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Research Article

Pheno-Physiological Assessment of Grapes (*Vitis vinifera*) Germplasm

Muslim Shah, Muhammad Abbas, Waqar Ullah, Muhammad Imtiaz, Muhammad Ali, Badshah Islam, Fazal Said, Fazal Jalal and Sayed Hussain*

Department of Agriculture, Abdul Wali Khan University, Mardan, KPK, Pakistan

***Corresponding Author:** Sayed Hussain, Department of Agriculture, Abdul Wali Khan University, Mardan, KPK, Pakistan.

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Abstract

Grape (*Vitis vinifera* L.) is one of the most popular and delicious fruits, and rich source of vitamins and minerals. In Pakistan, grape germplasm is cultivated in very large amount, and shows a wide range of ripening periods with fruit quality, while an unexploited resource for breeding programs. Therefore, an assessment study was conducted on six grape cultivars (Alphanso Lavallee, Superior seedless, Tarakaya ilkeren, unlabeled 1, unlabeled 4 and unlabeled 5) to evaluate the pheno-physiological features such as berry size, berry colour, berry compactness, average bunch weight, number of berries per bunch, seed per berry, berry weight, TSS under agro climatic condition of Islamabad, Pakistan. The data were subjected to one-way analysis of variance (ANOVA) under randomized complete block. Maximum average bunch weight was recorded in alphanso Lavallee, unlabeled 4 and superior seedless about 770.27 g, 544.58 g and 220 g, while minimum average bunch weight was noted in tarakaya and unlabeled 1 about 100 g and 138.71 g respectively. Cultivars unlabeled 5, superior seedless and unlabeled 1 had maximum number of berries per bunch about 138, 120 and 107 while minimum number of berries per bunch was observed in unlabeled 4 and tarakaya about 26.5 and 95 respectively. Furthermore, cultivars unlabeled 4, alphanso lavellee and unlabeled 1 showed highest berry weight 33.3 g, 25.46 g and 15.36 g while minimum berry weight was recorded in superior seedless 13.21 g, tarakaya 11.02 g and unlabeled 5 8.5 g respectively. Different cultivars showed different range of TSS as level superior seedless showed 16, tarakaya 14, Alphanso Lavelle 12.6 and unlabeled1 9.68. Based on pheno-physiological parameters such as, seeds per berry, average bunch weight, TSS, and berry color, of Alphanso Lavellee and unlabeled 1 showed best performance and are recommended for further research in this area.

Keywords: Pheno- Physiological; TSS; Cultivars; Grapes; Germplasm

Introduction

It is believed that the grape is one of the first fruit to be cultivated by man. Grape is a fruiting berry of the deciduous woody vines belongs to family Vitaceae and genes Vitis. The grape achieved his popularity for its high nutritious value, excellent in taste, multipurpose use and better returns [1]. Grape is one of the world's major fruits and has very old history. It has also been praised in "The Holy Quran". The European grapevine is believed to have originated in the area between Black and Caspian seas, where it still grows wild. It is believed that it was introduced/spreaded throughout the Europe and later by explorer to all continents (Mukhtar., *et al.* 2011).

Grapes are a type of fruit that grow in clusters of 15 to 300, and can be crimson, black, dark blue, yellow, green, orange, and pink. "White" grapes are actually green in color and are evolutionarily derived from the purple grape. Mutation in two regulatory genes of white grapes turn off production of anthocyanin, which are responsible for the color of purple grapes. Anthocyanins and other pigment chemicals of the larger family of polyphenol in purple grapes are responsible for the varying shades of purple in red wines Grapes are typically an ellipsoid shape resembling a prolate spheroid.

Commercially cultivated grapes can usually be classified as either table or wine grapes, based on their intended method of consumption: eaten raw (table grapes) or used to make wine (wine grapes). While almost all of them belong to the same species, *Vitis*

vinifera, table and wine grapes have significant differences, brought about through selective breeding. Table grape cultivars tend to have large, seedless fruit with relatively thin skin. Wine grapes are smaller, usually seeded, and have relatively thick skins (a desirable characteristic in winemaking, since much of the aroma in wine comes from the skin). Wine grapes also tend to be very sweet: they are harvested at the time when their juice is approximately 24% sugar by weight. By comparison, commercially produced "100% grape juice", made from table grapes, is usually around 15% sugar by weight.

