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Explaining the Economic Performance of Ornamental Plant Producers Considering Brand Management and Market Dynamics

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Abstract

Uncertainty and market dynamics in competitive environments compel ornamental plant producers to rethink their strategies for improving economic performance. The key to attaining and sustaining economic performance lies in having and expanding exclusive resources, which makes replication by other companies challenging. This research focused on explaining the economic performance of ornamental plant producers considering their brand management and market dynamics. The study is applied research in terms of its objective and descriptive-survey based on its data collection method. Standardized questionnaires were used for gathering information. The statistical population of this study included all marketing managers, financial managers, and senior staff of ornamental plant production companies in the year 2024. Using Klein and Jackson's formula for structural equations, a random sample of 125 individuals was selected. Structural equation modeling and Smart PLS3 software were employed to test the hypotheses. According to the results, brand management and market dynamics play a significant and positive role in improving the economic performance of ornamental plant producers. These findings suggest that managers can observe the results of their decision-making through strategy selection, which reflects on their performance metrics. Assessing and comparing the observed performance with past trends, competitors or the industry average offers valuable feedback for future decision making and activities. Hence, continuous performance improvement has been one of the primary goals for companies over time. Additionally, companies must outperform their competitors in coordinating with supply chain members, analyzing the market, and responding to its demands, which can be achieved through marketing strategies and capabilities.

Keywords: Brand management, Market dynamics, Economic performance, Ornamental plants, Demands.

INTRODUCTION

Iran, with its suitable climatic diversity, inexpensive and qualified labor force, adequate sunlight, abundance of cellulose waste and proximity to consumer markets, is well-suited for the production and supply of various ornamental flowers and plants. Despite these natural advantages, Iran's share in the global production and trade of ornamental flowers and plants is quite limited. Official exports of flowers and plants have maintained a nearly stable rate of approximately $0.5 million over the past few years. However, considering that export declarations were based on previous currency contract rates, which were about one-fifth of actual proposed prices, it can be stated that the real value of official exports is at least five times higher. Furthermore, a significant portion of exports occurs informally and without completing export declarations such as a large amount of potted plants and ornamental seedlings from northern Iran that are sent to central Asian countries and Turkey or shipped via sea to arab countries (Mirzadeh and Jalili, 2020). On the other hand, today's environment brings fresh waves of change. Ornamental plant producers are witnessing significant fluctuations and considerable dynamics in their environments, which has prompted organizations to seek responses to these changes to achieve higher success and performance. In this context, communities and organizations that establish a meaningful relationship between scarce resources, managerial capabilities and their economic performance will attain success. In this complex and competitive environment, the product and service life cycles are shortening, future benefits are uncertain and competition among companies is intensifying. Consequently, it is important to give attention to market dynamics and brand management for survival and achieving competitive successes (Apaolaza *et al*., 2021). Analyzing economic performance enables marketers to measure their influence on variations in company value (Aydin *et al*., 2023). The high volume of ornamental plant imports by neighboring countries shows the importance of addressing production and export issues to increase Iran's market share in the global arena. Therefore, it is important to examine how marketing factors including brand management and market dynamics, influence the economic performance of ornamental plant producers. Thus, this research aims to explore whether brand management and market dynamics have an impact on the economic performance of companies involved in ornamental plant production.

The findings of this study can enhance knowledge in marketing literature and the ornamental plant production industry in the following ways:

This study is the first to analyze the economic performance of ornamental plant producers in relation to brand management and market dynamics. As a result, the findings have the potential to substantially enrich the literature on the factors impacting the economic performance of ornamental plant producers in developing nations such as Iran.

Moreover, the outcomes of this study can help policymakers and legislators to establish necessary incentive policies to support ornamental plant producers via brand management and market dynamics, thus improving the economic performance of these companies. Considering that no research has been conducted on the issues and challenges related to the economics of production, marketing and export in the ornamental plant industry, further studies in this area can lead to changes in production methods for large-scale production, reduction of production costs and a better understanding of ornamental plant markets to align production with global consumption patterns and the regulations regarding the export of ornamental plants.

THEORETICAL FOUNDATIONS AND HYPOTHESIS DEVELOPMENT

Brand management

Brand management has long been a fundamental focus in companies' strategies and programs. A brand is recognized as an intangible but essential asset. Research in branding has

experienced several advancements, from David Aaker's presentation of brand equity in 1991 to Jennifer Aaker's study in 1997, which introduced the concept of brand personality (Brodie *et al*., 2011; Hollebeek *et al*., 2014). Branding is a highly applicable strategy for differentiation between service and manufacturing industries. In today's world, companies and organizations not only compete for a larger market share but also strive to create alignment between customer perceptions and their products, services and brands. Researchers believe that brands have the capacity to embody and reflect an individual's desired identity. Brands are utilized at various levels. In the mid-1990s, a shift in focus became evident in branding literature. During this period, organizations gradually adjusted their branding strategies to emphasize corporate branding over product branding (Santos *et al*., 2022). Consequently, the concept of branding has not yet been defined comprehensively which has resulted in a plethora of varying definitions. The American Marketing Association defines a brand as a name, term, sign, symbol, design or a combination of these, intended to identify the goods and services of one seller or group of sellers and to differentiate them from those of competitors. In another definition, a brand represents a customer experience associated with a collection of images and ideas, often including symbols like logos, slogans and designs. Brand recognition and other responses to the brand (such as its recognition) are originated from experiences related to a product or service that arise from direct engagement with advertisements, design and media interpretations of it (Garanti and Kissi, 2019).

Market dynamics

The factors influencing market dynamics can be classified into three components: The state of competition, customer conditions and government regulations governing the industry. In summary, some indicators of a dynamic market that create the necessary environment for competition among companies and enhance the company's position include:

- Diversity and multiplicity of competing products
- A large number of rival companies
- The influx of foreign products into the market
- Government regulations for product promotion
- The level of import tariffs on foreign products
- The number of required permits (such as health permits) for product production
- Competitors' use of new technologies for developing new products
- The economic power of consumers
- The diversity of consumers and final decision-makers in product purchases such as employed women
- Government control policies regarding product pricing
- Various and stringent implementation standards

Researchers believe that knowing at which stage of economic development the target market stands can assist market management in better understanding the type and level of demand and the marketing system in that country (Aydin *et al*., 2023).

Economic performance

Today, organizations, managers and organizational leaders seek to enhance and improve their operational performance (Apaolaza *et al*., 2021). Economic performance is an approach that allows investment managers to achieve their objectives more effectively and swiftly by aligning the interests of managers with their own through better investment decisions. Economic performance changes should be considered at all levels of the organization to ensure

that individual and group objectives align with the company's goals. Furthermore, measuring the level of economic performance requires tools that assess various aspects of operational performance. To evaluate economic performance, in addition to considering tangible economic results, such as return on investment and increased profit margins, tools must also assess the levels of creativity, innovation and organizational knowledge (Isaac *et al*., 2023).

Brand management and economic performance

Branding and its related aspects can result in consumer loyalty and a willingness among consumers to pay higher prices for products and services. Consequently, strengthening a brand can improve an organization's economic performance and financial profitability (Blanchard *et al*., 2019). This topic is significant as global statistics indicate that approximately 2.99 million brands were registered in 2013 which represents a 2.4% increase over the previous year. These figures show the significant economic importance of brands. It is worth noting that the importance of brands primarily stems from their relationships with customers and other stakeholders (Aydin *et al*., 2023). The importance of economic performance and brand management arises from three main brand functions (trust, symbolic and referential) for consumers and other stakeholders. First, from a behavioral perspective, a brand provides referential authority and thus increasing market transparency and convincing buyers to select the most suitable offer with greater speed and ease. Second, a brand can establish trust based on awareness and perceived competence and thus eliminating asymmetry between sellers and buyers and facilitating market transactions. Third, a brand can create a process and performance of prestige for customers and becomes a tool for customer identity (Ricky *et al*., 2015). Thus, the first hypothesis of the research is proposed as follows:

Hypothesis 1: Brand management a significant impact on the economic performance of ornamental plant producers.

Market dynamics and economic performance

The uncertainty and dynamics in competitive markets compel companies to rethink their approaches to achieving sustainable competitive advantages. To achieve and maintain a sustainable competitive advantage, it is essential to have and develop unique resources that are challenging for other companies to replicate. These resources are primarily embedded in the human capital of companies based on the competencies of their employees including skills, knowledge, expertise and different capabilities (Hollebeek *et al*., 2014). One of the factors creating market dynamics is the uncertainty inherent in these markets and understanding the degree of dynamics in export markets is crucial for identifying sources of uncertainty. Market uncertainty is characterized by the challenges in predicting environmental and organizational conditions which can have a substantial effect on strategic marketing decisions and ultimately the company's economic performance. Studies indicate that examining risk as a multidimensional concept provides a deeper understanding of its effects on company strategy (Apaolaza *et al*., 2021). Product market uncertainty indicates unexpected changes in product demand, customer preferences, and shifts in substitute and complementary goods as well as technological changes. On one hand, in uncertain product market conditions, companies tend to prefer less rigid control strategies as these provide greater flexibility. On the other hand, because of the intangible characteristics of some products, like services which hinder customers' ability to notice changes, service companies prefer to maintain total control over their investments in order to internationalize their unique processes and lower transaction costs. Similarly, manufacturing companies also prefer complete control strategies to acquire knowledge more easily and

quickly about local markets and their changes in response to product market changes, thereby improving their economic performance in the market (Ibrahim and Aljarah, 2018). Therefore, the second hypothesis of this research is proposed as follows:

Hypothesis 2: Market dynamics has a significant impact on the economic performance of producers of ornamental plants.

Research background

In many research paradigms, a literature review is typically conducted. It is noteworthy that, until now, there have been limited efforts to explain the factors influencing the economic performance of ornamental plant producers. Research closely related to this study has been conducted in Iran and other countries which will be briefly summarized in this section:

Yakubu *et al*. (2024) explored the impact of niche marketing strategy on the performance of small and medium-sized enterprises (SMEs) in Nasarawa State, Nigeria. The study aimed to assess how niche marketing strategy affects the performance of SMEs in this state. The total population included 400 registered SMEs with the Ministry of Commerce and Industries of Nasarawa State, Lafia. A sample of 200 was determined using Yamane's sample size formula from the total population of 200 registered SMEs. The research design employed was a survey research design. Questionnaires were developed and distributed to the registered SMEs in Nasarawa State with the data collected analyzed using a five-point Likert scale questionnaire. The findings revealed that marketing strategy significantly influences the performance of SMEs. It was established that the product positioning strategy of SMEs with an overall mean score of 2.74 (above the decision-making rule mean of 2.50) has a significant effect. However, it was indicated that the market segmentation strategy has no significant impact on the performance of SMEs, as reflected by an overall mean score of 2.01, which is lower than the decision-making rule mean of 2.50.

Aripin *et al*. (2024) investigated the influence of marketing duality on performance. This study aimed to examine the effects of marketing duality on company performance employing a response surface approach to address empirical challenges. The research utilized qualitative descriptive analysis to uncover the impacts of marketing duality and quantitative response surface analysis to model the relationship between marketing variables and company performance. The findings showed that the impact of marketing duality has a significant effect on company performance with interactions between marketing variables being complex and not always linear.

Ellitan *et al*. (2023) explored how experiential marketing and customer satisfaction can increase repurchase intention. Marketing activities are increasingly focusing on customer satisfaction. Identifying the factors that lead to customer satisfaction can enhance repurchase intention. This research work discusses how experiential marketing can serve as a strategy that restaurant marketers use to improve customer satisfaction and encourage repurchase intention. It is anticipated that this work will add valuable insights and become a reference for both the present and future particularly in the area of marketing management related to experiential marketing, customer satisfaction and repurchase intention. It can be concluded that a higher sense of experience leads to greater customer satisfaction as all businesses focusing on products and services aim to provide a pleasant experience for their customers. As customer satisfaction increases, the intention to repurchase also grows. Additionally, greater customer satisfaction correlates with a higher intention to repurchase.

Ho *et al.* (2023) examined the benefits of market orientation in the agricultural value chain of an emerging economy. Data from 190 actors in the cattle value chain in the central highlands

of Vietnam were analyzed in this study to assess the relationship between market orientation and innovation. Results show that market orientation does not have a significant relationship with performance. However, customer orientation and inter-functional coordination positively correlate with innovation which in turn is positively associated with financial performance. The results offer insights into the relationships among market orientation, innovation and performance in agricultural value chains in developing economies.

Acosta *et al.* (2018) investigated the internationalization of SMEs to analyze the impact of international market orientation, network capabilities and international entrepreneurship approach on the international performance of these businesses. In particular, both direct influences of explanatory variables on international performance and the dependencies among them were examined. Results derived from a study of 161 Mexican SMEs utilizing SEM-PLS analysis demonstrate that network capabilities have a positive impact on the international performance of these companies and international entrepreneurship approach, but not by international market orientation. Similarly, there exist relationships and dependencies among the explanatory variables of international performance for SMEs, where a positive impact of the international entrepreneurship approach on network capabilities and international market orientation of SMEs is observed.

Bhattarai *et al.* (2018) investigated whether the access to certain business approaches such as market orientation and market agility contributes to both the economic and social performance of social enterprises. Their study, which drew on empirical data from 162 social enterprises in the UK, show that market orientation enhances both social and economic performance simultaneously. In contrast, market disruption capability improves only economic performance and not social performance. Nevertheless, they discovered a positive interaction between market disruption and market orientation regarding social performance, while the effect on economic performance was negative.

Mansourian and Taghinasab (2023) explored the link between marketing agility and economic performance in market turbulence. The study was applied in terms of its objective, survey-based in terms of method and descriptive in nature. The study's population included 35 companies listed on the Tehran Stock Exchange that operate in the automotive and parts manufacturing sectors. Using the Morgan-Krejcie table, a sample of 370 individuals was randomly selected. Data analysis was carried out with the assistance of SPSS and SMART PLS statistical software. The hypothesis test results indivated a significant positive correlation between marketing agility and economic performance, taking into account various levels of market turbulence. Marketing agility significantly and positively affects economic performance. Additionally, there exists a significant positive correlation between marketing agility and innovation capability which in turn significantly influences economic performance. The relationship between marketing agility and economic performance is moderated by market turbulence but this turbulence does not affect the relationships between marketing agility and innovation capability or between innovation capability and economic performance.

1- A significant relationship exists between marketing capabilities and international investment performance.

2- A significant relationship exists between marketing capabilities and marketing communications.

3- A significant relationship exists between marketing capabilities and competitive strategy.

4- A significant relationship exists between competitive strategy and international investment performance.

5- A significant relationship exists between competitive strategy and marketing communications.

6- A significant relationship exists between marketing communications and international investment performance.

7- Technological turbulence does not moderate the relationship between marketing communications and competitive strategy.
8- Technological turbulence moderates the relationship between marketing capabilities and marketing communications.

Afsharfar (2022) studied the impact of market orientation and marketing capabilities on economic performance considering the moderating role of innovation. The study was applied in terms of its objective and descriptive-survey-based in terms of data collection. A questionnaire was used as the data collection tool, which was developed based on both library and field research. The statistical population of the study consisted of 412 employees of Hekmat Bank, and 200 individuals were selected as the sample employing Cochran's sample size formula. In this study, stratified random sampling was the chosen method, with market orientation and marketing capabilities serving as independent variables, economic performance as the dependent variable and innovation as the moderating variable. The standardized questionnaire was distributed among the sample population after confirming its validity (content) and reliability (Cronbach's alpha). The findings from structural equation modeling in LISREL showed a significant positive influence of market orientation and marketing capabilities on the economic performance of Hekmat Bank. Furthermore, innovation moderates the impact of market orientation on economic performance.

Dehdar (2022) studied the impact of marketing performance and marketing strategy on economic performance in private medical clinics in Isfahan. Data was collected via a questionnaire with its validity confirmed using Cronbach's alpha, scoring 0.85. Structural equation modeling and LISREL software were used to analyze the data and test the hypothesis with the research components evaluated on a five-point Likert scale. The study was applied in terms of its objective and conducted using a descriptive-survey method. The statistical population comprised customers of private medical clinics in Isfahan during spring 2021, and the sampling method was random convenience sampling. The results showed that marketing performance and marketing strategy influence economic performance.

Javidi and Boroumand (2019), in their research titled ‘Investigating the relationship between international marketing strategies and international experience with export performance (case study: Zahreh Tarshiz Glazed Tile Company)’, showed a significant link between international marketing strategies and international experience with export performance, thereby confirming the main hypothesis. The findings from the secondary hypothesis indicated a significant link between international marketing strategies and export performance, as well as between international experience and export performance. International marketing strategies had a more significant influence on export performance than international experience and all three secondary hypotheses were confirmed.

RESEARCH METHODOLOGY

This research is applied in nature and descriptive-correlational regarding data collection methods. Furthermore, it employs a deductive-inductive reasoning approach and bacause to the study of data related to a specific time period, data analysis is conducted cross-sectionally and based on path analysis methods. A questionnaire was used as the data collection tool. The data analysis is of a descriptive-correlational type, utilizing quantitative methods. Information and data collection were carried out in two ways. First, relevant information regarding the research variables (literature review) was extracted from reputable internal and external databases such as Noormags, Ganj, Civilica, SID, Human Sciences Portal, IranDoc, Emerald, Elsevier, Web of Science and others using index cards and the note-taking method. Second, in the fieldwork section,

data were collected using standardized questionnaires: The brand management questionnaire by Tamer *et al*. (2017), comprising 11 questions: The market dynamics questionnaire by Tamer *et al.* (2017), consisting of 6 questions, and the economic performance questionnaire by Touni *et al.* (2020) which includes 8 questions, all gathered through surveys from the study sample.

Statistical population, sampling method, and sample size

The statistical population consists of all marketing managers, financial managers, and senior staff of ornamental plant production companies in 2024. The sample size will be calculated using the Klein and Jackson formula. In confirmatory factor analysis, the minimum sample size is dictated by the factors rather than the variables. If structural equation modeling is employed, around 20 samples are required for each factor (latent variable). For confirmatory factor analysis, a recommended sample size is approximately 200 samples for ten factors. Based on Klein's criteria, a minimum of 5 to 25 participants requires for each questionnaire item. The simple random sampling method will be used. Since the questionnaire contains 25 items and 5 participants are required for each item, the sample size will be 125 individuals.

