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Melon Selection for Breeding Based on Traits and Diversity

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Abstract

Genetic improvement of vegetables like melonsneeds information on its phenotypic diversity and so on. To choose the appropriate breeding strategies to fulfill the goal of breeding, information on genetics and genetic resources is essential. Information on genetic diversity, genetic resource and types of breeding of vegetable crops is helpful for breeders. Based on the targets of breeding, improving of melon by scientific methods will result in useful varieties or hybrids. Increasing genetic diversity is vital for the production of hybrid seeds. Hence, determining the distribution of genetic relationships between popular and commercial melon accessions and foreign accessions could improve the proficiency of melon genetics. The recent breeding effort has developed several hybrids aiming to enhance storage and shelf life, disease resistance and resistance to abiotic stresses in the world. Generally, cultivars with a longer shelf life are thought of by customers as having low fruit quality and therefore, present minimal acceptability. Africa and Asia have been proposed as possible regions of origin. Besides the domestication of melon might have occurred independently or in parallel in Asia and Africa.

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Introduction

Melon landraces grown in the semi-arid to arid regions of the world, indicated that melon is a warm season crop grown mainly in sub-tropical and hot-arid regions. Melon is grown on more than 85000 acres of land in Iran. Cucurbits (family *Cucurbitaceae*) are one of the most important plant groups for providing edibles and valuable fibers, vitamins and medicinal targets. Breeders may use genetic variability information to assist them in choosing parental genotypes for hybridization, for the development of new cultivars. Melon germplasm gene bank collections have been studied in order to understand the patterns of genetic diversity and relationships.[2,3] An understanding of component qualities is required when using indirect selection criteria to select high-yielding genotypes.

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Phenotypic and Genotypic Values

The assessment of the degree of the total diversity of a germplasm collection requires the identification of characteristics based on phenotypic diversity. Multivariate data analysis is a prominent statistical tools for studying genetic relationships between morphological characteristics.[4,5,6] For identifying genetic variation and parental diversity, tracing the relationship of traits for increased crop yields, studying the interaction of genotype and environment, some useful methods such as principal components, clusters and factor analyses, are currently available. Using of genetic diversity for genetic improvement for development of tolerant cultivars provides an efficient and attractive approach for this end. Some melon landraces are cultivated as rain fed in most parts of the world despite of low precipitation, thus, melon landraces in this regions are potentially drought tolerant. In recent years, various types of melon landraces have been replaced by modern mostly commercial hybrid cultivars that are mainly imported by seed companies. The main advantage of modern cultivars is resistance to diseases, while they need more irrigation water. Understanding the complex biophysical, biochemical, molecular bases of plant stress tolerance is only a theoretical problem in environmental science and ecology, however, some practical applications can be used to find solutions to agricultural problems and increase crop yields.[7,8] RWC is defined as a percentage of the maximum amount of water that a plant's tissue can retain. As a result, RWC is regarded as the finest criteria status for plant water. In areas where there is a scarcity of water, physiological characteristics such as RWC might be valuable in determining crop performance in response to climatic changes such as drought.

