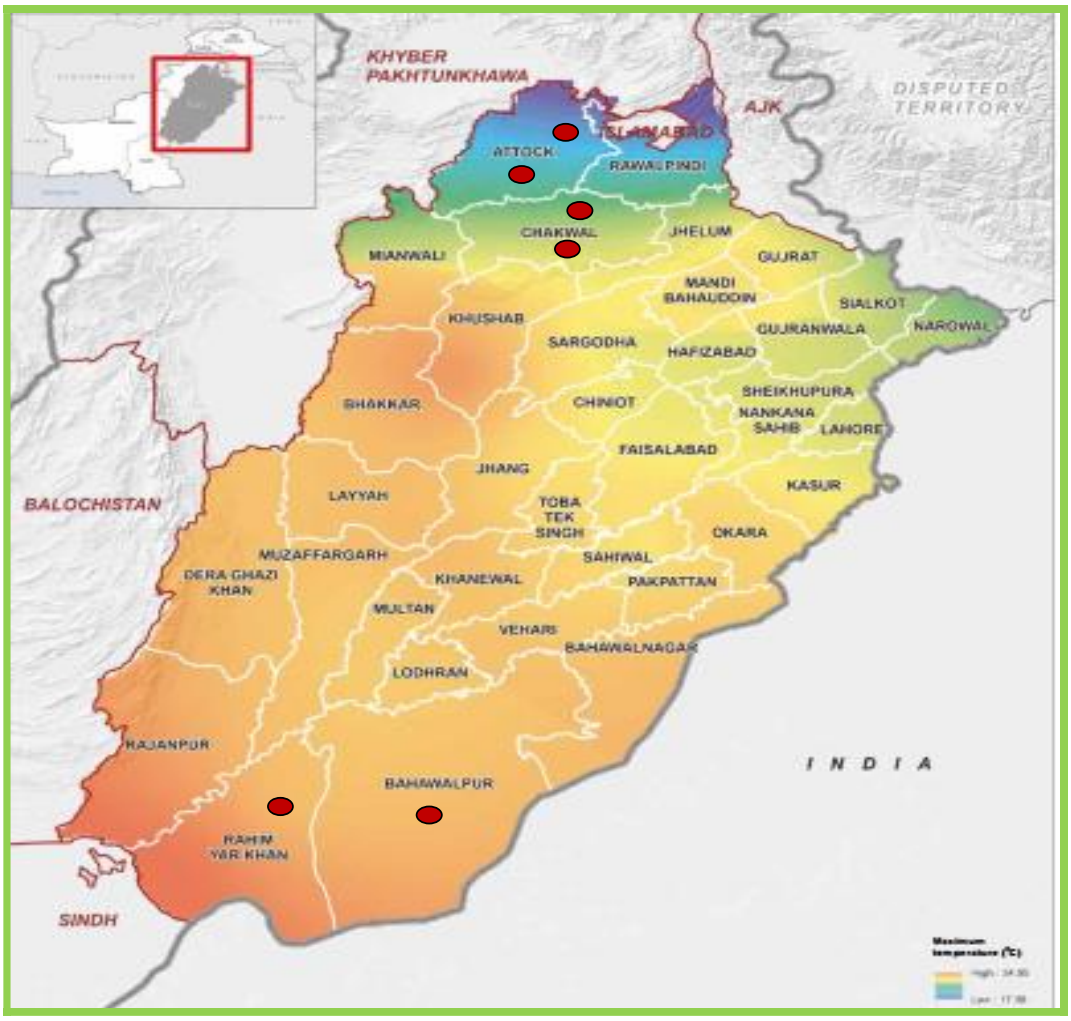

Figure 1. Red Circles on the map indicate the districts of Punjab under Study.