RESEARCH FINDINGS

Descriptive statistics

To familiarize with the characteristics of the statistical sample, the demographic information of the research participants is presented in table 1.

Table 1. Demographic characteristics of respondents.

Index		Frequency	Frequency percentage
Gender	Male	117	93.6
	Female	8	6.4
	Total	125	100
Education	Bachelor	24	19.2
	Master	97	77.6
	PhD and PhD candidate	4	3.2
	Total	125	100
Work experience	Up to 5 years	13	10.4
	6 to 10 years	18	14.4
	11 to 15 years	32	25.6
	Over 16 years	62	49.6
	Total	125	100
Age	Up to 30 years	15	12
	31 to 40 years	84	67.2
	Over 41 years	26	20.8

The descriptive statistics on gender indicated that 8 respondents were women and 117 were men which shows that the majority of the collected data belongs to men. The results concerning the education of respondents revealed that 24 had a bachelor's degree, 97 had a master's degree, and 4 had a doctoral degree. It can be concluded that most of the collected data belongs to individuals with a master's degree. Regarding work experience, the results showed that 13 respondents had up to 5 years of experience, 18 had between 6 and 10 years, 32 had between 11 and 15 years and 62 had more than 15 years of experience. In terms of age, the

results indicated that 15 individuals were up to 30 years old, 84 were between 31 and 40 years old and 26 were over 41 years old.

Hypothesis testing

To assess the reliability of the measurement model, convergent validity and discriminant validity were examined using confirmatory factor analysis (CFA) and the average variance extracted (AVE) method. The confirmatory method evaluates the alignment of the data with a specific factor structure. In fact, CFA examines the appropriateness of the items chosen to represent a construct or latent variable. CFA extends traditional factor analysis and is a key component of structural equation modeling where specific hypotheses about the factor loadings are tested. According to Fornell and Larcker's criterion (1981), factor loadings greater than 0.5 are considered sufficiently valid. Additionally, the average variance extracted among constructs should be greater than or equal to 0.5. Based on the findings of this study, all factor loadings are at least 0.7 which confirms the convergent validity of the data. Furthermore, the t-statistics for all variables exceed 1.96 which indicates their significant impact on the corresponding constructs. As shown in table 2, the AVE for all variables is greater than 0.5, demonstrating acceptable convergent validity. The composite reliability and Cronbach's alpha coefficient for all constructs also show that the internal consistency of the measurement models is satisfactory.

Table 2. Convergent validity and reliability.

Dimensions	Cronbach's alpha	Rho	Composite reliability	AVE
Economic performance	0.952	0.983	0.963	0.772
Brand management	0.988	0.991	0.989	0.894
Market dynamics	0.966	0.981	0.974	0.863

To assess discriminant validity, the method proposed by Fornell and Larcker (1981) was employed. Thus, discriminant validity is confirmed when the square root of the Average Variance Extracted (AVE) for each construct surpasses the correlation values with other constructs. Table 3 presents the results of the average variance test between constructs (discriminant validity assessment). The diagonal values are the square roots of the AVE values.

Table 3. Average variance between constructs (assessment of discriminant validity).

Constructs	Economic performance	Brand management	Market dynamics
Economic performance	0.879		
Brand management	0.687	0.946	
Market dynamics	0.380	0.570	0.929

As shown in table 4, the R values for the latent variables in the model indicate the extent to which dependent variables are influenced by independent variables. Accordingly, 64.8% of the variation in economic performance is explained by brand management and market dynamics.

Table 4. R^2 values of the research model.

Dimensions	Coefficient of determination	Adjusted coefficient of determination
Financial performance	0.648	0.647

Examination of the Q2 values in table 5 indicates that none of the Q2 values are negative and the minimum required values for prediction have been met.

Table 5. T-statistic values of the research model.

Dimensions	CV. Redundancy (Q2)	CV. Communality (Q2)
Economic performance	----------	0.671
Brand management	----------	0.807
Market dynamics	0.704	0.761

In this section, the hypotheses were tested using path coefficients and t-statistics. A t-statistic greater than 1.96 indicates that the path is significant and the hypothesis in question is accepted at the 0.05 significance level. Table 6 presents the results of the t-test.

Table 6. Hypothesis testing.

Hypothesis	Variable		Path coefficient	T-statistic	Sig. level	Result
	Independent	Dependent				
1	Brand management	Economic performance	0.607	10.092	0.000	Confirmed
2	Market dynamics	Economic performance	0.391	6.534	0.000	Confirmed

The findings from the first hypothesis test regarding the influence of brand management on the economic performance of ornamental plant producers, shown in table 6, showed that the standardized path coefficient for the brand management - economic performance relationship is 0.607, with a t-statistic of 10.092, which is significant at the 95% confidence level. Thus, brand management positively and significantly affects the economic performance of ornamental plant producers. The results from the second hypothesis test concerning the impact of market dynamics on the economic performance of ornamental plant producers demonstrated that the standardized path coefficient for the market dynamics - economic performance relationship is 0.391, with a t-statistic of 6.534, which is significant at the 95% confidence level. Therefore, market dynamics has a positive and significant impact on the economic performance of ornamental plant producers.

DISCUSSION AND CONCLUSION

The commercial production of ornamental plants in Iran has a history of about 90 years. However, it experienced limited growth up until the Islamic Revolution's success. After the revolution, with the ban on the import of these goods, producers gained new life, which resulted in a production leap that continues to this day with an annual increase of over 10% in the cultivation area of these products. Therefore, attention to the economic performance of ornamental plant producers is of high importance. This study investigated the effects of brand management and market dynamics on the economic performance of ornamental plant producers. The findings showed that both brand management and market dynamics have a positive and significant impact on the economic performance of these producers (Aydin *et al*., 2023). The economic performance of a company is a major concern for managers of economic units. Managers strive to manage their companies better and deliver outstanding performance using new methods. Various factors influence the economic performance of companies and each company seeks to select a range of efficient and effective strategies to enhance business processes and trends (Blanchard *et al*., 2019). The level of development of countries, the acceptance of methods, the risk tolerance of managers in selecting methods and the availability of software that facilitates the application of these methods in companies help to competitive advantages in their selection.

One of the major concerns for management and organization experts in recent decades has been identifying the factors that influence economic performance and finding ways to improve company performance. Brand management is a function of marketing that involves analyzing and planning how a brand is perceived in the market through strategies and techniques. The main goal of brand management is to create, measure and control brand value—building a brand that adds value both in terms of monetary and non-monetary aspects during interactions with the product (Apaolaza *et al*., 2021). Brand management is part of marketing management and deals with the overall development of the brand from its inception until its eventual decline. The functions of brand management include:

• Identifying the ideal target market and understanding what motivates them to choose one product over others positions the brand within the same motivational framework;
• Creating an ideal marketing message that resonates with the needs of the target market and aligns with the proposed value proposition;
• Communicating the brand promise to customers through nearly every possible touchpoint;
• Efforts to create and measure brand value occur regularly (Ricky *et al.*, 2015).

Thus, the brand management process focuses the brand manager on identifying a beneficial and strategically advantageous position in the market which can be utilized to address existing competition and establish a positive long-term image. This is in normal accomplished by the use of mental maps and positioning maps which lead to improved economic performance for the company (Hollebeek *et al*., 2014).

In the complex, dynamic and highly variable environment of today, companies need to develop and implement strategies that help them to consistently improve their performance. In such a competitive environment, only companies that can keep up with the competition and adapt to the changing conditions of the competitive market will survive. In other words, company managers will see the outcomes of their decision-making reflected in the form of strategy choices as indicated by performance metrics. Analyzing and comparing observed performance with past trends, competitors or industry averages provides valuable feedback for decision-making and future activities. Thus, one of the main goals of all companies over time has been to achieve continuous performance improvement. Furthermore, companies must take the initiative compared to their competitors in creating alignment among supply chain members and analyzing the market to respond to its needs. This can be reached by leveraging marketing strategies and their capabilities (Ibrahim and Aljarah, 2018).

Many studies conducted over the past few decades regarding the application of marketing capabilities in manufacturing companies reveal the growing importance of these capabilities and show that effective and practical marketing capabilities can have positive impacts at the organizational level. Results derived from this study show that marketing is now recognized as a strategy for implementing organizational programs. As a result, all companies should define a goal-oriented marketing framework based on their position and resources to take effective steps toward improving economic performance (Santos *et al*., 2022; Garanti and Kissi, 2019).

Furthermore, some suggestions are provided for ornamental plant producers based on the results: Since brand management is a function of marketing that involves analyzing, strategizing and planning how a brand is perceived in the market, ornamental plant producers can positively impact their economic performance through digital marketing, social media marketing, video marketing and mobile marketing by effectively branding their companies. In addition, it is suggested that ornamental plant producers survey their customers to gather feedback on product quality. Companies can create a favorable perception among customers by improving product and service quality. This strengthens brand management capacity and

leads to competitive advantage which finally improves their economic performance. Marketing and sales managers of ornamental plant producers should conduct extensive advertising and with emphasizing the company's strengths over competitors increase their market presence. Furthermore, managers should consistently prioritize service quality as an important factor in enhancing their market assessment capacity to improve the company's economic performance.

The main limitation of this study was in the inherent limitations of the questionnaire used for data collection. One of the key limitations of the questionnaire is the extent to which respondents can understand, interpret and analyze the topic. Given this limitation, it is suggested that future research focus on the practical application of theories related to market share in the context of ornamental plant producers. Moreover, future researchers should examine the impact of electronic marketing strategies on the export performance of ornamental plant producers particularly considering the mediating role of service quality. Finally, it is suggested that future researchers propose a comprehensive model to enhance the competitive advantage of ornamental plant producers.

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Exploring Citizens' Aesthetic Perception in Urban Green Space Design: A Study of Ornamental Trees and Shrubs Distribution in Bushehr, Iran

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Abstract

Expanding and restoring urban green spaces represent a growing social demand among citizens in developing countries. However, in Iran, these efforts face significant challenges due to the country›s arid regions and the heightened expectations of people regarding visual and environmental quality. The selection of tree species in urban landscape design plays a crucial role in shaping the aesthetic, emotional, and environmental aspects of urban areas. To evaluate the impact of ornamental trees and shrubs in Bushehr›s urban space, a questionnaire-based survey was conducted with a statistical sample of 200 Bushehri citizens, focusing on five species: *Bougainvillea* sp., *Ficus elastica*, *Conocarpus erectus*, *Clerodendrum inerme*, and *Dodonea viscosa*. Analysis revealed that «emotional feeling» and «perceived environmental beauty» constituted 70.9 % of society's aesthetic perception variance. Additionally, Friedman's nonparametric test highlighted significant differences in society's aesthetic perception of the studied trees, with respondents noting higher perceived cognitive beauty in *Bougainvillea* sp. and *F. elastica*. Effective selection of plant species for urban green spaces not only enhances visual appeal but also positively impacts people's emotional well-being. This requires a thorough consideration of environmental factors and emotional responses. By integrating these concepts into the design, along with raising awareness of arid region species, satisfaction with urban spaces can be partially increased.

Keywords: Aesthetics, Shrubs, Trees, Urban green space.

INTRODUCTION

Population growth and urbanization are undeniable realities of the modern world. As urban areas expand, there is a growing demand for appealing landscapes. However, concurrently, the availability of spaces conducive to enhancing landscape beauty both quantitatively and qualitatively is diminishing (Ma, 2005). In recent years, the traditional spatial-based approach to landscape performance has evolved towards multifunctional paradigms. This shift is driven by the belief that landscapes become more practical and effective when they serve ecological, economic, sociocultural, historical, and aesthetic purposes simultaneously. Therefore, when planning and constructing landscapes and green spaces in climatically unique regions, such as arid and semi-arid areas, it becomes crucial to prioritize multipurpose functionality. This includes addressing climate change-related challenges, notably the water crisis and its socioeconomic implications, alongside considerations for aesthetic dimensions.

In developing countries, there is a burgeoning social and civic demand for the expansion and revitalization of urban green spaces. However, this aspiration faces significant challenges, particularly in arid regions, due to population growth and the scarcity of sustainable water resources. Simultaneously, community expectations regarding the visual appeal of green spaces add to the complexity. Addressing this requires the localization and introduction of alternative drought-resistant species. This strategy offers a partial solution to mitigate dissatisfaction in dry climates (Karimian, 2019).

The term 'aesthetic' finds its roots in the Greek word 'aisthēta,' which translates to perceptible things. Beauty, as described by Lothian (1999), is a natural delight derived from experiencing natural landscapes, whether observed physically or perceived mentally as an intrinsic quality of the environment within human consciousness. Gobster *et al.* (2007) further elaborate on aesthetics, defining it as the sensation of joy evoked by perceptible features within landscape patterns, observable directly and temporarily from the landscape itself. Thus, the aesthetic perception of a landscape arises from diverse stimuli and the amalgamation of various senses in perceiving it, with particular emphasis placed on visual beauty (Karimian, 2019). Cultural-based aesthetic theories, as proposed by Bourassa (1990), acknowledge factors such as social, religious, racial, and historical influences in shaping people's aesthetic responses. These theories underscore the intricate interplay between culture and aesthetics in shaping individuals' perceptions of beauty. Plants hold significant symbolism in Iranian culture, representing freshness and beauty (Aminzadeh, 2001). One of the most notable Persian concepts related to green spaces is the term "Pardis", which has influenced numerous words in other languages (Barati, 2003).

The concept of humans as the creators and primary influencers of urban environments emerged in the 15th century, leading to the development of attractive squares, green spaces, landscapes, and intersections within cities (Shokouie, 2017). Scholars unanimously recognize the vital role of urban green spaces in fostering sustainable cities (Seiferling *et al*., 2017). These spaces offer a multitude of benefits, including enhancing urban aesthetics, promoting public health, and increasing land value (Pandit *et al*., 2013; Roy, 2017). Additionally, they contribute to green views, provide shade, support biodiversity (Cowett and Bassuk, 2014; Li *et al*., 2018; Subburayalu and Sydnor, 2012), mitigate air pollution (Harris and Manning, 2010), combat heat island effects (Lanza and Stone, 2016), and influence microclimates (Sanusi *et al*., 2017). Street trees, a prominent feature of urban green spaces, thrive in close proximity to people's daily lives (Plant and Sipe, 2016). While much research on street trees has focused on their functional benefits, such as data collection and policy development, attention to species diversity is crucial (Vogt *et al*., 2017; Berland and Lange, 2017; Buijs *et al*., 2019; Foo, 2018; Galenieks, 2017).

Studies emphasize the importance of selecting street tree species capable of withstanding harsh environmental conditions, ensuring they provide optimal benefits and endure challenging growth conditions (Mullaney *et al*., 2015; Jim, 2003; Sjöman and Nielsen, 2010; Chen, 2017). The growth environment of street trees differs significantly from trees cultivated in other parts of cities, impacting citizens' perception (Mullaney *et al*., 2015; Yang *et al.*, 2012; Escobedo and Chacalo, 2008). Integrating citizens' perceptions and preferences into existing selection criteria is expected to enhance their satisfaction (Kim *et al*., 2021). Trees in urban areas serve four main functions: Ecological: They provide habitats for wild species (MacGregor-Fors *et al.,* 2011). Temperature: Trees and their density help reduce urban heat island effects (Grimm *et al.*, 2008). Economic: Their shade can lower maintenance costs for urban infrastructure (Conway and Urbani, 2007; Sanesi and Chiarello, 2006). Social: Trees contribute to stress reduction and are commonly used for stress mitigation.

Iran, a country where approximately two-thirds of its land area lies in arid and semi-arid regions, faces challenges in maintaining sustainable water resources due to their limited availability (Karimian, 2019). Consequently, there is a necessity to transition towards water-sensitive urban designs, xeriscaping, and altered planting patterns. Climatic classifications indicate that precipitation ranges from 100 to 250 mm in arid regions and 250 to 490 mm in semi-arid regions, with Iran being considered arid given its average precipitation of about 200 mm. Moreover, approximately 120 million hectares of Iran's total land area of 165 million hectares have arid desert climates (Khosroushahi, 2012). Designing landscapes and green spaces in arid regions presents unique challenges due to harsh climatic conditions, including limited precipitation, acute water scarcity, high temperatures, intense solar radiation, persistent winds, significant fluctuations in day and night temperatures, and low humidity levels. Despite the acknowledged importance of trees in urban areas and contemporary urbanization strategies (Ezcurra, 1990), tree cover remains predominantly sparse. While the role of urban trees in supporting wildlife has been extensively studied (Chace and Walsh, 2006; Hamer and McDonnell, 2008), there has been limited investigation into people's perceptions of trees (MacGregor-Fors *et al.*, 2011). Therefore, addressing the issues of green space and aesthetics in urban areas is crucial.

Ode *et al.* (2008) delineated nine visual concepts, collectively shaping the notion of visual aesthetics in landscapes. These concepts encompass complexity, coherence, stewardship, disturbance, visual scale, image ability, naturalness, historicity, and ephemera. Dulebenets *et al.* (2018) highlighted essential contradictions in organizing aesthetic elements, such as equipment and facility inadequacies, disordered lighting, asymmetric coloring, and unbalanced spacing. Celik and Aciksoz (2017) evaluated the natural, cultural, economic, and structural features contributing to urban green space aesthetics, examining their ties to globalization and seeking sustainability solutions in Bartin, Turkey. Natural elements, labeled as "natural tranquilizers," are deemed beneficial for urban areas, offering respite from the stress prevalent in daily life (Othman *et al.*, 2015). Barrett *et al.* (2009) underscored that global population growth manifests concerns across various domains, including landscape aesthetics, disease ecology, energy resource management, environmental literacy, food production, genetic diversity, and landscape vitality. Veinberga *et al.* (2019) explored human perception of ecological qualities and landscape aesthetics, assessing four types of plantings in urban green spaces across six ecological and beauty characteristics in four Latvian cities. Tork (2011) advocated for leveraging natural ground to enhance aesthetic perception and quality of life, emphasizing the significance of natural elements and criteria in shaping human existence.