Methods in Diversity

ANNs are widely regarded as one of the most accurate, efficient and widely used approaches for data mining and prediction. Previous research has shown that a network can provide accurate estimates of any function with the accuracy that is expected.[9,10,11] Plant productivity is influenced by physiological and agronomic factors, as well as climatic factors. Physiological and agronomic factors determine the productivity level that will be achieved, while physiological and agronomic factors determine the likelihood of developing a particular species for productive purposes.[12 13] Among the methods of morphological marker, molecular, and biochemical methods, are the most important features for plant improvement.[47] Plant breeding relies heavily on understanding physiological adaption for the genetic enhancement of certain features. The water index is used to assess the canopy's water status, taking into account factors including stomatal conductance, leaf water potential, relative water content and canopy temperature. The hydration status of plant tissue is indicated by relative water content (RWC), which is expressed as a percentage of maximum water content at full turgor.[14,15,16] As a result of stressful circumstances, stomatal aperture and closure govern the amount of CO_2 accessible at the Rubisco site, limiting photosynthesis. The percentage reduction in light-saturated photosynthesis related to stomatal conductance has been characterized as a stomatal constraint to photosynthesis. Melon (*Cucumis melo* L.) is the most significant fruit in Iran, as well as a temperate and warm-season crop of the *Cucumis* genus and *Cucurbitaceae* family. Several intraspecific classifications have been shown and it is the most diversified species.[17,18] Assessment of genetic diversity in diverse species is interesting and important for managing and safeguarding plant genetic resources. It also shows the way to practical applications like widening the genetic base of the species and exploitation of heterosis for breeders.[19] Breeders will be able to pick favored parents in hybrids in order to produce desirable cultivars while still retaining population diversity if they have information about the extent of genetic variation. Inbreeding has resulted in the loss of genetic variety, to combat this issue, species diversity is a major concern. According to Naroui rad, morphological analyses are the most important requirement in the initial assessment of genetic variation for genotype and cultivar classification and identification. Morphological characterization has been done by several studies for local germplasm and indicates various genetic sources.[20,21] Genetic diversity also is one of the main target and suitable for long-term survival.[22] Morphological characterizations may be used in breeding programs to increase genetic availability and make better use of genetic variation. To make the most of genetic diversity, careful consideration of appropriate factors must be made and precise morphological variability characterization in germplasm collections must be carried out.[23] Iran is one of the most

significant locations of origin for melons, therefore anticipates a lot of genetic variation are helpful. Researchers have used a variety of morphological, phonological and physiological techniques in melons (*Cucumis melo*).[24] At the National Plant Gene Bank of Iran, morphological features of several Iranian melon accessions were employed to categorize them. Half-sib progeny tests include the top-cross progeny test, open-pollinated progeny test, and poly-cross progeny test. A half-sib is a plant (or a family of plants) that shares a pollen source or a common parent. Individuals are rated based on their half-sibling progeny in a half-sibling selection. The ability to predict breeding values is required for long-term breeding projects to be effective. Breeding values are used to select breeding and production populations, which are then assessed side by side as part of the long-term breeding process.[25,26] Breeding values are utilized during selection of breeding and production populations, evaluated side by side, with development of long-term breeding. Precision estimations of genetic factors, as well as realistic projections of breeding values, are essential for breeding success. A major goal of muskmelon (*Cucumis melo* L.) breeding is to increase yield. The availability and application of genetic variation for yield or yield-related attributes will most likely determine muskmelon improvement. There is a scarcity of knowledge on muskmelon breeding, particularly for the progeny test, as well as the technique for determining the degree of breeding success. Muskmelon yield and quality need to be increased. The long shelf life of some melon (*Cucumis melo*) cultivars, such as the well-known Honeydew (C. melo var. inodorus), is an essential trait. In order to use this cultivar as a source for this trait, its genetic basis must be clarified, based on the results of some studies obtained, especially as reflected by fruit yield, it is possible to develop melon hybrids with higher salinity tolerance than is currently observed in tolerant cultivars. On the other hand, most of the traits contributing to fruit quality are found to be governed by additive effects, allowing for their further improvement through recurrent selection to develop new cultivars of high yield and good quality for cultivation under saline conditions.[48] Plant breeders need germplasm, germplasm collection is necessary to identify the diversity range. Comprehensive research and assessment of germplasm are required for agronomic and genetic improvement[27] in order to understand the genetic background and breeding value of available germplasm.[28] To measure parental components, progeny testing is based on values discovered in the offspring. In breeding, determining the relationship between progeny tests (heritability, correlation, additive and genetic variations) is critical to determining which test is most efficient for breeding and developing better cultivars. Progeny testing, both half-sib and full-sib are employed, but with adjustments to fit the crop and trait. Planting timing and generation analysis are required for progeny testing.[29] Estimating genetic diversity and finding linkages among germplasm improves the efficiency of germplasm collection management and genetic development, according to one study. For intra-population recurrent selection to succeed, breeders must be concerned with the genetic basis of the population under selection.[30,31,32] Cross-pollination breeding is often employed to generate better cultivars and enhance diverse populations in order to choose clones for a synthetic cultivar.[33]