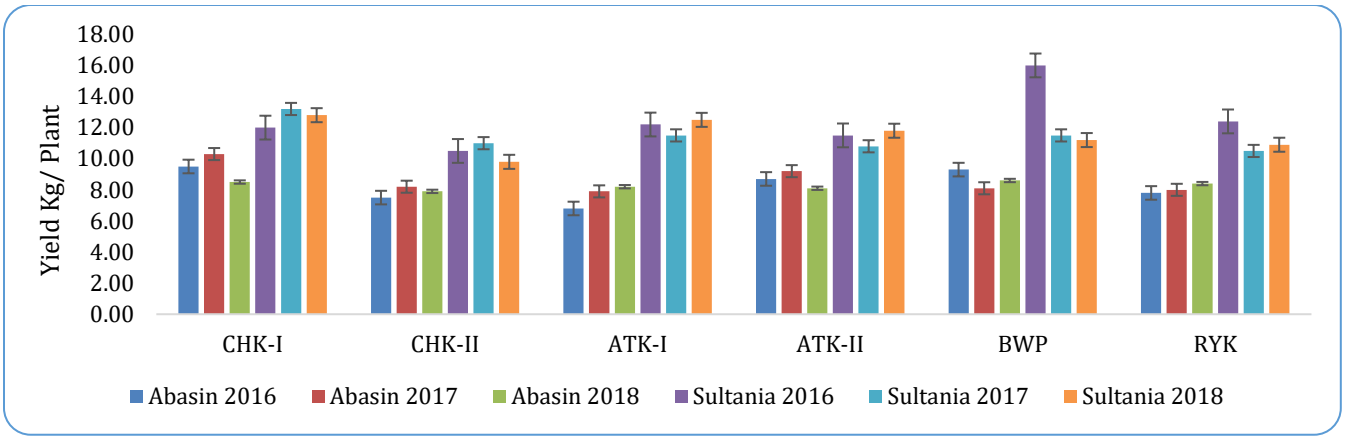

Figure 2. Average fruit yield (kg/Plant) in various geographical locations of Punjab in cv. Abasin and Sultanina.

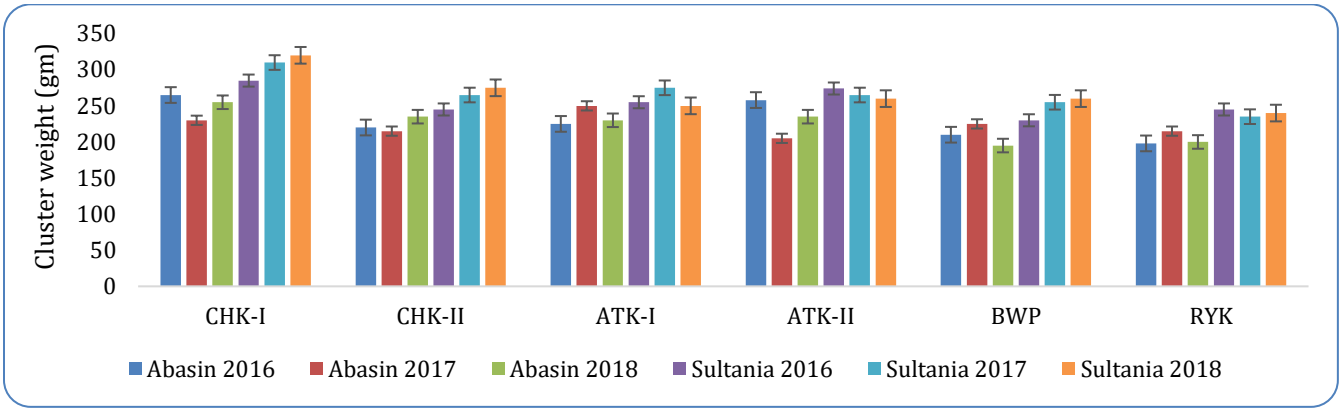

Figure 3. Cluster weight (gm) in various geographical locations of Punjab cv. Abasin and Sultanina.