This study aims to discern and examine the aesthetic impacts of ornamental trees and shrubs in urban green space design within Bushehr.

MATERIALS AND METHODS

Species selection and study site

Out of the 90 street tree species planted in Bushehr, five primary species were selected for the research based on their prevalence in main streets and their ability to absorb pollutants. The research comprised two phases. During the first phase, ecological indices of the trees were identified. A comprehensive list of ornamental plants was obtained from the Organization of Urban Parks and Green Spaces of Bushehr, encompassing 123 species of plants, shrubs, and trees with their phenology. From this list, ten superior species were chosen based on various criteria, including growth parameters, regional adaptability, suitability for the urban environment, aesthetic appeal, architectural qualities, and unique characteristics within the city (Asgharpour, 2009).

To make these selections, consultations were held with organizations such as the Organization of Urban Parks and Green Spaces, the Department of Environment, as well as experts in horticulture, green space management, and urban architecture. The selected species included buttonwood (*Conocarpus erectus*), sacred fig (*Ficus religiosa*), great bougainvillea (*Bougainvillea* sp.), sorcerers bush (*Clerodendrum inerme*), palm (*Phoenix* sp.), neem (*Azadirachta indica*), jambolan (*Syzygium cumini*), rubber fig (*Ficus elastica*), royal poinciana (*Delonix regia*), and sticky hop bush (*Dodonaea viscosa*) grown in Bushehr. Inductively coupled plasma mass spectrometry (ICP-MS) was used to measure the concentration of heavy metals (Amareh *et al*., 2024). Based on the results of heavy metal uptake, five ornamental flowers of *Bougainvillea* sp., *C. erectus*, *C. inerme*, *D. viscosa*, and *F. elastica* were finally chosen as they had the highest rate of heavy metal uptake (Fig. 1).

In the second phase, the focus shifted to assessing the aesthetic effects of the selected tree species within the urban space of Bushehr. To accomplish this, the research team compiled and refined evaluation criteria based on an extensive literature review (Todorova *et al*., 2004; Lampinen *et al*., 2021; Camacho-Cervantes *et al*., 2014; Kim *et al.*, 2021). These criteria were then transformed into an initial questionnaire. Subsequently, the questionnaire was subjected to validation by 10 experts specializing in art, horticulture, and landscape design to ensure its aesthetic validity. Their feedback and insights were instrumental in refining the questionnaire to ensure its effectiveness in assessing the aesthetic aspects of the target tree species.

Based on the content validity index (CVI), respondents were asked to rate each item on the questionnaire as irrelevant, needing major revision, relevant but needing minor revision, or completely relevant. This process aimed to assess how well the selected questions satisfied all criteria required for inclusion in the final instrument and whether the domains chosen for forming the final instrument adequately reflected all aspects of the studied construct (Polit and Beck, 2006; Grant and Davis, 1997; Rubio *et al*., 2003; Abdollahpour *et al*., 2010).

Content validity is considered a crucial step in questionnaire design and is the primary type of validity to ensure when creating an instrument (Grant and Davis, 1997; Rubio *et al*., 2003; Abdollahpour *et al.*, 2010). To evaluate content validity, the questionnaire was distributed to 10 experts in horticulture, landscape design, and art. They were asked to provide their opinions on the 19 items of the questionnaire using the four criteria mentioned above.

The CVI score was calculated by determining the total agreement scores for each item that received scores of 3 and 4 (the highest scores), divided by the total number of voters. Items with a CVI score of >0.79 were considered acceptable. The analysis revealed that all items achieved CVI scores >0.79, except for items 6, 7, 9, 14, and 19, which were deemed suitable for evaluation (Table 1).

Table 1. The content validity index.

	Features	Content validity index					
		Irrelevant	Needing major revision	Relevant but needing minor revision	Completely relevant	Standard value	Sum of columns 4 + 3
2	I feel good when I see this tree amidst the greenery.			40	60	62	100
12	This tree is compatible with the weather conditions of the city.			10	90	62	100
17	Proper grooming and pruning make it more beautiful.			22.2	77.8	78	100
1	This tree beautifies urban green spaces.			11.1	88.9	78	100
4	This tree gives a pleasant color and scent to the green space.		10	30	60	62	90
13	It creates a natural atmosphere in the street.		10	10	80	62	90
16	They cool the air on hot days.		11.1	22.2	66.7	78	88.9
5	This tree gives a warm and friendly feeling to the environment.		20	30	50	62	80
8	This tree is attractive.		20	60	20	62	80
11	I feel happy when I see this tree.	20		50	30	62	80
3	This tree can be a symbol of the green space in the region.	22.2		55.6	22.2	78	77.8
10	It is a unique tree.	11.1	11.1	33.3	44.4	78	77.7
14*	It keeps us aware of the seasonal changes of nature.	11.1	11.1	33.3	44.4	78	77.7
7*	This tree creates a sense of security in the street.	20	10	50	20	62	70
15	It provides a suitable place for the local residents to gather.	10	20	50	20	62	70
18	When it dries, it creates an unpleasant scene in the environment.	20	10	10	60	62	70
6*	This is a lovely tree.		40	30	30	62	60
19*	Houses in the vicinity of green space created by these trees are in a better position for buying and selling.	22.2	33.3	33.3	11.1	78	44.4
9*	It creates a sense of liberation in me.	40	20	30	10	62	40

After scoring, items that did not meet the minimum required score were discarded, while those with borderline scores were revised to enhance their validity. Following confirmation of validity, a pilot test was conducted to evaluate the instrument's reliability. Cronbach's alpha was calculated to be 0.91, confirming the instrument's reliability.

The questionnaire comprised two sections. The first section gathered demographic information (educational level and age), while the second section focused on assessing aesthetic perception and tree features within the urban environment. These included aspects such as urban space beauty, evoking positive feelings, symbolizing green spaces, adding freshness and scent, creating a warm and friendly atmosphere, attractiveness, uniqueness, providing delight, adapting to climatic conditions, creating natural surroundings, offering a gathering place, cooling the air, and enhancing beauty through grooming and pruning.

Respondents were presented with images of each studied species separately and asked to rate their agreement with the questionnaire items for each species on a scale from 1 to 10 (1 = very weak agreement, 10 = very strong agreement). Data were collected during the winter of 2022 and analyzed using nonparametric tests such as the Kruskal-Wallis and Friedman tests, as well as exploratory factor analysis R. Additionally, Bartlett's test and the Kaiser-Meyer-Olkin (KMO) measure were employed to ensure sample size adequacy and the sphericity of variables before conducting factor analysis.

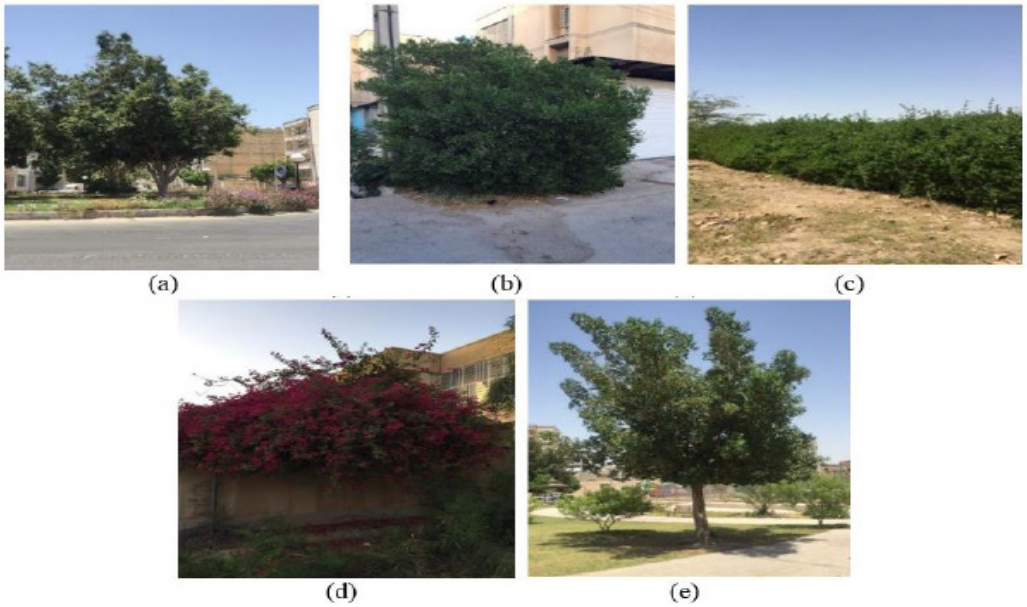

Fig. 1. (a) *Ficus elastica*; (b) *Dodonea viscosa*; (c) *Clerodendrum inerme*; (d) *Bougainvillea* sp.; and (e) *Conocarpus erectus*.

RESULTS

The findings revealed that the majority of respondents fell within the age brackets of 30-40 years (33.7%) and 40-50 years (30.2%). Regarding educational attainment, the highest frequency was observed among individuals holding a bachelor's degree (45.8%), while the lowest frequency was recorded among those with an under-high school diploma (4.9%) (Table 2).

Table 2. The respondents' age and educational level characteristics.

Variable	Levels	Frequency	%
Age	<20 years	24	11.7
	20-30 years	26	12.7
	30-40 years	69	33.7
	40-50 years	62	30.2
	50-60 years	18	8.8
	> 60 years	6	2.9
Educational level	Under diploma	10	4.9
	Diploma	19	9.4
	Associate degree	11	5.4
	Bachelor's degree	93	45.8
	Postgraduate degree	70	34.5

Regarding the respondents' aesthetic perception of *Bougainvillea* sp., the highest scores were observed in various aspects, with the most notable being the stimulation of a good feeling (9.33), symbolizing the green space (8.76), creating pleasant color and scent (8.38), provoking a warm and friendly feeling (8.86), attractiveness (9.09), uniqueness (8.41), creating a sense of delight (8.95), adaptation to climatic conditions (9.39), creating a natural space (8.97), creating a suitable place for gathering (8.33), and enhancing beauty with proper grooming and pruning (8.48). Conversely, the highest scores for creating an unpleasant scene due to drying (7.21) and cooling the air on hot days (7.92) were associated with F. elastica (Table 3).

Additionally, the lowest averages for aesthetic perception features were observed in various aspects, notably:

Creating an urban green space (5.28), inducing a good sense (5.06), symbolizing the green space (4.41), creating pleasant color and scent (3.72), inducing a warm and friendly feeling (4.66), attractiveness (4.67), uniqueness (4.46), creating a sense of delight (4.12), creating a natural space (5.95), creating a suitable place for gathering (5.29) and enhancing beauty with proper grooming and pruning (7.39). These lowest averages were associated with *C. erectus*. Additionally, the lowest averages for adaptation to climatic conditions (7.17) and cooling the air on hot days (6.17) were related to *D. viscosa* (Table 3).

In general, the respondents' highest mean aesthetic perception was associated with *Bougainvillea* sp. (8.64), while the lowest was observed for *C. erectus* (5.41) (Fig. 2).

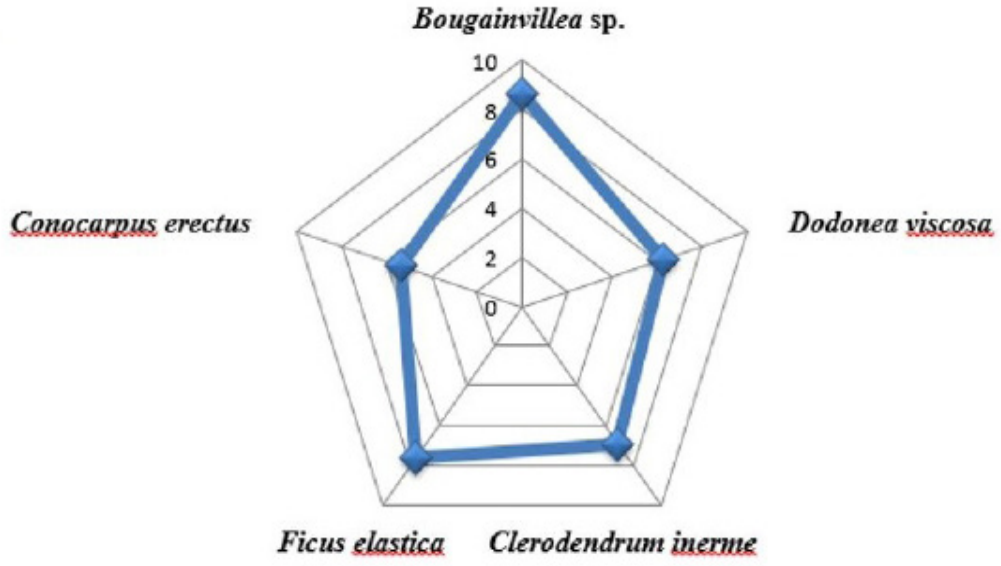

Fig. 2. The average aesthetic perception of the ornamental trees in Bushehr's urban green space.

The Kruskal-Wallis test examining the effect of education on aesthetic perception of the landscape trees indicated no significant difference among the education groups. However, when studying the difference in aesthetic perception of common trees in urban landscape design among different age groups, the test revealed significant differences in the aesthetic perception of *F. elastica* (Chi2 = 3.404, $P < 0.05$). Further comparison of the mean ranks showed a significant difference only between the age groups of <20 years and 30-40 years regarding aesthetic perception of *F. elastica*, while the age groups did not significantly differ in aesthetic perception of the other plants (Table 4).

Table 3. The aesthetic characteristics of the trees.

Characteristic	*Bougainvillea sp.*		*Conocarpus erectus*		*Ficus elastica*		*Clerodendrum inerme*		*Dodonea viscosa*	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
This tree beautifies urban green spaces.	9.26	1.416	5.28	3.495	7.95	2.037	7.50	2.351	6.56	2.500
I feel good when I see this tree in the green.	9.33	1.454	5.06	3.538	7.76	2.157	7.10	2.261	6.08	2.566
This tree can be a symbol of the green space in the region.	8.76	1.915	4.41	3.694	7.23	2.632	6.24	2.652	5.59	2.940
This tree gives a pleasant color and scent to the green space.	8.38	2.269	3.74	3.565	7.17	2.585	6.50	2.539	5.84	2.671
This tree gives a warm and friendly feeling to the environment.	8.86	1.756	4.66	3.460	7.43	2.493	6.64	2.382	5.84	2.657
This tree is attractive.	9.09	1.684	4.67	3.455	7.54	2.689	6.80	2.628	5.83	2.562
It is a unique tree.	8.41	2.031	4.46	3.539	7.23	2.664	6.13	2.888	5.56	2.753
I feel happy when I see this tree.	8.95	1.803	4.12	3.437	7.23	2.476	6.38	2.751	5.77	2.733
This tree is compatible with the weather conditions of the city.	9.39	1.337	7.31	3.168	8.10	2.142	8.00	2.250	7.17	2.705
It creates a natural atmosphere in the street.	8.97	1.670	5.95	3.349	8.01	2.098	7.07	2.573	6.79	2.701
It creates a proper place for local residents' gatherings.	8.33	2.323	5.29	3.526	7.70	2.392	5.97	3.046	5.66	2.900
It cools the air on hot days.	7.21	2.639	6.67	3.384	7.92	2.355	6.62	2.902	6.17	2.734
Proper grooming and pruning make it more beautiful.	8.48	2.357	7.36	3.199	8.05	2.260	8.33	2.191	7.68	02.538
When it dries, it creates an unpleasant scene in the environment.	7.50	3.019	6.78	3.299	7.54	2.696	7.26	2.875	7.01	2.863
Total			75.7		106.8		96.5		87.5	

Table 4. The difference among educational groups and age groups in their aesthetic perception of the ornamental trees in Bushehr.

Species	Age group		Educational level	
	Chi-square	p-value	Chi-square	p-value
Bougainvillea sp.	2.696	0.747	7.131	0.129
Conocarpus erectus	3.403	0.638	5.037	0.283
Ficus elastica	14.923	0.011	1.372	0.849
Clerodendrum inerme	4.364	0.498	2.241	0.692
Dodonea viscosa	0.624	0.987	1.969	0.742

Also, the results of the nonparametric Friedman test showed statistically significant differences in the aesthetic perception of the studied ornamental trees in the green space of Bushehr (Chi2 = 325.4; P < 0.01) (Table 5).

Table 5. The comparison of the ornamental trees in the urban green space of Bushehr.

Tree	Mean rank
Bougainvillea sp.	4.43
Conocarpus erectus	1.99
Ficus elastica	3.48
Clerodendrum inerme	2.84
Dodonea viscosa	2.26
P < 0.01; Chi-square = 325.4	

Table 6. Identification of aesthetic perception components of urban residents in Bushehr.

Item	Component	
	Emotional feeling	Environmental beauty
It is a unique tree.	0.872	
This tree can be a symbol of the green space in the region.	0.855	
I feel happy when I see this tree.	0.833	
This tree is attractive.	0.828	
This tree gives a warm and friendly feeling to the environment.	0.822	
I feel good when I see this tree in the green.	0.774	
This tree gives a pleasant color and scent to the green space.	0.732	
It creates a proper place for local residents' gatherings.	0.720	
This tree beautifies urban green spaces.	0.648	
This tree is compatible with the weather conditions of the city.		0.850
Proper grooming and pruning make it more beautiful.		0.791
It cools the air on hot days.		0.637
When it dries, it creates an unpleasant scene in the environment.		-0.632
It creates a natural atmosphere in the street.		0.583
Percent of variance	62.115	8.676
Eigenvalue	8.696	1.227

To assess the community's overall aesthetic perspective, an exploratory factor analysis (R type) was conducted to categorize the general aesthetic items. Total scores of the items were calculated separately for all five trees. Bartlett's test and the Kaiser-Meyer-Olkin (KMO) measure were then utilized to assess the feasibility of factor analysis through principal component analysis, with the results confirming its feasibility (KMO test = 0.943; < 0.01).