In Pakistan only, European grapes varieties are cultivated. Grapes are the most remunerative summer fruit crops, native to warm, tropical and temperate zone between 34°N and 49°S mountainous and sub-mountainous areas up to 2000 m altitude or more are suitable for its cultivation [2,3]. The required pH range for its best cultivation is about 5.5 to 7.0. Acidic soils (pH 4.5–5.8) are low in plant nutrients (Ca_2^+, Mg_2^+, Na^+, K^+) because the exchange complex has high amounts of non-nutrient cations (H^+, $AlOH_2^+$, Al (OH_2^+). However alkaline soils (pH 8–10) have growth-limiting salts and moisture deficits. The most fertile soils for plant growth are between these extremes [4]. The grapes producing regions in the world are generally divided into two groups: (a) areas with 18.7°C average temperature during mid-summer months below, which ripening is difficult and (b) areas with -1°C average of coldest months below, which winter killing may occurs [5]. The quality of grapes depends on both biotic as well as abiotic factors [6].

According to the GOP (2015) In Pakistan, 70% grapes are grown mostly in Baluchistan province and some districts of Khyber Pakhtunkhwa with annual production of 122 thousand tons having average yield of 19 tons ha^{-1} against the potential of 25 tons ha^{-1}. This show that in the northern areas of Pakistan, Khyber Pakhtunkhwa and Baluchistan there is a considerable amount of biodiversity available in the grape germplasm for exploitation in genetic improvement and characterization for profitable cultivation of grapes. Germplasm is valuable as it contains the diversity of genotypes needed to develop new and improved lines [7] A constant and steady improvement is observed in worldwide for table grape consumption [8].

Hence climate plays an important role in the development of grapes such as berry growth and development, berry maturity, ripening, development of physical, as well as chemical characteristics of the berry quality such as size, colour, aroma, and accumulation of anthocyanins [9]. The maturity, ripening and harvesting time of grapes depend upon cultivar, geo-graphic location and agro climatic conditions. Different table grapes cultivars have been found to have varying tolerance to temperature, heat stress, rainfall and their distribution through the season [10]. Keeping the dietary importance and economic value of fruits, the present study was conducted in national agriculture research Centre (NARC) Islamabad to investigate the pheno-physiological characteristics of grapes cultivars for evaluation and selection of promising cultivars.

Materials and Methods

Present experiment was conducted at fruit program, Horticulture Research Institute (HRI), Department of Horticultural Research and Development (DHRD) at National Agriculture Research Centre (NARC), Islamabad during the season, 2016. Six grape cultivars (Alphanso Lavellee, Superior seedless, Tarakaya ilkeren, unlabeled 1, unlabeled 4 and unlabeled 5) were selected to evaluate phenol-physiological characteristics of grapes germplasm grown under agro-climatic condition of Islamabad, Pakistan. These cultivars were planted in clay loamy soil of fruit orchard at NARC, Islamabad in February, 2010. All the culture operation was practiced according to the plant requirement. Flood Irrigation was practiced twice a month in summer and once in a month in winter depending upon the weather condition and Other nitrogen-rich grapevine fertilizers (such as urea, ammonium nitrate and ammonium sulfate) should be applied after the vine has blossomed or when grapes are about ¼ inch across. In current study we applied half (½) pound of ammonium sulfate, 3/8-pound ammonium nitrate or one fourth (¼) pound of urea per vine. Furthermore, the present study was comprised on the following parameters such as berry size, berry colour, berry compactness, berry weight, seed per berry, average bunch weight, number of berries per bunch and Total soluble solid.

Geographical location

Experimental site is located in longitude 78.03° east and latitude°3.42 west on the globe scale. Elevation of site was 683 msl (mean sea level).

Studied parameters

The following parameters were studied from the obtained data:

- **Berry size:** Berry size was noted visually such as small, medium and large size by selecting ten berries randomly in each cultivar.
- **Berry colour:** Berry colour was noted with the help of eyes and observed that different cultivars have different colour like dark green, black, light green etc.
- **Bunch compactness:** Bunch compactness was noted visually, while observed that different cultivars have different

bunch compactness level like, normal compactness, compact and lose.

- **Berry weight:** Berry weight was calculated by collecting berries randomly from different representative bunches and weighted with the help of electrical balance.
- **Seeds per berry:** Seeds per berry were calculated with the help of eyes counting after extracting seeds from berries.
- **Average bunch weight:** Average bunch weight was recorded by taking weight of bunch from 4 direction of my experiment variety
- **Number of berries per bunch:** Number of berries was recorded by counting barriers from four sides of my experiment.
- **Total soluble solids (TSS):** First of all, we extracted a juice from the grape berries and put 2 to 3 drops on the lens of the device which named as Atago hand refractometer and then we observed the total soluble solids (TSS).

Results and Discussion

In this we have found some differences in the parameters among the different grape's varieties, such as,

Berry weight

According to statistical analysis, weight of berry has been found different in weight among all the varieties. Maximum weight of berry was recorded in unlabeled 4 variety (33.3 g) and followed by Alphanso lavellee (25.23 g), unlabeled 1 was (15.36 g) superior seedless (13.21 g) and Tarakaya (11.01 g), while minimum berry weight was recorded in unlabeled 5 (8.5 g).