Some melon based on diversity are suitable for cultivation under protected conditions and some of them not, The high tunnel can provide several opportunities for the grower due to its ability to provide a protected growing environment without the cost of fossil fuels.[34,35] There is growing interest in high tunnels for both organic and conventional products due to their ability to provide a protected growing environment without the cost of fossil fuels. Farmers cultivate a variety of crops and employ season extension technology, including high tunnels, row covers, and greenhouse-grown transplants, to meet the demand for fresh local products throughout the year. Plasticulture, which includes row covers, high tunnels, and plastic mulch, is a useful technology for crop diversification and season extension since it allows farmers in Sistan to create microclimates for crops like a muskmelon.[35,36] Important tool like plasticulture, including row covers and high tunnels as well as plastic mulch, could be effective for crop diversification and season extension as it enables farmers in sistan to create microclimates for cropping such as muskmelon.[36] Plastic covers are one of the strategies for increasing yields. They are designed to change the environment to extend the harvest period, increase early crops, increase yields, improve quality, reduce mechanical damage caused by hail and heavy

rain, and reduce the incidence of phytopathogenic fungi, among other things. In Sistan, the open-field technique is the most common form of melon farming. Compared to greenhouses, a high-tunnel system is less expensive and offers a viable option because of its good technical/economic optimization ratio.[37,38,39] Consumer demand for fresh fruit, as well as organic food, is growing, and markets for this nutritious commodity are expanding. There have been a few studies on high tunnel farming that have been assessed as organic production. High tunnel systems for production have been popular in recent vegetables and this approach is efficient and increases vegetable yields over farm-produced systems. High tunnels play an important role in reducing direct sun exposure, and as a microclimate, biotic and abiotic stresses can be better controlled. Temperature changes will be less frequent, soil temperature will be higher and carbon dioxide levels will be higher, all of which positively affect tunnel production.[40,41]

In kinds of artificial intelligence, high performance has been demonstrated in managing vast amounts of data using different areas of machine learning. Comprehensive applications that identify or extract a model from a vast data set might be just as useful for breeders in phenotyping procedures. Machine learning has a limited number of input parameters in terms of predictability and good compatibility. Different machine learning techniques, including support vector machine (SVM), artificial neural network (ANN) and random forest (RF), have been employed in many disciplines for the construction of categorization models.[42,43]

Plant phenotyping is the measurement of complex features associated with growth. Machine learning implementation includes extensive statistical tools for variable selection and categorization.[44] Maximum likelihood was developed to make advanced classification since the use of machine learning techniques in agricultural and natural resources sciences is still unclear. For example, the information about the population of 60 melon accessions can help to select and find a better accession based on the dendrogram classification distance, component analysis for main factors, and means comparison of the traits for specific breeding purposes.[46] Based on machine learning in one study the most commonly used performance values comprise overall accuracy, kappa value, Receiver Operating Characteristics (ROC) and Area Under Curve (AUC) were performed to identify accuracy of the models, the results showed the best performance for CART than others,the AUC and kappa value were 0.85 and 0.80 and fruit weight was the most important trait that affecting diversity in melon accessions, regarding to these results Classification And Regression Trees (CART) is reliable for identification of melon accessions classes.

Conclusion

Genetic factors may impact each plant's physical traits. Variation across species that vary in a given gene, for example, may be used to investigate gene operation mode. To better understand genetic and morphological features functions, sophisticated technologies might be used to improve based on phenotypic traits analysis. Because of the large number of datasets used in these studies, accurate and fast computational methods are essential for extracting and analyzing phenotypic data and distinguishing between different varieties. Modern deep statistical and learning methods develop this sense and may include many more layers of artificial neurons, resulting in a higher discriminative index.[45] For pattern recognition, K-Nearest Neighbor (KNN) is one of the most common algorithms. One kind of machine learning is the automated process of revealing patterns in vast amounts of data using statistical techniques and models, where the fitted model may be used to forecast targets on the data. Many machine learning algorithms have been developed, but only a few studies have evaluated a variety of distinct learners, typically, model comparison studies have been confined to just a few models. By linking plant consumption as a predictor and effectiveness as a response, a Partial Least Square Discriminant Analysis (PLS-DA) model might be useful in this endeavor. PLS-DA is appropriate for this research because of the many plants involved, yet, PLS-DA was designed to predict responses by magnifying the relationship between responses and predictors.[44,45] Finally methods and traits which used in evaluation of diversity are different but plant breeders must be focused on targets and simple way.

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