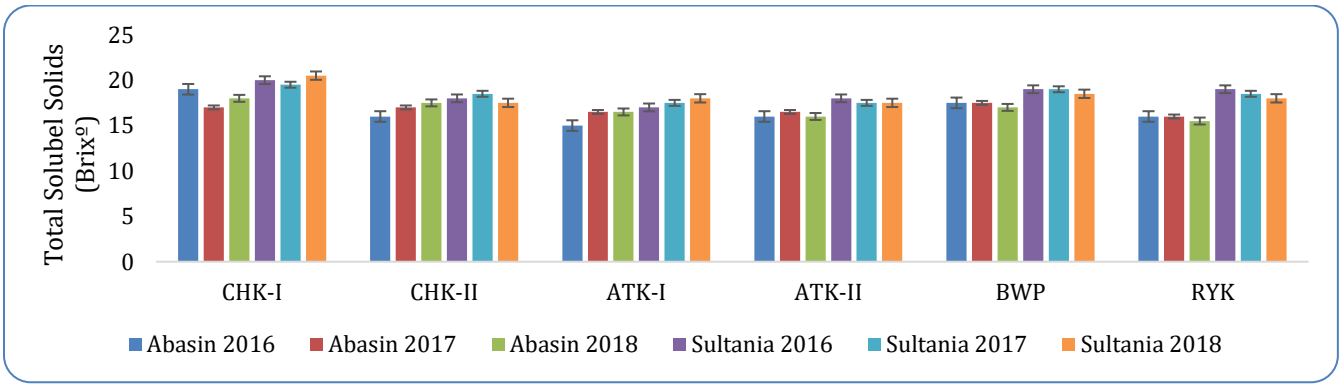

Figure 4. Total soluble solids (Brix°) in various geographical locations of Punjab cv. Abasin and Sultanina.

Total soluble solids (TSS) and titratable acidity (TA) at various geographical locations of Punjab

The Sultanina performed variably in terms of TSS and Titratable acidity in various geographical locations of Punjab (Figure 4-5). The Sultanina showed a higher TSS level in geographical locations of South Punjab of RYK in 2016 (21.32), 2017 (20.68) and 2018 in CHK-I (20.82) as shown in Figure 4. The greater level of TSS (%) is South Punjab is may be due to the longer period of dryness during fruit ripening periods. The titratable acidity of the fruits showed less in Sultanina compared with Abasin-2000 the reference variety (Figure 5). The titratable acidity was least in 2016 (0.25%), 2017 (0.27%) in the geographical location of BWP, while during 2018 the least acidity was showed in RYK (0.24 %). The results concluded that more sweetness and less acidity is

produced in South Punjab geographical locations.

Average berry volume (cm^3) and appearance at various geographical locations of Punjab

The response (<0.05) of Sultanina for better berry volume (cm^3) and attractiveness are greater in the regions of Pothwar while it was shown less in South Punjab (Figure 6). The average berry volume (cm^3) is better in the geographical region of ATK-I (2.32) during 2016, while it was showed better in CHK-I during 2017 (2.33) and 2018 (1.97) in Figure-6.

The berry quality of the leading introduced variety of Sultanina's appearance is better in ATK-II (7.89) during 2016, while it showed better in CHK-I in 2017 (8.34) and CHK-II in 2018 (8.15) as shown in Figure 7. The average berry volume is better in high altitudes of Punjab may be due to the sudden rise in temperature before monsoon season.

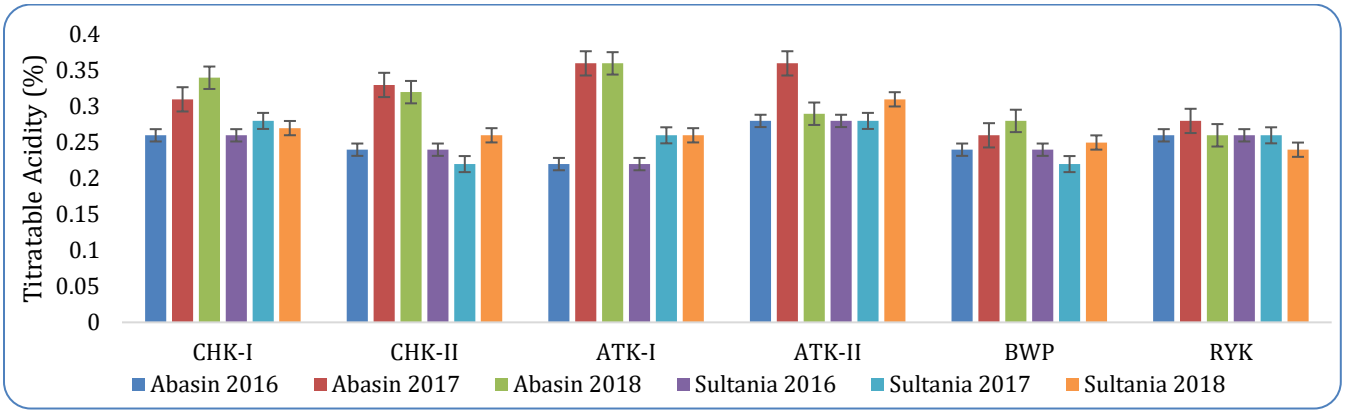

Figure 5. Titratable acidity (%) of Abasin and Sultanina in various geographical locations of Punjab.