Berry needs long warm hot dry summer and cool rainy winter (Winkler., *et al.* 1974). Climate play very important role during the berry maturity, ripening, development of physical, as well as chemical characteristics of the berry quality such as size, colour, berry growth and development, aroma, accumulation of anthocyanin [9].

Seed per berry

Maximum number of seeds per berry was recorded in Alphanso Lavallee (4) and unlabeled 4 (4). Both of varieties are statically different with each other followed by unlabeled1 (3), unlabeled5 (2) Tarakaya (2) and superior seedless. While minimum number of seeds per berry was recorded in superior seedless.

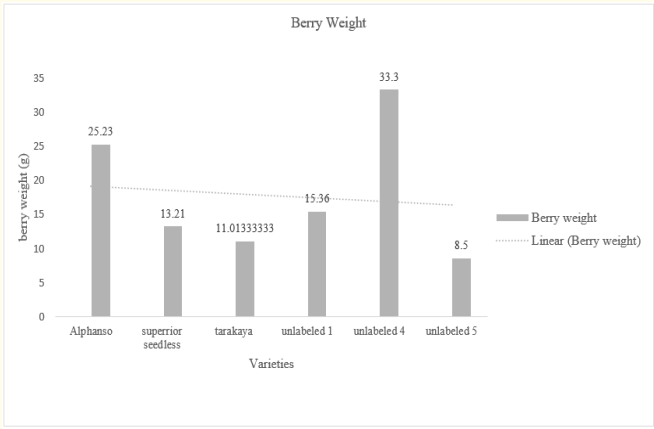

Figure 1: Pheno-physiological Assessment of Grapes Germplasm on berry weight.

The normal or perfect number of seeds in the grape is four; Coombe, B.G. [11] in general though, the actual number is much less. Environmental and nutritional conditions at bloom time affect the success of fertilization, and the resulting number of seeds per berry.

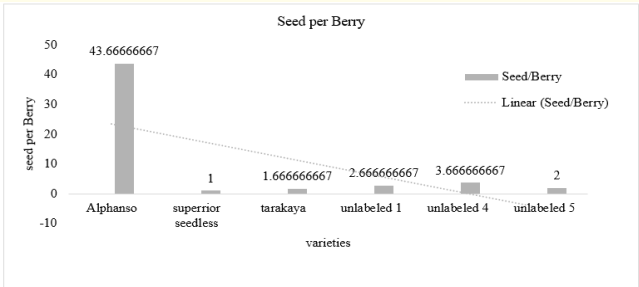

Figure 2: Pheno-physiological Assessment of Grapes Germplasm on seed per Berry.

Average bunch weight

Statistical analysis showed highly significant results at $P \leq 0.01$ regarding the effect of treatment (ANOVA 3).

All the varieties showed different berry weight according to the analysis. Maximum Average Bunch weight was recorded in Alphanso Lavallee (770.18 g) followed by Unlabeled (544.05g), Superior seedless (216.66g), Unlabeled 1 (138.14g) all the treatment is statically different from each other while minimum was recorded in Tarakaya (103g) and the data for Unlabeled 5 was missing.

It is affected by environmental conditions. For example, wet weather during bloom could cause poor set and may lead to low bunch weight; also, a dry summer tends to reduce berry size and thus may decrease average bunch weight. Other factors that may affect bunch weight include cultural practices (irrigation, fertilizers), diseases, insects, and birds [12,13].

The differences in bunch weight in different varieties was attributed to inherent characters of the variety, difference in number of berries per bunch and berry size [14,15].

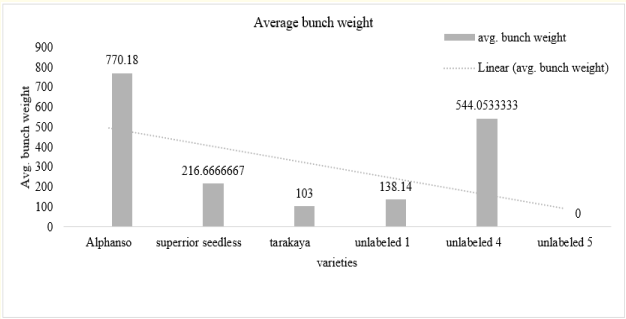

Figure 3: Pheno-physiological Revelation of Grapes Germplasm on Average Bunch weight.

Number of berries per bunch

Statistical analysis showed highly significant results at $P \leq 0.01$ regarding the effect of variety (ANOVA 4).

All the varieties showed different number of berries per Bunch according to the analysis. Maximum Berries per Bunch recorded in unlabeled 5 (137.66) followed by Superior seedless (119.66), unlabeled 1(107.6), Tarakaya (95) and Alphanso Lavallee (66.6) while minimum berry weight was recorded in unlabeled 4 (26.33).