The data were divided into two factors based on eigenvalues of >1, which collectively accounted for 70.9 percent of the total variance in the data. The results revealed that people's aesthetic perception comprised two general components: emotional feeling (including uniqueness, symbolism of the green space, creating a sense of delight, attractiveness, a warm and friendly ambiance, inducing a positive feeling, providing pleasant colors and scents, offering a suitable place for social gatherings, and enhancing the beauty of the urban green space) and perceived environmental beauty (encompassing adaptation to climatic conditions, enhancing beauty through proper grooming and pruning, cooling the air on hot days, creating an unpleasant scene when drying, and providing a natural atmosphere to the street) (Table 6).

DISCUSSION

Trees offer numerous benefits in urban environments, playing a pivotal role in upholding sustainability (Li *et al*., 2018; Park *et al*., 2017). Street trees, found abundantly in urban green spaces, serve as accessible natural elements for residents (Plant and Sipe, 2016) and must endure water scarcity and adverse conditions (Chen *et al*., 2017). Hence, considering the functional role of street trees is crucial when selecting species (Li *et al*., 2018; Buijs *et al*., 2019). A well-designed urban green space not only enhances aesthetics but also contributes to physical and mental well-being. Emphasizing the aesthetic aspect is fundamental in plant selection for green spaces. Urban green spaces, integral to urban ecosystems, are integrated into parks, green belts, roadsides, residential areas, and other locations.

To excel in green space management, it's crucial to utilize trees and shrubs that are well-suited for the specific region, as they can withstand potential stresses and adapt to local conditions. Moreover, when considering aesthetic aspects, it's essential to take into consideration the opinions of both experts and the general public regarding the plants present in green spaces. Therefore, to investigate the aesthetic and ecological impacts of ornamental trees and shrubs in the design of urban green spaces in Bushehr, this study gathered input from citizens, horticulturists, and aesthetic experts. As a result, the five best trees (*Bougainvillea* sp., *F. elastica, C. erectus, D. viscosa,* and *C. inerme*) were selected based on the ecological and aesthetic parameters.

In terms of educational attainment among respondents, the highest frequency was observed for those with a bachelor's degree, while the lowest frequency was noted for individuals with an under-diploma degree. Additionally, the analysis revealed no significant differences among the studied groups regarding their perception of aesthetic components.

Regarding age distribution, the highest frequency was observed in the 30-40 and 40-50 age groups, while the lowest frequency was found in the >60 age group. Analysis of differences in aesthetic perception among age groups concerning the commonly planted trees in Bushehr's landscape showed significant variation only for *F. elastica* between the <20 years and 30-40 years age groups. No significant differences were observed for other age groups.

Overall, the highest average aesthetic perception was observed for *Bougainvillea* sp. and *F. elastica,* while the lowest was recorded for *C. erectus* and *D. viscosa* (Fig. 1). This suggests that citizens in Bushehr have a stronger aesthetic appreciation for *Bougainvillea* sp. and *F. elastica*. The preference for flowering plants and trees in the city aligns with findings by Iwamura and Yokohari (2001) and Todorova *et al*. (2004), indicating a general attraction towards flowers.

Bougainvillea sp., a native flower commonly used for indoor decoration, boasts a delicate appearance with thin, dark green leaves resembling an umbrella crown. It thrives in low-light indoor environments and contributes to air purification by absorbing pollutants. Similarly, *F. elastica*, with its large, vibrant leaves, imparts a sense of abundance and beauty to indoor spaces, effectively filtering the air and creating a conducive environment for gatherings.

The perception of these plants by citizens aligns with their role in enhancing urban spaces, fostering warmth, friendliness, uniqueness, and delightfulness, while also providing suitable venues for social interactions. These findings are consistent with previous research highlighting the pivotal role of trees in enhancing the aesthetic appeal of street landscapes. Studies by Schroeder and Cannon (1983), Sommer *et al.* (1990, 1992), Wolf (2003), Kim *et al.* (2021), and Todorova *et al.* (2004) have all underscored the importance of trees in shaping the visual appeal and ambiance of urban environments. Additionally, these findings emphasize the significance of the space beneath trees, corroborating the observations made by Kim *et al.* (2021) and Todorova *et al*. (2004).

Bougainvillea sp. stands out as a vibrant and visually striking plant that holds significant potential for enhancing the urban green spaces of Bushehr. Its suitability for planting in urban environments stems from its ability to thrive in hot and humid climates, tolerate varying levels of sunlight, and exhibit relative resistance to pests and diseases. These characteristics make it well-suited to Bushehr's climate conditions. Furthermore, its trailing growth habit makes it an ideal choice for adorning the entrances and walls of buildings, adding a touch of natural beauty to urban landscapes.

Considering the preferences of the residents of Bushehr, *Bougainvillea* sp. can be effectively integrated into urban settings, including parks, pavilions, and gateways. Its diverse range of colors further enhances its potential for creating visually appealing urban landscapes. Moreover, the plant's ability to bloom throughout most seasons adds an element of diversity and vitality to the urban environment, contributing to the overall aesthetic appeal of the cityscape. Therefore, *Bougainvillea* sp. emerges as a promising option for incorporating environmental aesthetics into the urban fabric of Bushehr.

Ficus elastica, the second preferred choice among the people of Bushehr, offers both aesthetic and environmental benefits, making it an excellent option for cultivation in urban green spaces. Its variegated and visually appealing leaves enhance the aesthetic appeal of urban landscapes, while its ability to thrive in adverse conditions makes it a resilient choice for urban environments. This plant can tolerate varying levels of sunlight, including shade and semi-shade, making it adaptable to the climatic conditions of Bushehr.

Additionally, *Ficus elastica* exhibits a relatively high level of resistance to pests and diseases, further enhancing its suitability for cultivation in Bushehr's green spaces. Its malleable nature allows it to be shaped and cultivated to fit the desired aesthetic preferences of urban planners and landscape designers. Moreover, *Ficus elastica* is known for its air-purifying properties, contributing to improved air quality and reduced noise pollution in urban areas.

Given its ability to provide ample shade, *Ficus elastica* is particularly well-suited for semi-tropical cities like Bushehr, where intense sunlight is prevalent. The respondents' high scores for items such as "creating a suitable space for friendly gatherings" and "matching Bushehr's urban space" reflect their recognition of these beneficial attributes of *Ficus elastica,* further emphasizing its suitability for urban green spaces in the city.

Clerodendrum inerme is, a resilient evergreen shrub, presents an excellent option for enhancing the green spaces of Bushehr. Its adaptability to hot and humid climates, along with its capacity to thrive in both shade and semi-shade conditions, makes it well-suited for the city's

environmental requirements. Additionally, its relative resistance to pests and diseases, coupled with its malleability, allows for easy cultivation and shaping to fit various urban landscapes. *Clerodendrum inermis* is particularly recommended for street sides and parks due to its aesthetic appeal, including its evergreen foliage, high prunability, and form-ability. Its presence adds to the beauty of urban spaces while also serving practical purposes such as noise reduction. By absorbing noise, *Clerodendrum inermis* contributes to mitigating noise pollution, making it an ideal choice for areas between streets and sidewalks.

The outcomes of this study hold significant implications for forthcoming street tree selection endeavors in Bushehr, encompassing extensive programs aimed at enhancing parks and green spaces. Through the integration of citizens' preferences and perceptions, these methodologies offer a pathway to crafting urban green areas that resonate with the community's values and needs. Consequently, this approach is poised to elevate citizen engagement and participation levels within the realm of urban planning and development initiatives.

The process of selecting plant species for urban decoration presents a multifaceted challenge. Beyond mere visual aesthetics, the strategic distribution of ornamental trees and shrubs throughout Bushehr's urban green spaces holds the power to evoke emotional responses in individuals. Thus, the selection of suitable plant species demands a comprehensive examination of both environmental and emotional factors. Natural landscapes and flowering species not only enhance the visual appeal but also have a profound impact on individuals' mental and emotional well-being, fostering feelings of serenity, freshness, and connection with nature. In this context, *Bougainvillea* sp. emerges as a particularly suitable candidate for Bushehr's urban landscape. This species exhibits remarkable adaptability to the local environmental conditions, thriving in the city's temperate and humid climate. Its ability to withstand high levels of moisture and sunlight renders it well-suited for the region. By incorporating *Bougainvillea* sp. into urban green spaces, planners can simultaneously address both environmental and emotional considerations. This strategic selection not only enhances landscape beauty but also contributes to citizen satisfaction, fosters a deeper connection with nature, and reinforces Bushehr's environmental authenticity.

CONCLUSION

The study revealed that the aesthetic perception of the studied trees was significantly influenced by two key components: "Emotional feeling" and "perceived environmental beauty." Citizens viewed *Bougainvillea* sp. and *F. elastica* as having higher perceived cognitive beauty, indicating that these species align more closely with public preferences and hold greater value. This underscores the importance of incorporating citizens' preferences into urban park designs to ensure their success. Future research avenues could explore the development of modern artificial intelligence-based approaches to incorporate public opinions into the selection of plant species for urban green spaces. However, it's crucial to consider climate as a critical criterion in this process, particularly in urban areas, to ensure the suitability and sustainability of the chosen plants.

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Effect of Different Level of Auxin, Cytokinin and Gibberellin on Growth, Phenolic Compounds and Activity of Antioxidant Enzymes of *Opuntia cylindrica*

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Abstract

Cacti are among the most important and diverse plant families cultivated worldwide for various purposes, including food, medicine, cosmetic, and ornamental. To investigate the growth and physiological changes of *Opuntia cylindrica* under the treatment of auxin (IBA), cytokinin (Kin), and gibberellin (GA) hormones in concentrations of 250, 500, and 1000 mg/L, this study was conducted in a completely randomized design in the greenhouse of Islamic Azad University, Gorgan branch in 2020. The IBA treatment not only did not cause a significant change in the fresh weight (FW) and height, but also had no significant effect on the content of pigments, sugar, soluble protein, and phenolic compounds except flavonoids, the activity of phenylalanine ammonia-lyase (PAL) and superoxide dismutase (SOD) enzymes. But the treatment of cactus with Kin was caused a significant increase in FW, content of soluble protein, phenolic compounds, and increase the activity of PAL, SOD, and peroxidase (POD) enzymes. GA treatment caused a decrease in FW by 14 and 23%, a significant decrease in the content of pigments Chl. a by 31 and 70% and Chl. b by 37 and 68% and POD enzyme activity by 60 and 50% at 500 and 1000 mg/L, respectively. While the content of phenolic compounds and the activity of PAL and SOD enzymes were significantly enhanced. It seems that Kin at the concentrations of 500 and 1000 mg/L was the best treatment for reinforcement of the growth of *O. cylindrica* with high phenolic and antioxidant capacity. On the other hand, the decrease in FW and the content of chlorophylls in plant treated with GA, indicated the presence of stress in the plant, and the increase in the content of phenolic compounds and the activity of antioxidant enzymes specially at concentrations of 500 and 1000 mg/L probably moderated the stress.

Keywords: Antioxidant systems, Growth, Hormone, *Opuntia cylindrica*, Physiological parameters.

INTRODUCTION

The Cactaceae is one of the most remarkable and diverse families of flowering plants in nature, which mostly grow in hot, semi-arid, and arid regions of the world (Casas and Barbera, 2002; Hultine *et al*., 2023). This family has nearly 130 genera that have about 2000 species in different growth forms or shapes (Shedbalkar *et al*., 2010). These plants are often grown on sloping land as a barrier against soil erosion, for ecological restoration and land restoration, and also, they are also used commercially as fruits for humans and animal feed and are highly regarded as ornamental flowers (Lema-Ruminska and Kulus, 2014; Inglese *et al*., 2017; Stavi, 2022). The *Opuntia* genus is one of the most important known genera among the cactus family (Ritz *et al*., 2012). This genus is used in many regions especially in the Mediterranean-Central Asian area due to its edible fruit, leaf buds, nutritional and medicinal properties, and presence of valuable chemical compounds including phenolic compounds, flavonoids, carotenoids, saponins, steroids, terpenoids, vitamins, flavonoids and betalain (Inglese *et al*., 2017; Bouzroud *et al*., 2022). In addition, the *Opuntia* genus is traditionally used in the treatment of hypoglycemia, stomach ulcers, neuron protection through antioxidant activity, viral disease, diabetes, bronchitis burns, and asthma around the world (Madrigal-Santillán *et al*., 2022; Prisa, 2023).

The growth and chemical compositions of cactus plants are greatly influenced by environmental factors, growth conditions, plant age, and species (Bouzroud *et al*., 2022). Therefore, suitable inducers may improve the growth, medicinal value, and attractiveness of ornamental plants. Plant growth regulators including auxin, cytokinin, and gibberellin play a vital role in regulating growth processes in plants. Investigation of the impact of the plant hormone on the growth, nutrition, and ornamental value of cacti has a high economic value and is beneficial in many aspects (Cortés-Olmos *et al.*, 2023).

The current study has aimed to get more insight into the physiological responses of opuntia cylindrica as a species in the genus of opuntia to plant growth hormones including auxin (IBA), cytokinin (kinetin; Kin) and gibberellin (GA) at different concentrations in greenhouse condition. Fresh and dry weight and height were measured to evaluate the economic importance of different hormones in the growth of cactus cuttings. Antioxidant compounds and enzymes were analyzed to explore the possible impact of hormones on medicinal and nutritional value. On the other hand, the antioxidative defense of *O. cylindrica* to the possible negative effects of hormones at specific concentrations was studied.

MATERIALS AND METHODS

Growth conditions and plant harvesting

The same-shaped cactus (*O. cylindrica*) cuttings in terms of weight and height were obtained from the greenhouse of Islamic Azad University, Gorgan Branch. The pot (10 and 9 cm in diameter and height, respectively) experiment was done in autumn 2020. The cactus cuttings were grown in suitable soil including cocopeat, peat moss, and perlite in proportions of 10, 30, and 60% respectively. Some chemical and physical properties of growing media was tested (Table 1).

Table 1. Chemical and physical characteristics of individual media component.

Media components	pH	EC (dS m^{-1})	Moisture content (%)
Cocopeat	6.8	0.80	37.36
Peat moss	3.5	0.15	42.00
Perlite	7.1	1.50	24.50

The temperature of the greenhouse varied between 30 to 37 ºC, the humidity was reported by 80%, light intensity and photoperiod were 5000 lux and 12-14 hours, respectively. The cactus cuttings were pretreated with auxin hormone (IBA) at a concentration of 1500 mg/L for 8 seconds before being transferred to the pot. For the control sample, distilled water was used instead of hormonal pretreatment. Cacti were irrigated once a week with normal water in the amount of 50 ml. Four months after planting cactus cuttings in the pots, pretreatment cacti were treated with IBA (PT), cytokinin (kinetin; Kin), and gibberellin (GA) hormones each in three concentrations (250, 500, and 1000 mg/L) during four stages with an interval of five weeks. Furthermore, all treatments and controls were performed in four replicates (pots). Plant sampling was done five weeks after the last treatment. The shoots were separated from the roots and their fresh weight (FW) was weighed. To determine dry matter content (DMC; it was determined by dividing dry weight by fresh weight and multiplying by 100), total phenols, flavonoids, and flavonols content, the plant materials were air-dried at 35 °C (± 2) for 24 h. For measurement of the chlorophyll a (Chl. a), chlorophyll b (Chl. b), soluble protein, soluble sugar, anthocyanin content, and enzyme activity, the plant materials were frozen immediately in liquid N2 and stored at -80 °C.

Determination of photosynthetic pigments

The extraction of frozen plant samples was done by using 80% acetone (g/10 ml). Then the extraction was centrifuged at 3000 g for 20 min and subsequently the content of pigments was measured spectrophotometrically at 470, 646, and 663 nm (Lichtenthaler, 1987). The content of pigments was calculated using the following formula and expressed based on the µg/g FW of the plant.

$$Chl\ a = 12.7(A663) - 2.69\ (A645)$$
$$Chl\ b = 12.7\ (A663) - 4.78\ (A645)$$

Determination of soluble sugar content

Soluble sugar content was measured by the anthrone-sulfuric acid colorimetric method (Irigoyen *et al*.,1992). Air-dried shoots were extracted by 95% (v/v) ethanol (g/10 ml) using centrifugation at 3500 g for 10 min. The reaction mixture containing 0.1 ml of the plant ethanolic extract with 3 ml of freshly prepared anthrone solution (200 mg of anthrone + 100 ml of sulfuric acid) was incubated in a boiling water bath for 10 min. After cooling, the absorbance was recorded at 625 nm by using a spectrophotometer. The soluble sugar content was calculated based on the standard calibration curve of glucose and expressed as mg/g DW.

Determination of anthocyanin

The evaluation of anthocyanin content was done using the method of Masukasu *et al.* (2003). For the extraction of anthocyanin, fresh plant samples (0.2 g) were mixed with 3 ml of acidic methanol (V/V HCl 1%) and then filtered through filter paper. The extract was centrifuged at 6000 rpm for 20 min and subsequently kept overnight in the dark at 4°C. To measure the anthocyanin content, the absorbance of the supernatant was recorded at 550 nm by spectrophotometer, and the content of anthocyanin was calculated using the following formula and expressed based on mg/g FW of the plant.

$$Anthocyanin = \frac{(A550/3300)(1000)}{0.6}$$

Measurement of total phenols, flavonoids and flavonols

To extract phenolic compounds, 0.4 g air-dried plant samples were powdered and

homogenated with 10 ml of 70% methanol. The methanolic extract was sonicated and then centrifuged at 6000 rpm for 20 min (Thygesen *et al.*, 2007).

To evaluate total phenol, plant extract (125 µl) was mixed with distilled water (375 µl) and 10% Folin-Ciocalteu's reagent (2.5 ml). After 6 min, 2 ml of sodium carbonate (7.5% w/v) was added to the mixture. After incubation (90 min) at room temperature, the absorbance of the reaction mixture was recorded at 765 nm by a spectrophotometer. Finally, the content of total phenol was calculated using the standard curve of gallic acid (Singleton and Rossi, 1965).