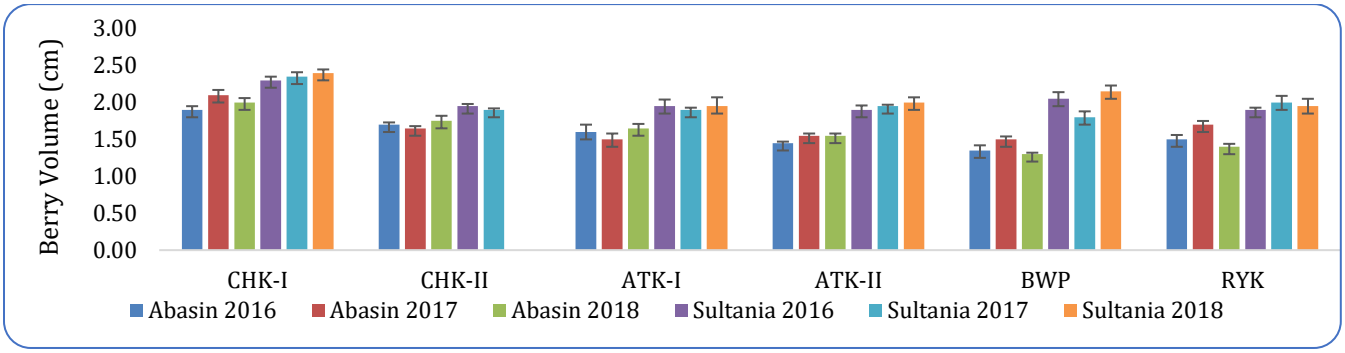

Figure 6. Berry volume (g) of Abasin and Sultanina in various geographical locations of Punjab.

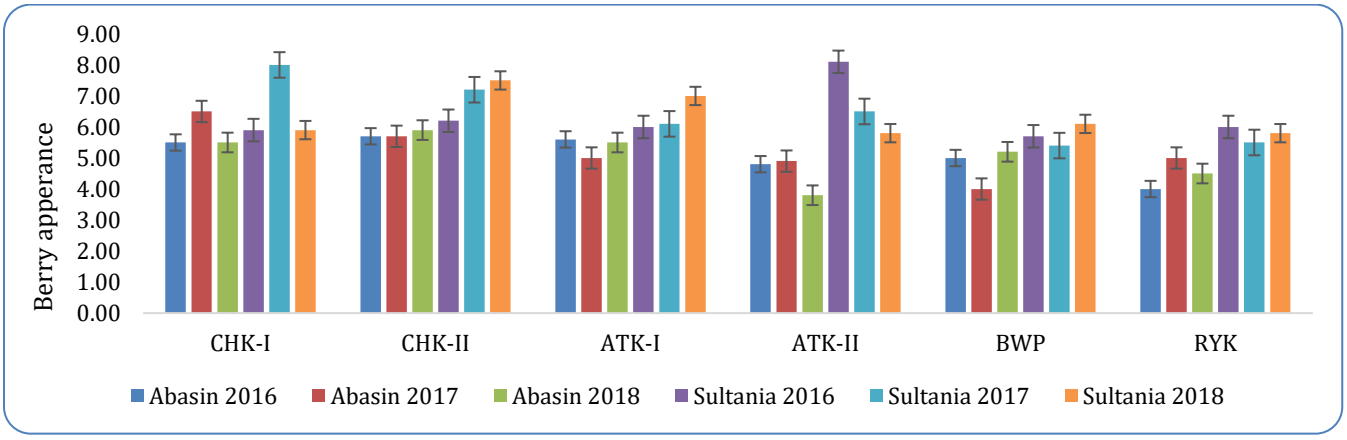

Figure 7. Berry appearance in various geographical locations of Punjab in Abasin and Sultanina.