The number of berries per bunch is dependent on conditions during flowering and/or fruit set [16]. The impact that training/trellis systems could have on this process is via limitations of carbohydrate supply from reserves (grapevine imbalance) and impaired leaf photosynthesis (water stress and light conditions) to the inflorescence [17,18]. If vigorous growth diverts metabolites away from the inflorescence, fruit set may be reduced. Low percentage fruit set can also occur when low light conditions are associated with low temperatures (May, 2004). May and Antcliff [19] reported a direct effect of shading on crop development, where decreased light intensities produced smaller bunches and berries.

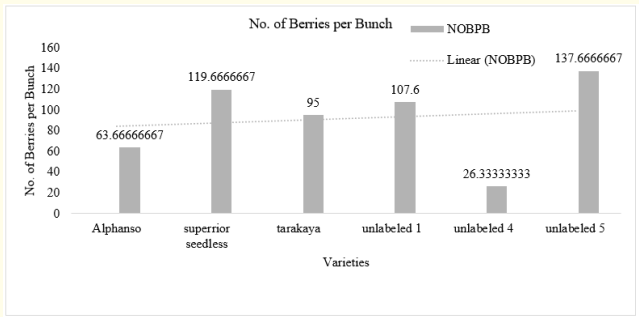

Figure 4: Pheno-physiological Revelation of Grapes Germplasm on number of Berries per bunch.

TSS

Statistical analysis showed highly significant results at $P \leq 0.01$ regarding the effect of treatments (ANOVA 6).

All the varieties showed different TSS according to the analysis. Maximum total soluble solid was recorded in superior seedless (16) followed by tarakaya (14), Alphanso Lavallee (11.1) and the TSS data for unlabeled 4 and unlabeled 5 was missing. While minimum TSS was recorded in Unlabeled 1 (9.66).

The difference in the total soluble solids might be due to different period of maturity among different varieties [20], and Havinal., *et al.* [21]. High variability of the soluble solids (TSS) among the hybrids, which reflect differences in their genotypes and the annual climate conditions [22]. TSS levels were lower in the early ripening grapes than in the mid-season and late-ripening grape varieties [23] the best time of harvesting was when the total soluble solid (TSS) value reached 22 percent [24]. A clear TSS gain started with veraison and reached harvest maturity with 23.3°Brix [25].

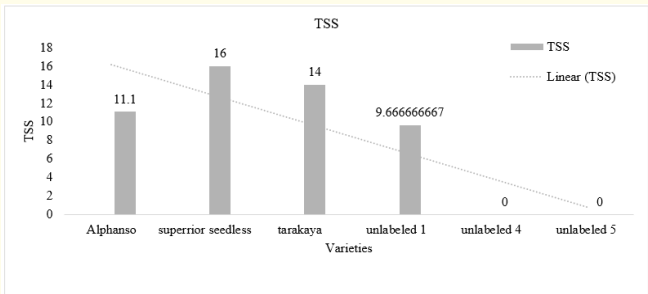

Figure 5: Pheno-physiological Revelation of Grapes Germplasm on TSS.

Berry size

Alphanso Lavallee, superior seedless and unlabeled 4 have large Berry size while tarakaya, unlabeled 1 and unlabeled 5 have medium berry size.

Berry colour

Alphanso Lavallee have black berry colour, superior seedless have light green, tarakaya have purple, unlabeled 1 have green with light red shade, unlabeled 4 have dark green and unlabeled 5 have green berry colour.

Bunch compactness

Alphanso Lavallee, superior seedless, tarakaya and unlabeled 5 have normal bunch compactness ratio while unlabeled 1 have very compact and unlabeled 4 have lose bunch compactness level. All parameters are important in the current study but the most important parameters are, Berry size, Average bunch weight, TSS and number of berries per bunch while the less important parameters are, berry weight, berry compactness, berry color [26-39].

Conclusion

In Asia, European grapes cultivars are cultivated and they are recommended for the best adaptation to the local environment. The present study was carried out at fruit program at national agriculture research Centre Islamabad to evaluate the performance of six different grapes cultivars under the agro climatic condition of Islamabad. The pheno-physiological parameters under assessment were berry size, berry colour, Berry compactness, average bunch weight, number of berries per bunch, seed per berry, berry weight and TSS. The result showed that unlabeled 1 and Alphanso has the best cultivars of grapes under agro climatic condition of Islamabad having large berry size, large bunch weight, maximum number of berries per bunch large, berry weight also attractive black colour and better sugar: acid ratio. So, I recommend the two varieties, one is Alphano and the second is unlabeled 1 which give a best production under the agro climatic condition of the Islamabad.

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