To evaluate the total flavonoid content, 2 ml of plant extract was homogenated with 2.8 ml of distilled water, 100 µl of aluminum chloride (10%), and 100 µl of potassium acetate (1 M). The mixture was kept in the dark for 30 min and then the absorption of the mixture was determined at 415 nm by using a spectrophotometer (Akkol *et al*., 2008).

To determine total flavanols, plant extract (1 ml) was mixed with 1 ml of aluminum chloride (2%) and 3 ml of sodium acetate (5%). After 2.5 h. the absorbance of the mixture was recorded at 440 nm using a spectrophotometer. Finally, the content of the flavonoids and flavonols was calculated using the standard curve of quercetin (Akkol *et al*., 2008).

Measurement of soluble protein and enzymes activity

To determine the soluble protein and enzyme activity, frozen plant samples were extracted in 0.1 M potassium phosphate buffer with pH 7.0 (g FW/10 ml). The filtered extract was centrifuged at 16,000 g for 25 min at 4 ºC. The soluble protein content was determined by Bradford's method using bovine serum albumin as a standard (Bradford, 1976).

To determine the activity of the phenylalanine ammonia-lyase (PAL), enzyme extract (800 µl) was homogenate with 600 µl of Tris-HCl (50 mM) and 900 µl of 2 mM l-1 henylalanine and the mixture was incubated at room temperature for 30 min. Then the reaction was stopped by 100 µL of HCl (2N). In the next step, the reaction was mixed with toluene (1.5 ml) and subsequently centrifuged at 5000 rpm for 5 min. The absorbance of the toluene phase containing trans-cinnamic acid was measured at 290 nm. Enzyme activity was expressed as mmol trans-cinamic acid/h/mg FW (Saunders and McClure, 1974).

To determine the activity of superoxide dismutase (SOD), enzyme extract (400 µl) was mixed with 1600 µl of potassium phosphate buffer (0.1 M), 0.1 mM EDTA, 13 mM methionine, 24 µM riboflavin, and 75 µM NBT. The reaction mixture was kept in the light at a distance of 10 cm from the light source for 10 min, and then the reaction was stopped by turning the lights off. The absorption of the reaction was determined with a spectrophotometer at 560 nm (Beauchamp and Fridovich, 1971). One unit of SOD activity was expressed as the amount of enzyme required to cause 50 % inhibition of NBT reduction under the experimental conditions. The activity of the enzyme was expressed as U/mg FW.

To measure the peroxidase activity, enzyme extract (200 µl) was mixed with 80 µl of guaiacol reagent (124.14 g/mol), 2.470 µl of potassium phosphate buffer (0.1 M), and 250 µl of hydrogen peroxide. After 1 min the absorbance of the reaction mixture was measured at 470 nm with a spectrophotometer (Nakano and Asada, 1981). The activity of the enzyme was expressed as U/mg FW.

Statistical analysis

To perform the statistical analyses, a one-way analysis of variance (ANOVA) was used. Tukey's HSD all-pairwise comparisons at the level of $P < 0.05$ as a post-hoc test was used to compare the treatment means. To analyze the data, the software of SPSS version 20 for windows 7 and to make the graph, the prism software (San Diego, CA, USA) was applied.

RESULT

Growth factors

There was not significant difference among the control, PT and different concentration of IBA in relation to FW and height. While in the case with Kin at different concentrations in comparison with control, and PT, there was only significant different in relation to FW. Likewise, there was significant difference among the control, PT and different concentration of GA in relation to FW, and height (Table 2).

Table 2. ANOVA table to indicate the significance difference among treatments or groups (pre-treatment with auxin at 1500 mg/L (PT) and PT along with IBA, Kin and GA) in relation to fresh weight (FW) and height.

Treatment (group)	Dependent variable	SS	df	MS	F	p-value
Control, PT and IBA (250, 500 and 1000 mg/L)	FW	1059.515	4	264.879	1.875	0.167
	Height	22.800	4	5.700	2.265	0.111
Control, PT and Kin (250, 500 and 1000 mg/L)	FW	1548.677	4	387.169	9.008	0.001
	Height	18.700	4	4.675	2.646	0.075
Control, PT and GA (250, 500 and 1000 mg/L)	FW	11742.627	4	2935.657	14.573	0.000
	Height	522.300	4	130.575	27.782	0.000

The mean of SS, df, MS, and F is the sum of squares, the degrees of freedom, the mean sum of squares, and the F-statistic, respectively. The value of $P < 0.05$ indicates a significant statistical difference between the treatments.

The results showed that the PT hardly affected the FW, and height of the cactus cuttings compared to the control. Similarly, the PT+IBA treatment at different concentrations did not change the growth parameters including FW and height. The FW of the plants treated with PT+Kin at all three concentrations were significantly enhanced compared to that of the plants treated with PT, although, the height of the plants was hardly changed. In plants exposed to PT+GA, the FW was reduced at 250, 500, and 1000 mg/L compared to that of the plant treated with PT by 16, 14, and 23%, respectively. While the height was enhanced by 17, 24, and 28 % in plants exposed to 250, 500, and 1000 mg/L PT+GA, respectively (Table 3).

Pigments content

There was not significant difference among the control, PT and different concentration of IBA in relation to both Chl. a and Chl. b. In contrast, in the case with GA there was significant difference in relation to both Chl. a and Chl. b. Similarly, the content of Chl. a was significantly changed between the groups control, PT and different concentration of Kin while that of the Chl. b was not significantly changed between the groups (Table 4).

The results showed that the content of Chl. a and Chl. b was hardly changed in plants exposed to PT. The PT+IBA treatment at any concentration hardly affected the content of both Chl. a and Chl. b. Likewise, the content of both Chl. was hardly changed under treatment of PT+Kin at all three concentrations compare with that of the plant exposed to PT. While the content of Chl. a and Chl. b in plant treated with PT+GA was reduced by 32 and 37 % at the concentration of 500 mg/L and by 69 and 68% at 1000 mg/L, respectively compared with that of Chl. a and Chl. b in plant exposed to PT (Fig. 1)

Table 3. Impact of pre-treatment with auxin at 1500 mg/L (PT) and PT along with IBA, Kin and GA hormones at different concentrations of 250, 500 and 1000 mg/L on FW and height.

Treatment	FW (g)	Height (cm)
Control	247±10 a	41±1.2 a
PT	237±10 a	42±1.5a
PT + IBA (250 mg/L)	250±7 a	42.5±1 a
PT + IBA (500 mg/L)	258±14 a	44±2 a
PT + IBA (1000 mg/L)	239±16 a	41.2±2.2 a
Control	247±4.9 ab	41±1.2 a
PT	237±4.2 b	42±1.5 a
PT + Kin (250 mg/L)	263±2.5 a	43±1.6 a
PT + Kin (500 mg/L)	255±2 a	41.5±1.9 a
PT + Kin (1000 mg/L)	256±4 a	42.7±0.5 a
Control	247±4.9 a	41±1.2 c
PT	237±4.2 a	42±1.5 c
PT + GA (250 mg/L)	199±18 b	49±2.4 b
PT + GA (500 mg/L)	204±13 b	52 ±2.5 ab
PT + GA (1000 mg/L)	183±18 b	54±2.9 a

Data on growth parameters represent the mean of four biological replicates (± SD). Different letters indicate significant differences between treatments (P<0.05; One-way ANOVA, Tukey's HSD all-pairwise comparisons as a post-hoc test). The letter 'a' shows the highest value and the rest of the english alphabet shows lower values, respectively. FW is the abbreviation of fresh weight.

Table 4. ANOVA table to indicate the significance difference among treatments or groups (pre-treatment with auxin at 1500 mg/L (PT) and PT along with IBA, Kin and GA in relation to Chl. a and Chl. b.

Treatment (group)	Dependent variable	SS	df	MS	F	p-value
Control, PT and IBA (250, 500 and 1000 mg/L)	Chl. a	361.126	4	90.282	1.823	0.177
	Chl. b	305.380	4	76.345	1.037	0.420
Control, PT and Kin (250, 500 and 1000 mg/L)	Chl. a	879.835	4	219.959	3.595	0.030
	Chl. b	353.462	4	88.366	2.217	0.116
Control, PT and GA (250, 500 and 1000 mg/L)	Chl. a	11687.378	4	2921.844	81.081	0.000
	Chl. b	1548.531	4	387.133	14.464	0.000

The value of P < 0.05 indicates a significant statistical difference between the treatments.

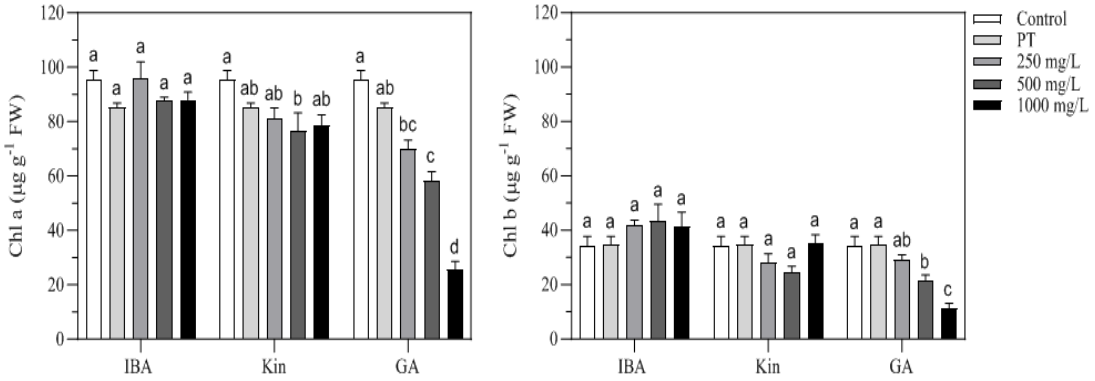

Fig. 1. Impact of pre-treatment with auxin at 1500 mg/L (PT) and PT along with IBA, Kin and GA hormones at different concentrations of 250, 500 and 1000 mg/L on the content of Chl. a and Chl. b. Data on pigment content represents the mean of four biological replicates (± SD). Different letters indicate significant differences between treatments (P < 0.05; One-way ANOVA, Tukey's HSD all-pairwise comparisons as a post-hoc test).

Soluble sugar and soluble protein content

The results of analysis of variance showed that there was not significant difference among the control, PT and different concentration of IBA in relation to soluble sugar and soluble protein content. While in the case with Kin at different concentrations in comparison with control, and PT, there was only significant different in relation to soluble protein content. Likewise, there was only significant difference among the control, PT and different concentration of GA in relation to soluble sugar (Table 5).

Table 5. ANOVA table to indicate the significance difference among treatments or groups (pre-treatment with auxin at 1500 mg/L (PT) and PT along with IBA, Kin and GA in relation to soluble sugar and soluble protein content.

Treatment (group)	Dependent variable	SS	df	MS	F	p-value
Control, PT and IBA (250, 500 and 1000 mg/L)	Soluble sugar	0.132	4	0.033	0.379	0.820
	Soluble protein	0.610	4	0.153	0.808	0.539
Control, PT and Kin (250, 500 and 1000 mg/L)	Soluble sugar	0.339	4	0.085	0.766	0.564
	Soluble protein	5.056	4	1.264	5.493	0.006
Control, PT and GA (250, 500 and 1000 mg/L)	Soluble sugar	2.320	4	0.580	5.426	00.007
	Soluble protein	1.263	4	0.316	1.480	0.258

The value of $P < 0.05$ indicates a significant statistical difference between the treatments.

The content of soluble sugar was hardly changed in plants exposed to PT compared with that of the soluble sugar in control plants. Similarly, the content of soluble sugar in plants treated with different concentrations of PT+IBA and PT+Kin was hardly changed compared to that of the soluble sugar in plant exposed to PT. likewise, soluble sugar was not affected by PT+GA at 250 mg/L, while the content of soluble sugar in plants treated with PT+GA at 500 and 1000 mg/L was enhanced by 37 and 36.7 %, respectively compared with that of the soluble sugar in plants exposed to PT (Fig. 2).

The content of total protein in plants pretreated with auxin (PT) was hardly changed compared to that of the control plant. Similarly, the content of protein was not significantly affected by PT+IBA and PT+GA at any concentrations compared with that of the protein in pre-treated plants with auxin. While the content of soluble protein in plants treated with PT+Kin at 500 and 1000 mg/L was enhanced by 14 and 8.4 %, respectively compared with that of the soluble protein in plants exposed to PT (Fig. 2).

Total phenols, flavonoids and flavanols content

The results of ANOVA showed that there was a significant difference among the control, PT and different concentration of IBA in relation to flavonoids and anthocyanin. In the case with Kin there was significant difference in relation to phenols, flavonoids, and anthocyanin. Similarly, there was a significant difference among the control, PT and different concentration of GA in relation to the content of phenols, flavonoids, flavanols, and anthocyanin (Table 6).

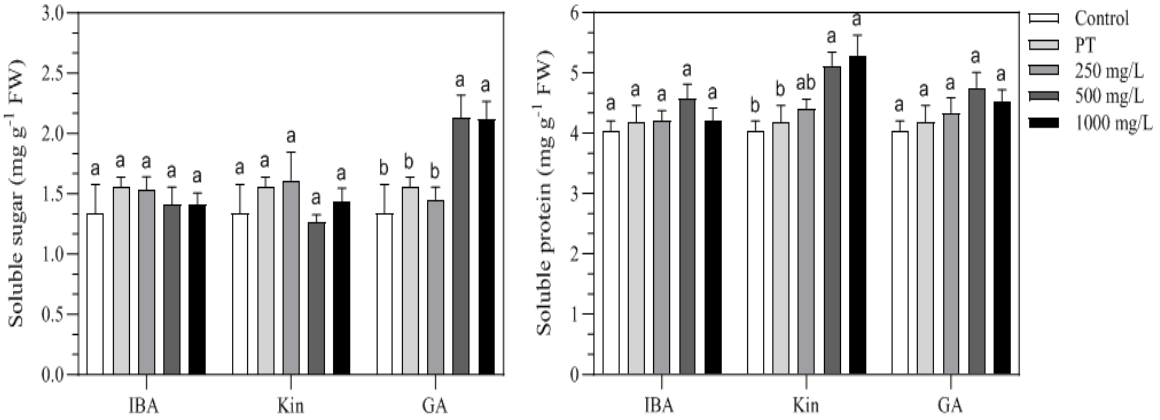

Fig. 2. Impact of pre-treatment with auxin at 1500 mg/L (PT) and PT along with IBA, Kin and GA hormones at different concentrations of 250, 500 and 1000 mg/L on the content of soluble sugar and soluble protein. Data on soluble sugar and soluble protein represent the mean of four biological replicates (± SD). Different letters indicate significant differences between treatments ($P < 0.05$; One-way ANOVA, Tukey's HSD all-pairwise comparisons as a post-hoc test).

Table 6. ANOVA table to indicate the significance difference among treatments or groups (pre-treatment with auxin at 1500 mg/L (PT) and PT along with IBA, Kin and GA in relation to the content of phenols, flavonoids, flavanols, and anthocyanin.

Treatment (group)	Dependent variable	SS	df	MS	F	p-value
Control, PT and IBA (250, 500 and 1000 mg/L)	Phenols	0.884	4	0.221	0.594	0.672
	Flavonoids	6.376	4	1.594	10.048	0.000
	Flavanols	0.124	4	0.031	0.665	0.626
	Anthocyanin	0.000	4	0.000	4.856	0.010
Control, PT and Kin (250, 500 and 1000 mg/L)	Phenols	7.127	4	1.782	17.038	0.000
	Flavonoids	26.212	4	6.553	32.686	0.000
	Flavanols	0.200	4	0.050	2.227	0.115
	Anthocyanin	0.000	4	0.000	3.493	0.033
Control, PT and GA (250, 500 and 1000 mg/L)	Phenols	12.267	4	3.067	13.609	0.000
	Flavonoids	13.451	4	3.363	10.506	0.000
	Flavanols	0.988	4	0.247	10.779	0.000
	Anthocyanin	0.000	4	0.000	8.035	0.001

The value of $P < 0.05$ indicates a significant statistical difference between the treatments.

The content of total phenols, flavonoids, and flavanols in plants pretreated with auxin (PT) was hardly changed compared with the content of these compounds in control plants. Likewise, the content of total phenols, flavanols, and anthocyanin was not significantly affected by PT+IBA at any concentrations except the content of flavonoids was enhanced by 43 and 44% in plant exposed to 500 and 1000 mg/L PT+ IBA, respectively compared with that of the compounds in pre-treated plant with IBA (Fig. 3).

In the plant treated with PT+Kin, the content of flavanols and anthocyanin was hardly changed compared with the content of these compounds in pre-treated plants with auxin. While the content of total phenols and flavonoids was enhanced by 21, 19, and 94, 93% at 500 and 1000 mg/L Kin along with PT (Fig. 3).

The content of total phenols, flavonoids, and flavanols in plants exposed to GA was

enhanced by 27, 26 and 79, 65 and 26, 27 % at 500 and 1000 mg/L, and the content of anthocyanin was enhanced by 33% at 1000 mg/L along with PT compare with the content of these compounds in pre-treated plant with auxin (Fig. 3).