Taste, Crispiness and Shelf life at various geographical locations of Punjab

The results showed a variable response in organoleptic characters of taste and Crispiness of Sultanina in comparison with Abasin in different geographical locations of Punjab (Figure 8-10). The taste of Sultanina is better in high lands of Punjab especially in ATK-I during 2016 (8.52) and CHK-II (8.28) while it was better in BWP during 2018 (7.97) while the taste was significantly better in Sultanina compared with Abasin as shown in Figure-8. The crispiness of Sultanina is significantly better in RYK (7.41) during 2016 while it developed better during CHK-I (7.87) and CHK-II (7.48) during 2017 and 2018, respectively (Figure-9). The results ($P<0.05$) showed shelf life of Sultanina in comparison with Abasin the shelf life of Sultanina is significantly better (Figure-10) while the compactness of CHK-I is better in 2016 (102.31), 2017 (94.12) and 2018 (104.23).

Response of cv. Sultanina for berry quality and biochemical attributes in various geographical locations of Punjab

The results indicated that Sultanina variety against in comparison with Abasin showed a variable response. Average cluster weight (g) showed better in (292.46) in CHK-I, while average fruit yield (kg/Plant) was better in BWP (12.53), TSS (Brixo) (19.42), Organoleptic score for taste (7.12) and organoleptic score for crispiness (6.97) is developed better in CHK-II. Average berry volume (cm^3) (2.19) and acidity (0.30 %) showed better in CHK-I. It is revealed that prominent quality and biochemical attributes developed better in the pothwar region as compared to plain areas of BWP and RYK in Punjab, keeping this view the variety Sultanina can be recommended for Pothwar regions of Punjab.

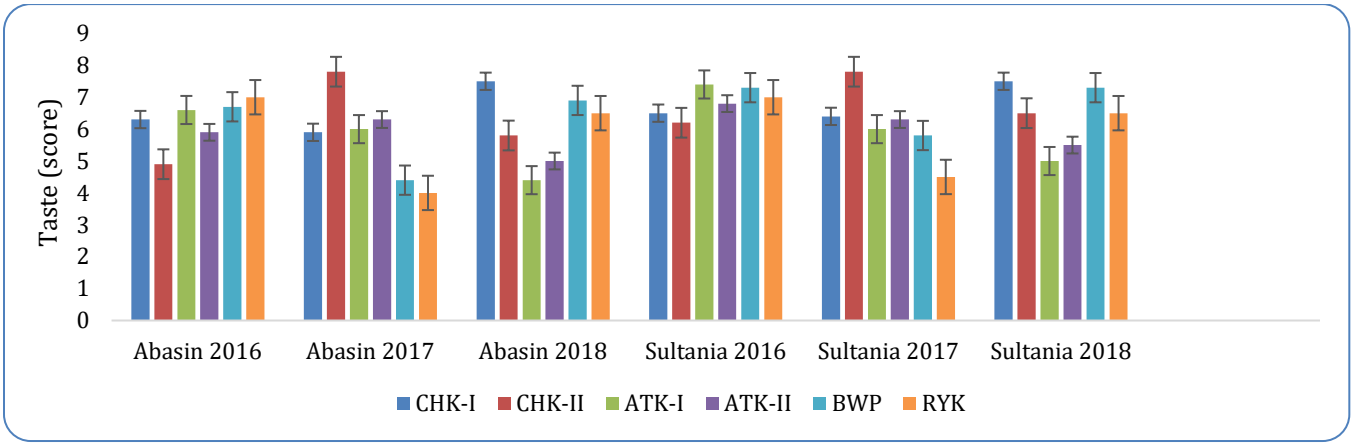

Figure 8. Taste (score) in various geographical locations of Punjab in cv. Abasin and Sultanina.