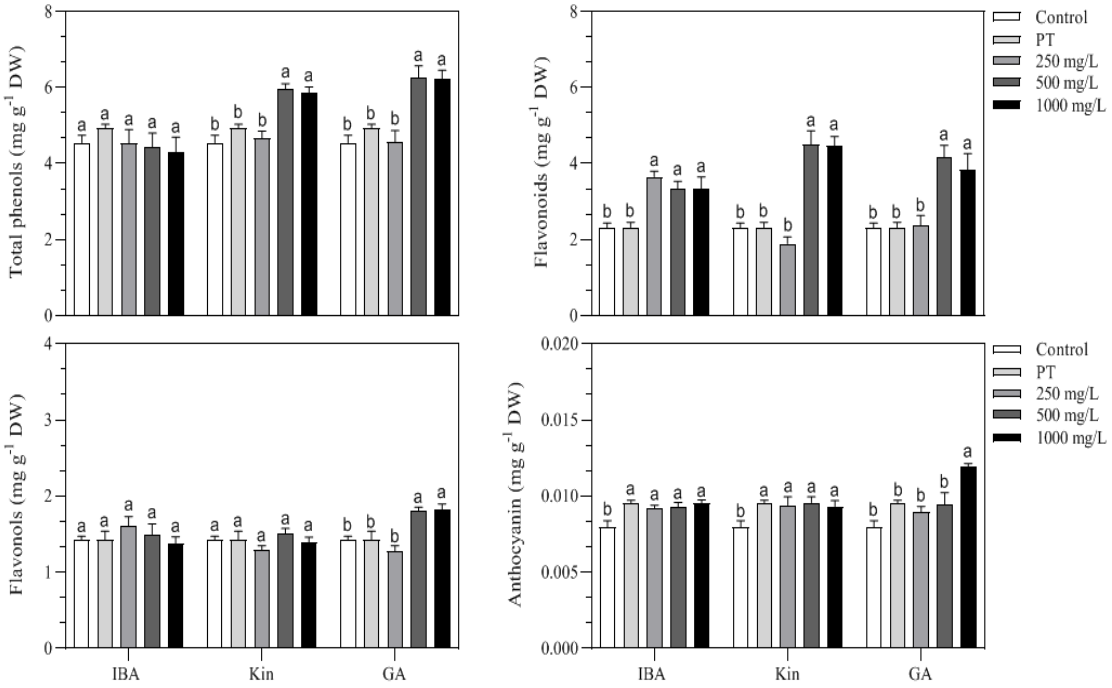

Fig. 3. Impact of pre-treatment with auxin at 1500 mg/L (PT) and PT along with IBA, Kin and GA hormones at different concentrations of 250, 500 and 1000 mg/L on the content of total phenols, flavonoids, flavonols, and anthocyanin. Data on phenolic compounds represent the mean of four biological replicates (± SD). Different letters indicate significant differences between treatments ($P < 0.05$; One-way ANOVA, Tukey's HSD all-pairwise comparisons as a post-hoc test).

Enzyme activity

The results of analysis of variance showed that there was a significant difference among the control, PT and different concentration of IBA in relation to PAL and POD activity. Similarly, in the case with Kin and GA at different concentrations in comparison with control, and PT, there was significant different in relation to PAL, SOD and POD activity (Table 7).

The activity of the PAL enzyme in plants pretreated with auxin (PT), was hardly changed compared with that of the control plant. Similarly, the activity of the PAL enzyme was hardly changed in pretreated plants with IBA exposed to any concentrations of IBA (Fig. 4).

The activity of the PAL enzyme was enhanced in pretreated plants with auxin exposed to Kin by 25, 28 and 27% and also exposed to GA by 26, 27 and 28 % at concentrations of 250, 500, and 1000 mg/L, respectively compared with the plant only pretreated with IBA (Fig. 4).

The activity of the SOD and POD enzymes in plants pretreated with auxin (PT), was hardly changed compared with that of the control plant. In pretreated plants with IBA exposed to Kin at concentrations of 500 and 1000 mg/L, the activity of SOD was enhanced by 3.7 and 3-fold and the activity of POD was enhanced by 2.8 and 2.6- fold, respectively (Fig. 4).

The activity of SOD was enhanced in pretreated plants with auxin exposed to GA by 2, 2, and 3-fold at concentrations of 250, 500, and 1000 mg/L, respectively. While the activity of POD was reduced in pretreated plants with auxin exposed to GA by 55, 59 and 49 % at concentrations of 250, 500 and 1000 mg/L, respectively (Fig. 4).

Table 7. ANOVA table to indicate the significance difference among treatments or groups (pre-treatment with auxin at 1500 mg/L (PT) and PT along with IBA, Kin and GA in relation to the activity of PAL, SOD and POD activity.

Treatment (group)	Dependent variable	SS	df	MS	F	p-value
Control, PT and IBA (250, 500 and 1000 mg/L)	PAL activity	7.384	4	1.846	5.755	0.005
	SOD activity	12.431	4	3.108	2.802	0.064
	POD activity	1.425	4	0.356	9.440	0.001
Control, PT and Kin (250, 500 and 1000 mg/L)	PAL activity	6.579	4	1.645	3.803	0.025
	SOD activity	300.849	4	75.212	96.162	0.000
	POD activity	4.905	4	1.226	15.268	0.000
Control, PT and GA (250, 500 and 1000 mg/L)	PAL activity	6.645	4	1.661	3.938	0.022
	SOD activity	49.626	4	12.407	34.032	0.000
	POD activity	0.488	4	0.122	10.799	0.000

The value of $P < 0.05$ indicates a significant statistical difference between the treatment.

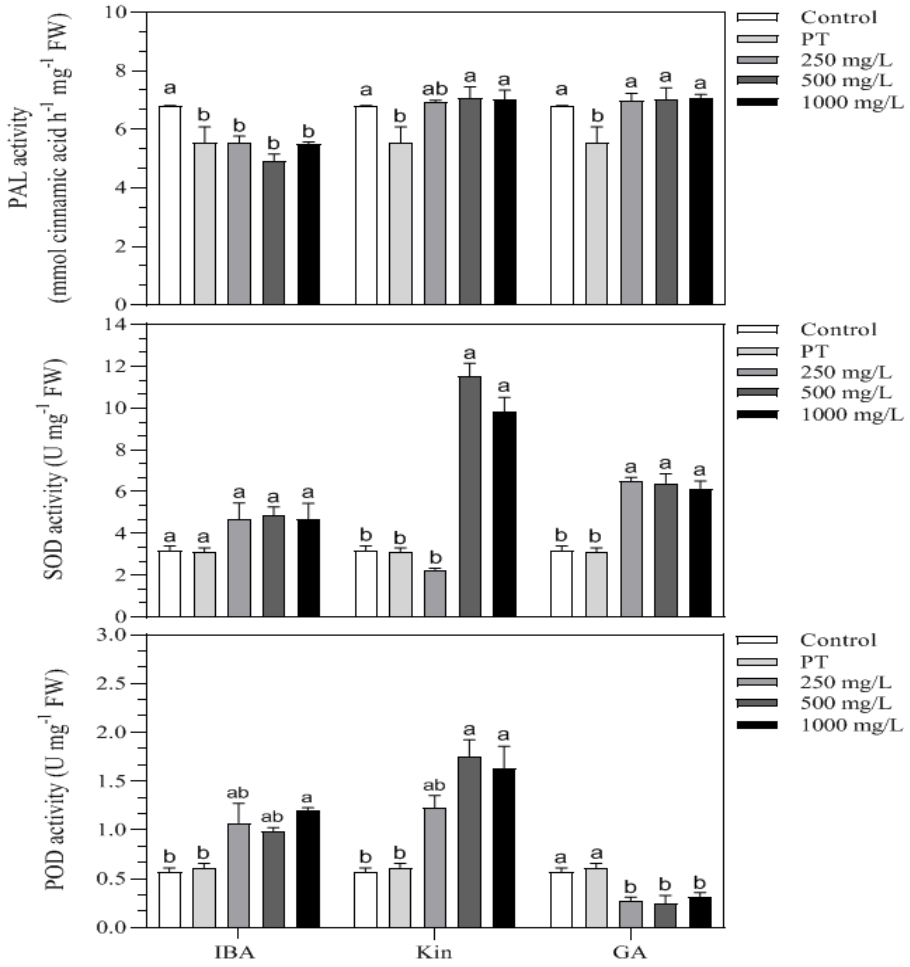

Fig. 4. Impact of pre-treatment with auxin at 1500 mg/L (PT) and PT along with IBA, Kin and GA hormones at different concentrations of 250, 500 and 1000 mg/L on the activity of PAL, SOD and POD enzymes. Data on enzyme activity represent the mean of four biological replicates (± SD). Different letters indicate significant differences between treatments ($P < 0.05$; One-way ANOVA, Tukey's HSD all-pairwise comparisons as a post-hoc test).

DISCUSSION

The commercial use of plant growth regulators like hormones including auxin, Kin, and GA which improve ornamental plants' morphophysiological traits and performance has received much attention nowadays (Ahmad *et al*., 2020; Krzemińska *et al*., 2023). However, plants' response to these compounds' use is largely influenced by the concentration, type of plant, growth stage, and the exposure of the plant to treatments (Miceli *et al*., 2019). Cytokinin stimulates cell division and mesophyll cell elongation which subsequently can affect plant growth (Sosnowski *et al*., 2023). Similarly, the present results showed that the application of Kin led to an increase in the biomass of *O. cylindrica* at all three different concentrations. While GA decreased the fresh weight and increased the height of the plant in all three concentrations compared to the plant treated with PT. It seems that applying GA caused the allocation of energy and organic matter for the longitudinal growth of the plant. Due to the impact of GA on the meristem cells in the internodes of the stem, it may increase the longitudinal growth and as a result, increase the height of the plant (Ahmad *et al*., 2020).

In addition, the decrease in the plant biomass was in line with the decrease in the content of chlorophyll content in *O. cylindrica* upon exposure to GA. It seems there is a limitation in biosynthesis and an increase in the degradation of photosynthetic pigments upon exposure of plants to GA hormones. It has been observed GA prevents the expression of genes involved in the biosynthesis of chlorophyll through the inhibition of DELLA transcription factors (Liu *et al*., 2017). Kin modulates the content of photosynthetic pigments by regulation of chlorophyll biosynthesis (Cortleven and Schmülling, 2015) or by delaying the degradation of chlorophyll (Hönig *et al*., 2018). However. It depends on cytokinin structure and concentration, the age of the plant (Zubo *et al*., 2008), and environmental conditions (Vlckova *et al*., 2006). In the current study, Kin showed an ambiguous effect on *O. cylindrica*. Exposing the plant to Kin resulted in no impact at 250 and 1000 mg/L or even a significant reduction of the content of Chl. a at 500 mg/L Kin.

Sugars are an important source of energy and carbon skeleton for the growth and development of plants. However, they also act as signaling molecules that can influence growth and metabolic processes (Rolland *et al*., 2006). It has been shown that plant hormones cause changes in the content of soluble sugars in different plants by modulating the expression of genes involved in the biosynthesis of sugar (Loreti *et al*., 2008). The findings showed that GA treatment increases sugar accumulation, adjusts the size of the sugar sink, and prevents sugar unloading from the sink (Li *et al*., 2024). This was in line with our finding which showed GA enhanced the content of soluble sugars at 500 and 1000 mg/L.

Phenolic compounds including anthocyanins, flavonoids, and flavonols as plant's secondary metabolites not only play a role in plant defense against herbivores, bacteria, fungi, and abiotic stress but also act as attractor of pollinators that lead to the distribution of plants (Lin *et al*., 2016). However, the presence of plant phenolic compounds is also interesting nowadays because of their positive impact on human health in the control of many chronic diseases due to their antioxidant potential and free radical-scavenging activity (Sardoei *et al*., 2014). Therefore, an increment of phenolics content in *O. cylindrica* induced by Kin and GA treatments would show its positive role in plant antioxidative potential. Indeed, cytokinin increases the level of phenolic compounds through a positive effect on its biosynthetic pathway, however, the type and concentration of cytokinin have different effects on the biosynthesis of the phenolic compounds (Grzegorczyk-Karolak *et al*., 2020). Interestingly, the content of phenolic compounds was in line with PAL enzyme activity. PAL as a kay enzyme is responsible for the biosynthesis of trans-cinnamic and subsequently other phenolic compounds from L-phenylalanine. PAL activity is

stimulated by a variety of environmental factors, including pathogenic factors, mechanical damage, ultraviolet radiation, heavy metals stress, low temperature, and low levels of nitrogen and phosphate. However, the regulation of PAL activity in response to plant hormones seems to have complex mechanisms (Zhang and Liu, 2015). The current study showed that external application of Kin and GA induced the activity of PAL in *O. cylindrica*, while auxin hormone hardly affected the activity of this enzyme compared with that of the PT plants.

Superoxide dismutase and peroxidase enzymes are among the most important enzymes of the plant's antioxidant defense system. The superoxide dismutase enzyme catalyzes the conversion of superoxide anion into hydrogen peroxide, which is an important step in neutralizing and reducing the level of oxygen-free radicals in plants. Peroxidase also plays an active role in neutralizing hydrogen peroxide (Rajput *et al*., 2021). The increase of POD enzyme activity following the rise of SOD enzyme activity in the plant treated with Kin hormone enforces the positive role of this hormone in increasing the antioxidant property of the cactus plant. While the significant decrease in the activity of the POD enzyme and instead the increase in the activity of SOD may indicate the presence of stress caused by GA hormone due to the possible accumulation of hydrogen peroxide.

CONCLUSION

In the present study, the role of hormones auxin, cytokinin and gibberellin on growth and antioxidant properties of the *O. cylindrica* cactus was investigated. The current study showed that cytokinin specially at concentrations of 500 and 1000 mg/L had resulted in the increase of fresh weight, the amount of total phenol and flavonoids, PAL enzyme activity as well as the increase in the activity of antioxidant enzymes SOD and POD. While the decrease in fresh weight and the content of chlorophyll a and b as well as the decrease in POD enzyme activity under gibberellin treatment is a possible sign of stress caused by this hormone. Therefore, an increase in the activity of antioxidant enzymes like POD and an increase in the content of phenolic compounds probably play an important role in the adaptation of plants to the adverse impact of gibberellin. It can be concluded that cytokinin had a positive and best effect on improving the antioxidant capacity and growth of *O. cylindrica* cactus and it is recommended to use cytokinin in cultivation of *O. cylindrica*.

ACKNOWLEDGEMENTS

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The Growth and Qualitative Traits of Eighteen Ornamental Cover Plants in the Climatic Conditions of Gorgan, Iran

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Abstract

Given the deficiency of water resources in many Iranian cities and the substantial water usage by lawns, exploring the feasibility of reducing lawn areas and expanding green areas with planting cover plants is a rational approach to achieving sustainable green space. Cover plants offer a more varied and natural visual appeal than grasses. An essential consideration in green space design is selecting plants that respond well to seasonal changes in different climates. The present study aimed to evaluate 18 cover plants in the climatic conditions of Gorgan, Iran, over the course of a year (four seasons). The traits measured included appearance quality, chlorophyll a, b, and total, carotenoid content, and plant growth percentage. The comparison of data means indicated that the highest and lowest growth rates throughout the four seasons were observed in *Carpobrotus acinaciformis* and *Festuca ovina*, respectively. *Carpobrotus acinaciformis* exhibited the highest levels of chlorophyll a, b, and total. *Alternanthera bettzickiana* showed the highest carotenoid content in its leaves, closely followed by *Frankenia thymifolia*. The best visual quality was for *Osteospermum ecklonis* in spring, followed by *Frankenia thymifolia*, *Plectranthus australis*, and *Lysimachia nummularia*. The research revealed that, out of the 18 cover crops examined, the most suitable species for the urban green spaces of Gorgan under full sunlight and with no shading are *Frankenia thymifolia*, *Osteospermum ecklonis*, *Liriope muscari*, *Sedum reflexum*, *Ruellia tweediana*, *Carpobrotus acinaciformis*, and *Armeria maritima*. Additionally, plants like *Cerastium tomentosum*, *Phalaris arundinacea*, and *Lysimachia nummularia*, which exhibited yellowing and diminished growth and appearance quality due to the intense summer light in the summer, are likely to thrive in Gorgan's urban green spaces if they are cultivated in shaded areas.

Keywords: Climate, Ground cover, Green spaces, Landscape.

INTRODUCTION

Given the deficiency of water resources in many Iranian cities and the substantial water usage by lawns, exploring the feasibility of reducing lawn areas and expanding green areas with planting cover plants is a rational approach to achieving sustainable green space (Mushtaqian and Staki, 2015). However, cover plants vary in their water requirements, depending on their genus and species. In a study on six *Sedum* species, Shooshtarian *et al.* (2011) concluded that after nine irrigation cycles, the chlorophyll content was higher in *S. lydium, S. acre*, and *S. spurium* than in *S. spectabile*, *S. album*, and *S. hybridium.* Furthermore, McKeown *et al.* (2023) observed that Wedelia, as a cover plant, exhibited superior coverage and growth rates than Liriope at the irrigation intervals of 5, 9, 13, and 18 days.

Many ornamental cover plants are perennials and do not need replanting each year, thus reducing labor costs (Marble *et al.*, 2017). Additionally, some cover plants can absorb heavy metals. It has been reported that *Armeria* is tolerant of heavy metal accumulation in its roots and leaves (Olko *et al*., 2008).

Cover plants contribute to urban aesthetics, purify the air by filtering dust and pollutants, prevent overheating and desiccation of the environment, and play a crucial role in maintaining air freshness and reducing various forms of environmental pollution. They also help prevent extreme weather conditions, such as destructive storms, intense heatwaves, and severe droughts, while controlling weed growth and minimizing soil erosion (Zarei *et al*., 2018; Amoroso *et al*., 2009; Foo *et al*., 2011).

Humans have an innate appreciation for beauty and enjoy it. In this context, the natural colors of plants are far more effective than man-made hues. Indeed, the color of a plant is the first characteristic that draws attention. Owing to their diverse colors, cover plants offer a more varied and natural visual appeal than grasses Along highways, we often encounter steep slopes with unappealing landscapes that can be transformed by planting resilient and adaptive cover plants into a vibrant, natural, and aesthetically pleasing environment (Rezaei and Zabihi, 2015).

Many plants undergo various transformations with changing seasons and weather patterns. Cover plants are no exception. An essential consideration in green space design is selecting plants that respond well to seasonal changes in different climates. A study of 19 cover plants identified *Sedum spurium* and *Thymus praecox* as suitable choices for the urban green spaces of Trabzon, Turkey (Acar and Var, 2001). Esmaeili *et al.* (2017) investigated five cover plants, including *Oxalis brasiliensis* L., *Trifolium repen*s L., *Phyla nodiflora* L., *Frankenia thymifolia* Desf., and *Vinca minor* L., in Shiraz's climate over four seasons and found that the plants exhibited distinct responses across the four seasons. For instance, the catalase enzyme activity was the highest among the studied plants in summer, and the proline content was significantly higher in *Frankenia thymifolia* than in the other species, especially in winter. Another study revealed that the phenolic content of *Glechoma* as a cover plant, which has medicinal characteristics, too, varied across seasons (Varga, 2016).

The seasonal color changes of certain ornamental plants are another significant aspect of green spaces, creating a harmonious color palette and showcasing unique beauty (Wang, 2021). Thus, cover plants can also contribute to this color diversity in green spaces with their array of colors and seasonal changes. For example, the foliage of *Frankenia* transitions from green in spring and summer to orange and red from late autumn to late winter in non-tropical and semi-tropical regions.

The present study aimed to evaluate 18 cover plants in the climatic conditions of Gorgan, Iran, over the course of a year (four seasons).

MATERIALS AND METHODS

The research was conducted on the campus of the Faculty of Plant Production at Gorgan University of Agricultural Sciences and Natural Resources (36°48'33'' N., 54°39'16'' E.) over the course of one year. Eighteen plant species were acquired from a nursery in Pakdasht, Tehran. Table 1 lists their names and characteristics, and Fig. 1 provides their images. All plants were in pots with a diameter of 14 cm and a height of 12 cm. Five samples of each plant species were planted in circular pots with a diameter of 100 cm. The soil used for the research was standard agricultural soil, which was tested and analyzed by the Water and Soil Laboratory of Dr. Mahzari. The results are presented in table 2. All plants received uniform watering.

Table 1. The characteristics of the studied plant species.

Scientific name	Family	Ornamental parts	Water requirement	Propagation method
Crassula campfire	Crassulaceae	Leaf	Low	Seed/ Plant division
Frankenia thymifolia	Frankeniacea	Leaf	Low	Plant division/ Stem cutting
Hedera algeriensis	Araliaceae	Leaf	Moderate	Stem cutting/ Grafting
Ophiopogon japonicus	Asparagaceae	Leaf	Modrate	Plant division/ Seed
Festuca ovina	Poaceae	Leaf/ Flower	Low	Plant division/ Seed
Osteospermum ecklonis	Asteraceae	Flower/Leaf	Moderate	Plant division/ Seed
Liriope muscari	Asparagaceae	Leaf/ Flower	Low	Plant division/ Seed
Sedum reflexum	Crassulaceae	Leaf/ Flower	Low	Plant division/ Seed
Ajuga reptans	Lamiaceae	Leaf/ Flower	Moderate	Plant division/ Seed
Phalaris arundinacea	Poaceae	Leaf	Low	Plant division/ Seed
Ruellia tweediana	Acanthaceae	Leaf/ Flower	Low-Moderate	Plant division/ Seed/ Stem cutting
Plectranthus australis	Lamiaceae	Leaf	Moderate	Stem cutting
Carpobrotus acinaciformis	Aizoaceae	Leaf/ Flower	Low	Seed/ Stem cutting
Alternanthera bettzickiana	Amaranthaceae	Leaf	High	Seed/ Stem cutting
Armeria maritima	Plumbaginaceae	Leaf/ Flower	Low	Plant division/ Seed
Lysimachia nummularia	Primulaceae	Leaf	High	Plant division/ Seed
Glechoma hederacea	Lamiaceae	Leaf	Low	Seed/ Stem cutting
Cerastium tomentosum	Caryophyllaceae	Leaf/ Flower	Moderate	Plant division/ Seed/ Stem cutting

Table 2. Physical and chemical characteristics of soilused.

Lab.No	Description	Dept. (cm)	pH	EC	Saturation percentage (%)	Total nitrogen (%)	N (%)	Organic carbon (%)	P (ppm)	K (ppm)	Clay (%)	Silt (%)	Sand (%)	Texture
757	Gorgan	0-30	7.34	1.52	15.3	9.18	0.38	1.8	7.6	296	18	66	16	Si – L

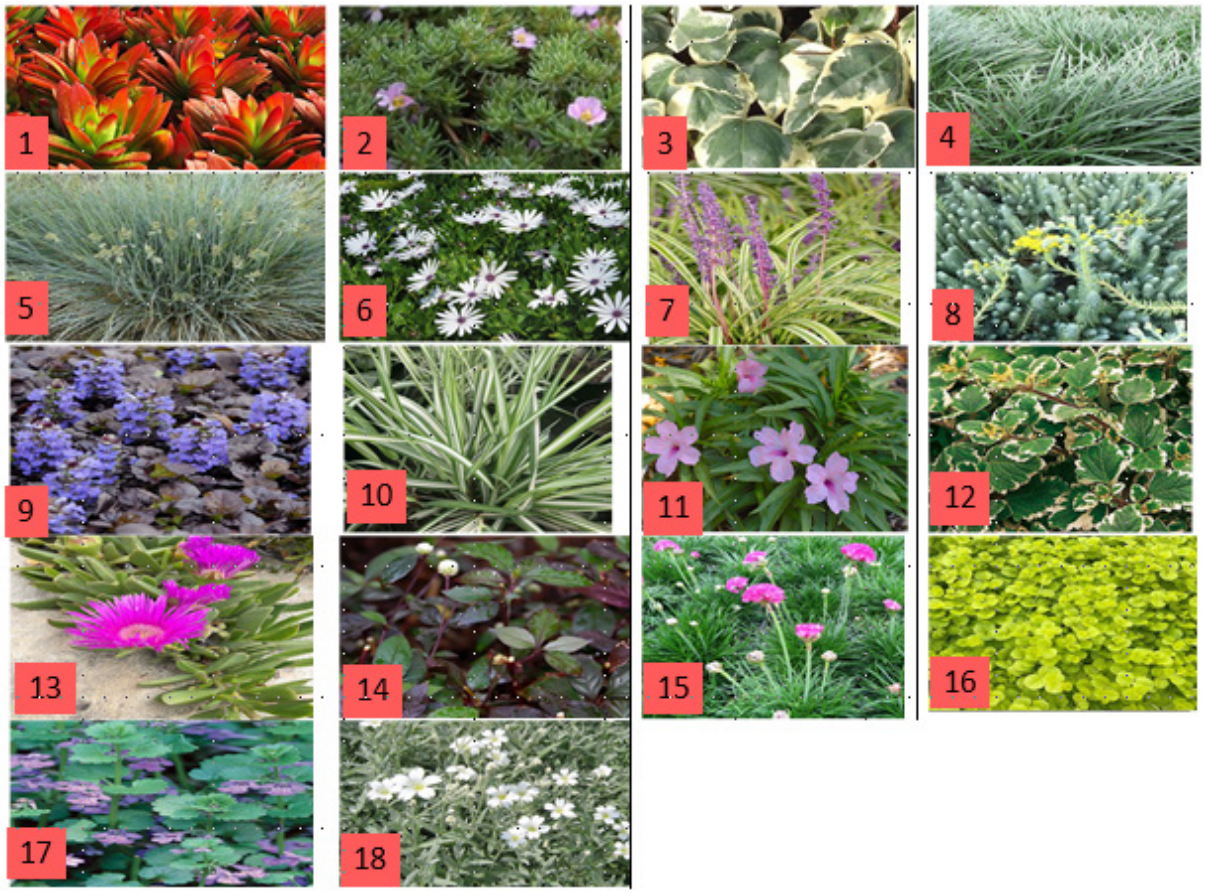

Fig. 1. *Crassula campfire*; 2. *Frankenia thymifolia*; 3. *Hedera algeriensis*; 4. *Ophiopogon japonicus*; 5. *Festuca ovina*; 6. *Osteospermum ecklonis*; 7. *Liriope muscari*; 8. *Sedum reflexum*; 9. *Ajuga reptans*; 10. *Phalaris arundinacea*; 11. *Ruellia tweediana*; 12. *Plectranthus australis*; 13. *Carpobrotus acinaciformis*; 14. *Alternanthera bettzickiana*; 15. *Armeria maritima*; 16. *Lysimachia nummularia*; 17. *Glechoma hederacea*; 18. *Cerastium tomentosum*.

The traits measured included appearance quality, chlorophyll a, b, and total, carotenoid content, and plant growth percentage. The appearance quality was determined through scoring parameters like leaf freshness and the presence or absence of spots on the leaves, which were evaluated by several graduate students (Zarei *et al*., 2018).

Chlorophyll content was measured following Barnes *et al*.'s (1992) method. So, 1 g of fresh leaves from each replication was precisely weighed and then chopped into small pieces using a sharp instrument like a scalpel. The minced samples were placed in a test tube and mixed with 10 ml of dimethyl sulfoxide (DMSO). They were then oven-dried at 75-80°C for 3 hours. Afterward, 1 ml of this mixture was transferred to a new test tube and diluted to 5 ml with DMSO. Pure DMSO served as the control. The absorbance of the samples was measured using a Unic-2800 spectrophotometer (Unico, the US) at 645, 663, and 480 nm to determine the chlorophyll a, b, and total chlorophyll contents. The readings were put in Eq. (1):

$$\begin{aligned} &\text{Chl. a (mg/g F.W.)} = 12.7(A663) - 2.69(A645)\times V/1000\times W \\ &\text{Chl. b (mg/g F.W.)} = 22.9(A645) - 4.68(A663)\times V/1000\times W \\ &\text{Chl. total (mg/g F.w)} = 20.2(A645) + 8.02(A663)\times V/1000\times W \end{aligned} \quad (1)$$

in which V represents the volume of the filtered solution (the supernatant), and W represents the sample fresh weight in g.

Arnon's (1965) method was employed to quantify the carotenoid content in gerbera. Initially, 0.5 g of petals were ground with 10 ml of 80% acetone in a porcelain mortar. The resulting mixture was transferred to plastic centrifuge tubes and spun at 5000 rpm and 20 °C using a HERMLE-Z300 centrifuge for 5 minutes. The clear supernatant was decanted, and the process was repeated with acetone. This procedure was performed three times until the residual plant tissue became colorless. The final solution was then adjusted to a volume of 50 ml with 80% acetone and was poured into a spectrophotometer cuvette to read its absorbance at 480 and 510 nm. Also, 80% acetone was used as the control. The carotenoid content was calculated in mg of carotenoids per g of fresh flower tissue using Eq. (2).

$$\text{Carotenoid content (mg/g F.W.)} = [7.6\ (A480) - 1.49\ (A510)] \times V/W \quad (2)$$

Imager software was utilized to calculate the plant growth and coverage percentage. This software is capable of differentiating the plant from the soil in overhead photographs and subsequently estimating the area shaded by the plant foliage. While this method does not directly measure the leaf area index, it can measure horizontal growth changes in plants by comparing the shaded area produced at different time intervals, which is particularly useful for evaluating the growth of cover plants. The software can also be used to measure leaf area or to distinguish leaf area from pest-affected areas for assessing damage or decay. The software is typically calibrated using a reference paper sheet with known dimensions placed in the initial photographs (Fig. 2).

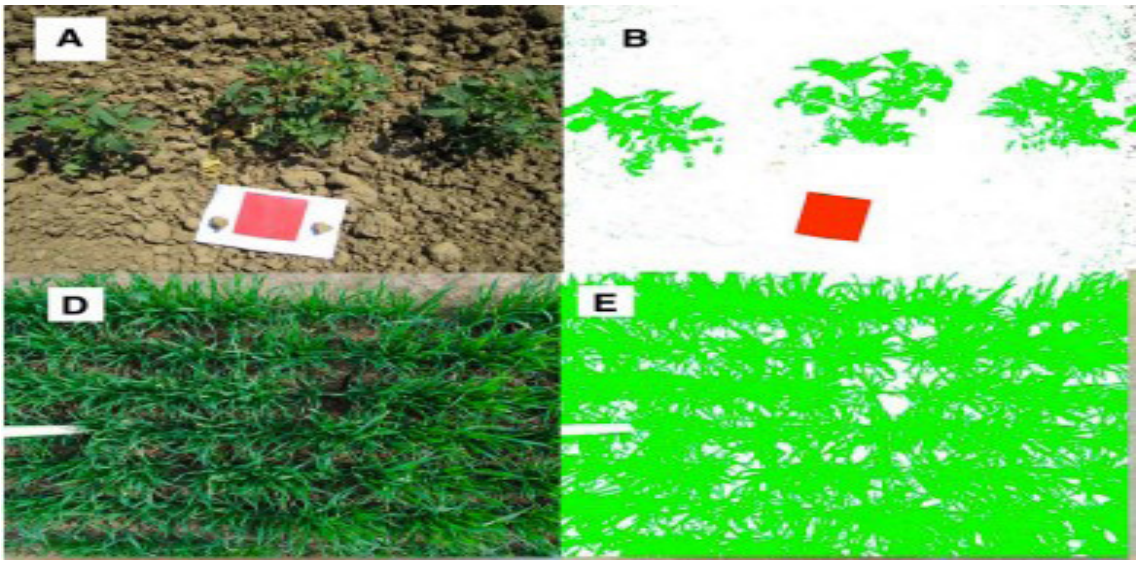

Fig. 2. The shade on the soil surface created by the plant as distinguished by the imager software on the soil surface.

Data were analyzed using SAS software, and the means were compared using the LSD test.

RESULTS AND DISCUSSION

Based on the results of analysis of variance (ANOVA), the plant type significantly ($P < 0.01$) affects chlorophyll a, b, total, and carotenoid levels. However, the effect of time (four seasons) and its interaction with cover plant type were not significant on these traits. Additionally, the effect of plant type, time, and their interaction was found to be significant ($P < 0.01$) on visual quality (Table 3).

Table 3. The analysis of variance for the effect of cover plant species and time on the measured traits.

S.o.V	df	Chlorophyll a	Chlorophyll b	Total chlorophyll	Carotenoid	Growth rate
Species	19	1.849**	0.494**	3.842**	0.349**	6823.847**
Time	3	11.612ns	1.444ns	21.250ns	5.003ns	8350.5643ns
Species × time	57	10.260ns	0.150ns	1.007ns	0.198ns	1334.310ns
Error	160	0.010	0.012	0.023	0.011	0.7591
CV (%)		8.852	28.552	9.969	13.746	1.597

*, ** and ns: Significant at P < 0.05, P < 0.01 and insignificant based on the LSD test, respectively.

Growth rate

The comparison of data means indicated that the highest and lowest growth rates throughout the four seasons were observed in *Carpobrotus acinaciformis* and *Festuca ovina*, respectively (Table 4).

Table 4. The comparison of means for the measured traits of the studied cover plants.

Species	Growth rate	Chlorophyll a	Chlorophyll b	Total chlorophyll	Carotenoid
Crassula campfire	67.81e	0.695m	0.182 f-i	0.877ij	0.642hij
Frankenia thymifolia	82.167c	1.502d	0.606c	2.109c	1.230b
Hedera algeriensis	36.336k	1.089fg	0.239ef	1.328ef	0.704ghi
Ophiopogon japonicus	46.61hi	0.882ijk	0.192e-h	1.074gh	0.700ghi
Festuca ovina	33.81l	0.828kl	0.546c	1.375ef	0.797fg
Osteospermum ecklonis	81.234c	1.001gh	0.572c	1.573d	0.917ef
Liriope muscari	54.157f	0.638mn	0.095hi	0.734jk	0.611j
Sedum reflexum	88.096b	1.161f	0.313dec	1.475de	0.718ghi
Ajuga reptans	34.299l	1.715c	0.546c	2.262c	1.044cd
Phalaris arundinacea	52.835fg	0.969hij	0.396d	1.366ef	0.595ij
Ruellia tweediana	47.277h	0.873jk	0.541c	1.415de	1.115bc
Plectranthus australis	48.363h	0.997ghi	0.231efg	1.228fg	0.714ghi
Carpobrotus acinaciformis	96.925 a	2.756a	1.165a	3.922a	0.662hi
Alternanthera bettzickiana	88.048b	1.345e	0.225efg	1.570d	1.383a
Armeria maritima	38.506j	1.367e	0.909b	2.276c	0.989de
Lysimachia nummularia	73.766d	0.719lm	0.189e-i	0.909hij	0.600ij
Glechoma hederacea	89.343b	0.838k	0.191e-i	1.030hi	0.642hij
Cerastium tomentosum	68.439e	2.155b	0.559c	2.714b	0.746gh

*In each column, means with similar letter(s) are not significantly different (P < 0.05) using the LSD test.

The vegetative growth of cover plants is a critical factor influencing their selection. The ability to cover the ground and the resultant aesthetic appeal are greatly dependent on the rate of the plant's vegetative growth. Cover plants exhibit a range of growth rates, from slow to fast. This parameter is affected by various factors, including climatic conditions (Zarei *et al*., 2018). The plants explored in this study also varied in their growth rates. Among the plants with a running growth habit, *Alternanthera bettzickiana*, *Glechoma hederacea*, and *Sedum reflexum* had the highest growth rate after *Carpobrotus acinaciformis*, but *Hedera algeriensis* had a lower growth rate over one year than the others although it is a runner plant. Typically, this plant thrives in bushes, hedges, and shaded areas (Reichard, 2000). Consequently, one reason for the observed growth rate could be the full sunlight exposure in the test environment, as these plants were cultivated in an unshaded area free of any obstacles that could reduce light availability. A study conducted in Italy under Mediterranean conditions examined four ornamental cover plants. The findings showed that *Hedera algeriensis* covered approximately 85% of the target area over four seasons (Ruggeri *et al.*, 2016), which contrasts with our results. On the other hand, among plants with a bushy to upright growth habit, *Osteospermum ecklonis* exhibited the highest growth rate, while the lowest was observed in *Festuca ovina*. However, fescue was found to effectively control weeds in the spaces between apple trees in another study (Hartley *et al*., 2000).

Foo *et al*. (2011) conducted a study on 12 cover plants, including *Ophiopogon japonicus*, which demonstrated moderate growth and coverage of about 50%, aligning with our findings.