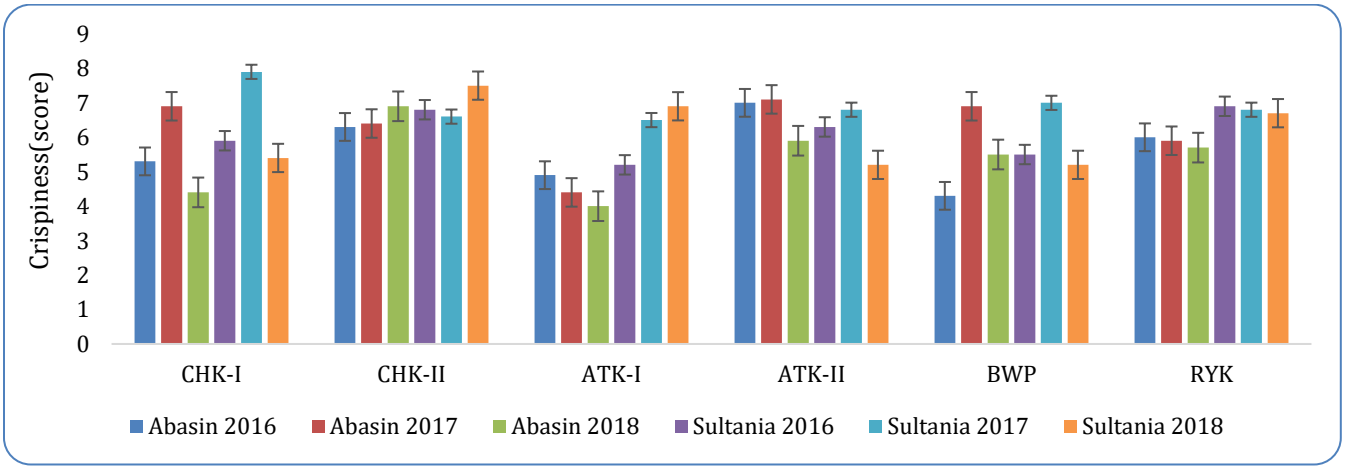

Figure 9. Response of Sultanina for crispiness (score) in various geographical locations of Punjab.

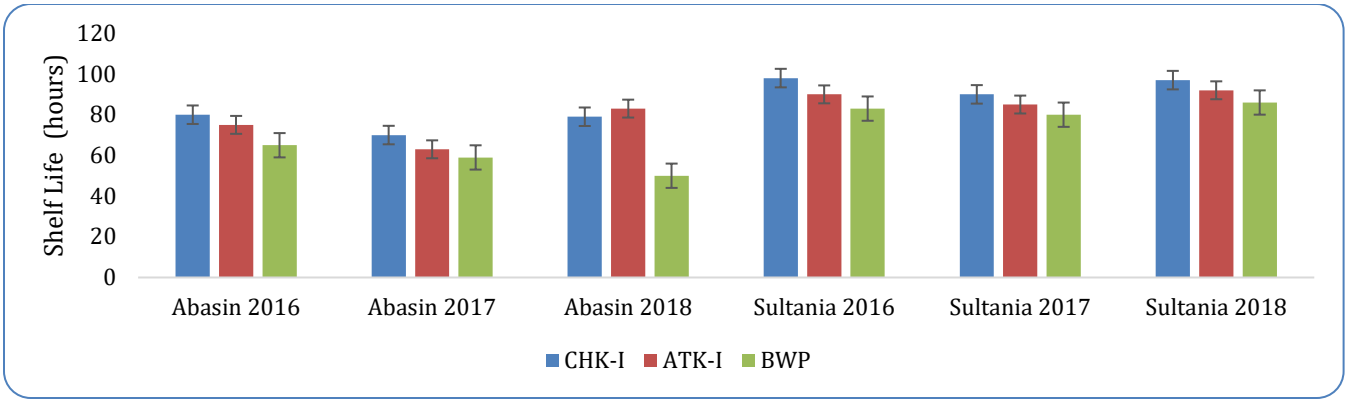

Figure 10. Response of Sultanina for shelf life (hr.) in various geographical locations of Punjab.

DISCUSSION

Global table grape markets need significant-quality fruit, acceptable berry size, suitable firmness, high sugar, attractive colour and desirable crispiness attributes that meet local and international demands. Chemical and organoleptic attributes respond significantly against altering climate and weather conditions (White *et al.*, 2006; Hall and Jones, 2009). High temperatures (> 35 ˚C) can desiccate foliage and loss or slow down the photosynthesis activity in plants that lower sugar accumulation and higher exposure of sunburn in berries. Lower reservoirs of plants sugar have negative impacts on berry yield and quality because of delayed harvests, as berry forces to maintain minimum sugar levels. However greater amount of TSS and Reduced TA were observed in RYK and BWP geographical locations of Punjab where the temperature is high compared with CHK-I and other areas of the Pothwar region. The early maturity of berries and development of significant size majorly developed in a warmer climate (Haselgrove et al. 2000). A recent finding for suitable early ripen variety in Pothwar region is Sultanina, which is a promising variety with high yield potential and good quality. Similarly, in sub-tropical regions of Punjab early maturing varieties are recommended (Khan *et al.*, 2011). Our findings are in agreement with the studies of Akram *et al.* (2019) that early maturing varieties are more suitable for cultivation in Chakwal climatic conditions than late ripening. Research showed that the abundance of anthocyanins is responsible for berry colour. The anthocyanins accumulation become lower in high temperature hence losing the berry colours from original to marginal and compromising (White *et al.*, 2006). Berry skin colour and total soluble solids (TSS) of berry flesh are the most important factors enhancing quality. It is a well-known fact that the colour of grape berries is controlled by various environmental factors; therefore, colouration is used as a key index of ripening (Taiz L and E., 1991; Oanh *et al.*, 2010). Red skin grapes varieties did not express attractiveness due to less accumulation of anthocyanins under low temperature during the ripening stages. The environmental temperature had significant effects on berry growth and development (Ortega-Regules *et al.*, 2006). Treatment effects in this study appear to be related to shifts in temporal development (indirect effect) and direct temperature effects (e.g. shifourt in subunit proportions). Climatic factors have a significant effect on fruit sets. Due to inhibition of pollen tube growth and ovule fertilization, fruit set is greatly reduced when temperatures fall below 65°F (18.3°C) or exceed 100°F (37.8°C) during fruit set. Cold temperatures are often associated with incomplete detachment of the calyptras, while both cold and hot temperatures may reduce fruit set by preventing the growth of pollen tubes and ovule development. Rainfall or high humidity may reduce fruit set, hindering pollination by impeding the complete detachment of the calyptras. Rain can also dilute the stigmatic fluid and thus interfere with the germination of pollen grains. The cold temperature did not support good fruit set in grapes. Grape production is significantly better due to high temperatures in early spring which are suitable for high-quality grape production in the Chakwal region. Berry composition is affected by factors such as genotype, climate, cultural practices, and edaphic factors (Verries *et al.*, 2008; Jackson and Lombard, 1993). When other factors are comparatively the same, the climate is the dominant factor that influences berry quality (Makra *et al.*, 2009). The most relevant variables for describing titratable acidity (TA)

changes in the climate gradient are primarily temperature derived variables and temperature itself. The joint effect of temperature and rainfall alters the TA are directionally the same as the individual effects. The negative effect of high temperature on TA is well known. Low temperatures have increased TA compared with the high temperature (Easterling *et al.*, 1997), increased hasten the acid loss may occur even without an increase in the maximum temperature.

CONCLUSION AND RECOMMENDATIONS

Pakistan agricultural system is developed with wonderful prospects. The grapes fruit is grown for 70 decades in Pakistan in the largest province of Baluchistan. It is observed that grapes production in Pakistan faces several challenges amongst that suitable variety compatible with the local environment is the most challenging. Due to the non-addition of new compatible variety in the system of production the yield is stagnant for the last five years (1.5 M tons.). The addition of Sultanina in the system will be increasing yield potential.

The Sultanina performed better in the highlands of Punjab where average cluster weight (292.46g), appearance (7.1) average fruit yield (11.67 kg/Plant), shelf life (92.34 hours) and acidity (0.30%) were highest in the Chakwal Region (CHK-I and II) while maximum TSS (20.04%) were observed better in Hotter regions of Rahim Yar Khan and Bahawalpur. The Sultanina is almost equally productive in hotter regions of Punjab compared with already cultivated leading grapes varieties of Abasin. Cultivated variety Sultanina is better adapted in highlands of Punjab such as Chakwal and Attock region and hence it is recommended for better yield and quality. The need is to popularize these recommendations among farmers. In this regard, effective communication from the public sector extension, in particular, is much needed.

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