Chlorophyll and carotenoid contents

Table 4 indicates that *Carpobrotus acinaciformis* exhibited the highest levels of chlorophyll a, b, and total, while the lowest levels were observed in *Liriope muscari*, with no significant difference from *Crassula campfire* and *Lysimachia nummularia*. Plants synthesize over 2000 compounds, many of which are colorful and known as pigments (Tanaka *et al.*, 2008). Pigments are categorized into four major groups in higher plants: Chlorophylls, carotenoids, anthocyanins, and betalains (Gandia-Hererro *et al.*, 2013). Greenness serves as a quality indicator in plants, although cover plants exhibit color variations beyond those induced by seasonal changes. Plants with leaves that are pied (have two colors) or typically less green contain lower chlorophyll contents. In our study, the plants that had their almost fully green foliage with no color change in cold conditions included *Ophiopogon japonicus*, *Osteospermum ecklonis*, *Ruellia tweediana*, *Carpobrotus acinaciformis*, *Armeria maritima*, and *Glechoma hederacea*, whereas the other 12 species displayed a diverse color spectrum. Although, the leaf color of *Frankenia thymifolia* and *Alternanthera bettzickiana* shifted to orange and red from late autumn to late winter, respectively, their chlorophyll contents did not show significant variations over time. A study evaluated 10 cover plants in the Kish Island region. The findings revealed that *Frankenia thymifolia* and *Carpobrotus acinaciformis* had the highest chlorophyll content (Shoshtarian *et al*., 2011), corroborating our results. On the other hand, the reduced chlorophyll detected in *Crassula campfire* in the present study may be attributed to the dominance of pink-to-red pigments in its succulent leaves over the green color in its typical growth conditions throughout the year, resulting in diminished levels of chlorophyll.

As per table 4, *Alternanthera bettzickiana* showed the highest carotenoid content in its leaves, closely followed by *Frankenia thymifolia.* On the other hand, *Phalaris arundinacea* had the lowest carotenoid content. The cold-induced color changes in *Alternanthera bettzickiana* and *Frankenia thymifolia* influenced the average carotenoid levels in their leaves compared to other cover plants studied. Jozay *et al.* (2023) noted that the carotenoid content in *Frankenia*

thymifolia increased as it got cold in winter in Mashhad, Iran, as opposed to spring and summer. The lower carotenoid content in *Phalaris arundinacea* could be linked to the pied color of its foliage. Pied leaves are distinguished by white, yellow, or red sections, which vary based on the presence or absence of chlorophylls, carotenoids, and anthocyanins (Esteban *et al*., 2008).

Visual quality

Based on the comparison of data means, the best visual quality was for *Osteospermum ecklonis* in spring, followed by *Frankenia thymifolia*, *Plectranthus australis*, and *Lysimachia nummularia*. Also, the lowest visual quality in spring was observed in *Crassula campfire, Ophiopogon japonicus, Ajuga reptans, Ruellia tweediana, Armeria maritima,* and *Cerastium tomentosum*. During the summer, *Carpobrotus acinaciformis* and *Glechoma hederacea* had the highest and lowest visual quality, respectively. The highest and lowest visual quality in the autumn was related to *Liriope muscari* and *Ajuga reptans*, respectively. *Osteospermum ecklonis* had the best, and *Plectranthus australis* had the worst visual quality in the winter (Table 5).

Table 5. The visual quality of the cover plants in four seasons on a scale of 0-10.

Species	Winter	Autumn	Summer	Spring
Crassula campfire	2^{g}	7^{c}	6^{d}	6^{d}
Frankenia thymifolia	8^{b}	8^{b}	7^{c}	8^{b}
Hedera algeriensis	4^{f}	7^{c}	5^{e}	7^{c}
Ophiopogon japonicus	6^{d}	6^{d}	5^{e}	6^{d}
Festuca ovina	6^{d}	6^{d}	5^{e}	7^{c}
Osteospermum ecklonis	9^{a}	8^{b}	7^{c}	9^{a}
Liriope muscari	5^{e}	9^{a}	6^{d}	7^{c}
Sedum reflexum	6^{d}	8^{b}	6^{d}	7^{c}
Ajuga reptans	6^{d}	5^{e}	5^{e}	6^{d}
Phalaris arundinacea	7^{c}	6^{d}	5^{e}	7^{c}
Ruellia tweediana	8^{b}	7^{c}	7^{c}	6^{d}
Plectranthus australis	1^{h}	7^{c}	8^{b}	8^{b}
Carpobrotus acinaciformis	7^{c}	8^{b}	9^{a}	7^{c}
Alternanthera bettzickiana	1^{h}	7^{c}	8^{b}	7^{c}
Armeria maritima	7^{c}	8^{b}	8^{b}	6^{d}
Lysimachia nummularia	2^{g}	7^{c}	4^{f}	8^{b}
Glechoma hederacea	2^{g}	6^{d}	3^{g}	8^{b}
Cerastium tomentosum	4^{f}	7^{c}	4^{f}	6^{d}

Visual quality, which is influenced by environmental factors such as light, temperature, and humidity, is a crucial criterion in green spaces. Plants have varying requirements. If their specific environmental needs are met, they will exhibit high quality; otherwise, their appearance quality will diminish. The high visual of *Osteospermum ecklonis* in spring, autumn, and winter can be attributed to its cooler temperature requirements, and as is observed in Fig. 2, Gorgan had relatively cooler temperatures in these three seasons. Since *Carpobrotus acinaciformis* is a tropical species (Campoy *et al.*, 2021), it achieved the highest appearance quality in summer. It, however, scored relatively well in other seasons, indicating its tolerance to various temperature ranges. According to Campoy *et al*. (2021), *Carpobrotus acinaciformis* is very highly tolerant

of climatic fluctuations. The low appearance quality of *Glechoma hederacea* in summer was due to leaf yellowing caused by intense light exposure, which resulted in leaf burn. However, its regrowth in autumn was facilitated by the expansion of its stolons in spring. *Liriope muscari* stood out for its excellent appearance and freshness in autumn, enhanced by the bloom of its lilac flowers. The superior visual quality of this plant in autumn, as opposed to spring and summer, may be linked to lower light intensity during this season. *Liriope muscari* thrives best in semi-shade conditions, achieving optimal quality (Gilman, 1999). Zhang *et al*. (2020) observed that *Liriope muscari*'s best growth occurred under low light conditions and tree shade.

CONCLUSIONS

The research revealed that, out of the 18 cover crops examined, the most suitable species for the urban green spaces of Gorgan under full sunlight and with no shading are *Frankenia thymifolia, Osteospermum ecklonis, Liriope muscari, Sedum reflexum, Ruellia tweediana, Carpobrotus acinaciformis,* and *Armeria maritima*. Additionally, plants like C*erastium tomentosum, Phalaris arundinacea*, and *Lysimachia nummularia*, which exhibited yellowing and diminished growth and appearance quality due to the intense summer light in the summer, are likely to thrive in Gorgan's urban green spaces if they are cultivated in shaded areas.

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Morphophysiological Response of *Gynura aurantiaca* to Application of Humic Acid and Vermicompost

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Abstract

This study investigated the effect of humic acid and vermicompost as natural soil fertilizers on morphophysiological characteristics in *Gynura aurantiaca*. To determine the effect of these substances at different doses on the growth and antioxidant enzyme activity of *Gynura*, vermicompst (0, 2, 4 and 6%) and humic acid (0, 0.25, 0.5 and 1 g/kg) were applied at soil applications. Morphological characteristics of *G. aurantiaca* including stem length, leaf area, stem diameter, leaf diameter, the weight of fresh and dry roots and shoots and its physiological and biochemical characteristics including the content of chlorophyll a, b and total, soluble solids, and antioxidant enzymes activity were studied. The experiment was conducted as a factorial experiment based on completely randomized design with three replications in the research greenhouse of Shiraz University in 2019. Treated plants with 0.5 g/kg humic acid in combination with 6% vermicompost increased the root dry weight. 1 g/kg humic acid in co-application with 6% vermicompost enhanced leaf area, stem diameter, leaf diameter, plant height, root fresh weight, shoot fresh weight and shoot dry weight as well as the antioxidant enzymes activity of POD and CAT. The improved chlorophyll a, b and total contents were observed in plants treated with 0.5 g/kg humic acid in combination 4 % vermicompost. These results indicate that co application of humic acid and vermicompost is a useful fertilizer to improve growth in *Gynura* plants.

Keywords: Antioxidant enzyme activity, Biofertilizer, Chlorophyll content, Sustainable agriculture.

INTRODUCTION

A substantial increase was found in the use of organic additions in agriculture in recent years, owing to rising concerns about environmental issues such as soil degradation, waste recycling, as well as societal demands for more ecologically friendly plant and food production systems. This has helped to enhance the scientific research about the effects of these amendments on both the soil and the plant. Although, the majority of this study has concentrated on the effects of well-known organic additions such as animal manures, green manures, and compost, research into further alternative organic amendments such as vermicompost and humic acid is becoming increasingly important (Edwards *et al*., 2004; Lazcano and Dominguez, 2010).

Humic acid, a natural polymer with carboxyl and phenolic positions for the exchange process, is a blackish or brownish- colored. Humic acid constitutes stable and soluble complexes with micronutrients as a result of chemical and biological decomposition of soil organic matter, pit, lignin, and other materials. Additionally, it has a molecular weight of 3,000 to 30,000 daltons (Befrozfar *et al*., 2013; Boogar *et al*., 2014; Noroozisharaf and Kaviani, 2018; Karimi *et al*., 2020). Humic acid has been shown to have a direct impact on plant growth components like cell permeability, respiration, photosynthesis, and cell elongation. Other effects of humic acid on decreasing the incidence of plant disease have been demonstrated in numerous researches. Aside from the obvious effects on nutrient absorption and plant primary metabolism, humic chemicals may also have a significant impact on secondary metabolism (Noroozisharaf and Kaviani, 2018). Early flowering (Baldotto and Baldotto, 2013), increased leaf area (Ahmad *et al*., 2013), number of flower and leaf, plant height, flower dry weight (Mirzaee Esgandian *et al*., 2020), chlorophyll content (Haghighi *et al*., 2012), and macro and micronutrient acquisition were all stimulated by the application of humic acid (Karimi *et al*., 2020).

Vermicomposts as a product of nonthermophilic bio-degradation of organic materials, are the result of interactions between an active biological mixture of bacteria, enzymes, plant residue, manure, and earthworm cysts (capsules) (Lazcano and Martin, 2010; Befrozfar *et al*., 2013; Sardoei *et al*., 2014). Vermicompost improves soil aeration and structure, reducing soil compaction and enhancing water retention potential, through its high organic matter content. By promoting improved root growth, nutrient absorption, and soil nutrient status, it also enhances soil nutrient status, both macro- and micro-nutrients (Lazcano and Dominguez, 2011). These materials have been found to show the same impacts with growth regulators and hormones (Mahboub Khomami *et al*., 2021).

Previous greenhouse and field researches demonstrated the impacts of numerous vermicomposts on ornamental foliage plants and cut flowers (Atiyeh *et al*., 2000; Mahboub Khomami, 2011). Significantly, hastening plant growths after substitution of vermicompost in growth medium, owing to modifications of water usability, enhancing access to micro and macro nutrients, provoking bacterial activity, increasing the activity of particular enzymes, making growth accelerating materials followed from the interaction of microorganisms and earthworms (Mahboub Khomami *et al*., 2021). Application of 50% of vermicompost fertilizer improved cranesbill growth and flowering attributes (Borji *et al*., 2014). The use of vermicompost made from water hyacinth (*Eichhornia crassipes*) improved the development and flowering of *Crossandra udulaefolia* substantially (Gajalakshmi and Abbasi, 2002). Vermicompost has been found to have a higher proportion of nitrogen, carbon, and mineral resources that is suitable for the need of the recipient plant. The use of such nutrients provides resources necessary for the formation of molecules in plants, resulting in improved growth, increased disease resistance, and the ability to combat unpleasant chemical substances found in the proximity of the plants. Various examples of such plant action have been mentioned (Sardoei *et al*., 2014).

The genus *Gynura* Cass., which belongs to the Asteraceae family, has more than 50 species of perennial herbs and subshrubs native to tropical Africa and Asia (Huxley *et al*., 1992). The leaves of *G. aurantiaca* (Blume) Sch. Bip. ex DC. are covered in numerous tiny, vivid purple hairs that give the plant a rich, colourful glow (Chen *et al*., 2002). So, it is well known as an ornamental foliage plant. Purple passion, velvet plant, or purple velvet plant are all common names for *G. aurantiaca*. As purple passion is young, it has an upright habit, but as it become mature, it shows more vine-like and spreading habit, which make it ideal for hanging baskets. Furthermore, the plant's distinctive coloration makes it ideal for adding a splash of color to combination planters. The rich purple color is really appealing (Cui *et al*., 2019).

The application of the organic fertilizers is one of the suitable methods in creating plants, owing to the remarkable impact on advancing soil properties, decreasing ecological side effects, and better plant growth; nonetheless, information on the effects of humic acid and vermicompost on plant growth and physico-biochemical attributes of *Gynura aurantiaca* is lacking and inconclusive. The slow growth of *Gynura* plants during growth and development is one of the most important problem these days. It was thus decided to investigate the effects of using organic fertilizers (humic acid and vermicompost) instead of chemical fertilizers on improving the ornamental characteristics of *Gynura aurantiaca*, such as leaf area, antioxidant enzyme activity, total carbohydrate content, and chlorophyll content.

MATERIALS AND METHODS

single-leaf stem cuttings of *Gynura aurantiaca* were purchased from Armaghan Plant Company, Shiraz, Iran. Cuttings were cultivated in moist perlite culture medium and harvested after rooting completely (20 days after planting) in 2019 at the greenhouse with average day/night temperature was 28 ± 2/20 ± 2 °C with relative humidity of 55±5%.

In order to keep the humidity around the cuttings, the culture medium was covered with transparent plastic. However, the plastic was removed for one hour every day to prevent stalk rot. The rooted plants were sown in pots with the rim diameter of 7 cm and filled with perlite: peat moss: leaf mold (1:1:1).

This research was conducted as a factorial experiment based on a completely randomized design (CRD) with three replications. As the plants reached 3-4 fully expanded leaf stage, they were transferred to the larger pots (diameter of 10 cm) and filled with sand: peat moss: leaf mold (2:1:1).

After a week, humic acid (Huminbest 85%, Germany) (0, 0.25, 0.5, 1 g/kg) and vermicompost (0, 2, 4, 6 %) were added in to the cultivation media. The treatments were applied monthly, and continued for three months. The following attributes were measured, one month after the last treatment.

Plant length and stem diameter

At the end of the experiment, the stem length and diameter were measured by ruler a digital caliper, respectively.

Leaf area

At the end of the experiment, leaf area was measured (Delta-T-Devices LTD England) in 3 leaves. The results were expressed as a mean value of three leaves.

Leaf diameter

At the end of the experiment, leaf diameter was measured using digital caliper.

Fresh and dry weight of shoots and roots

At the end of the experiment, roots and shoots were measured using a digital balance with 0.001 g accuracy. To measure the dry weight of roots and shoots, these organs were placed in separate envelopes and dried in an oven at 60 °C for 48 h and then it was measured by a digital balance.

Chlorophyll contents a, b, and total

Chlorophyll (chlorophyll a, chlorophyll b and total chlorophyll,) contents of the leaf samples were measured following the formula described by Arnon (1949), as DMSO is used as the extraction solvent. The optical density (OD) of the extract solution was recorded at 663 and 645 nm by the spectrophotometer (Epoch, Bio Tek©, USA). The final content of each pigment was expressed as mg per g fresh weight of the leaves.

1) Chlorophyll a (mg/g FW) = (12.7 (A_{663}) - 2.69 (A_{645}) × Volume made)/(Wt of the sample)
2) Chlorophyll b (mg/g FW) = (22.9 (A_{645}) - 4.68 (A_{663}) × Volume made)/(Wt of the sample)
3) Total Chlorophyll (mg/g FW) = (20.2 (A_{645}) + 8.02 (A_{663}) × Volume made)/(Wt of the sample)

where Wt is the weight of the sample and A λ is the absorption at wavelength λ (nm).

Soluble solids content

Soluble solids content was extracted twice from 0.1 g of leaf powder with ethanol (80%) and estimated by using phenol reagent, according to the protocol described by Fox and Robyt (1991). The absorbance of the samples was determined at 490 nm, using a spectrophotometer.

Antioxidant enzymes activity

The enzyme extraction of leaf samples was prepared according to the protocol described by Ozden *et al.* (2009). To determine the CAT enzyme activity, 1 mL of the reaction mixture (50 mM phosphate buffer (pH 7.0), 15 mM of H_2O_2 and 50 µl of enzyme extract) was measured at 240 nm. CAT enzyme activity was determined as the reduction of H_2O_2 with the extinction coefficient of 39.4 mM^{-1} cm^{-1}. The activity of SOD enzyme was measured at 560 nm using the method described by Giannopolitis and Ries (1977) and expressed as unit/mg FW. For POD assay, the reaction (50 µl of enzyme extract, 2.9 ml of 10 mM potassium phosphate buffer (pH = 7) and 0.05 ml of 20 mM guaiacol) was started by adding 20 µL of 40 mM H_2O_2 and the activity of the enzyme was determined using the extinction coefficient of 26.6-1 mM^{-1} cm^{-1}.

Statistical analysis

This research was conducted as a factorial experiment based on a completely randomized design (CRD) with three replications data were analyzed statistically using SAS software (ver. 9.4) and means were compared using the least significant difference (LSD) test at $P < 5\%$.

RESULTS

Root and shoot growth

Application of 1 g/kg humic acid increased the leaf area (128.67%), stem diameter (12.63 %), leaf diameter (13.63%), plant height (88.36 %), shoot fresh weight (176.84 g), root fresh weight (276.76 %), shoot dry weight (127.58) and root dry weight (143.47%) of *Gynura* plant, compared with the control (Fig. 1). When humic acid was used in combination with vermicompost, the shoot and root growth was nearly doubled. The 0.5 g/kg humic acid in

combination with 6% vermicompost increased the root dry weight by 330 %. Treatment of plants by 1 g/kg humic acid in combination with 6% vermicompost increased the leaf area, stem diameter, leaf diameter, plant height, root fresh weight, shoot fresh weight and shoot dry weight by 415 %, 37.90 %, and 65.90 %, 269.98%, 404.57, 282.17% and 400%, respectively (Fig. 1).

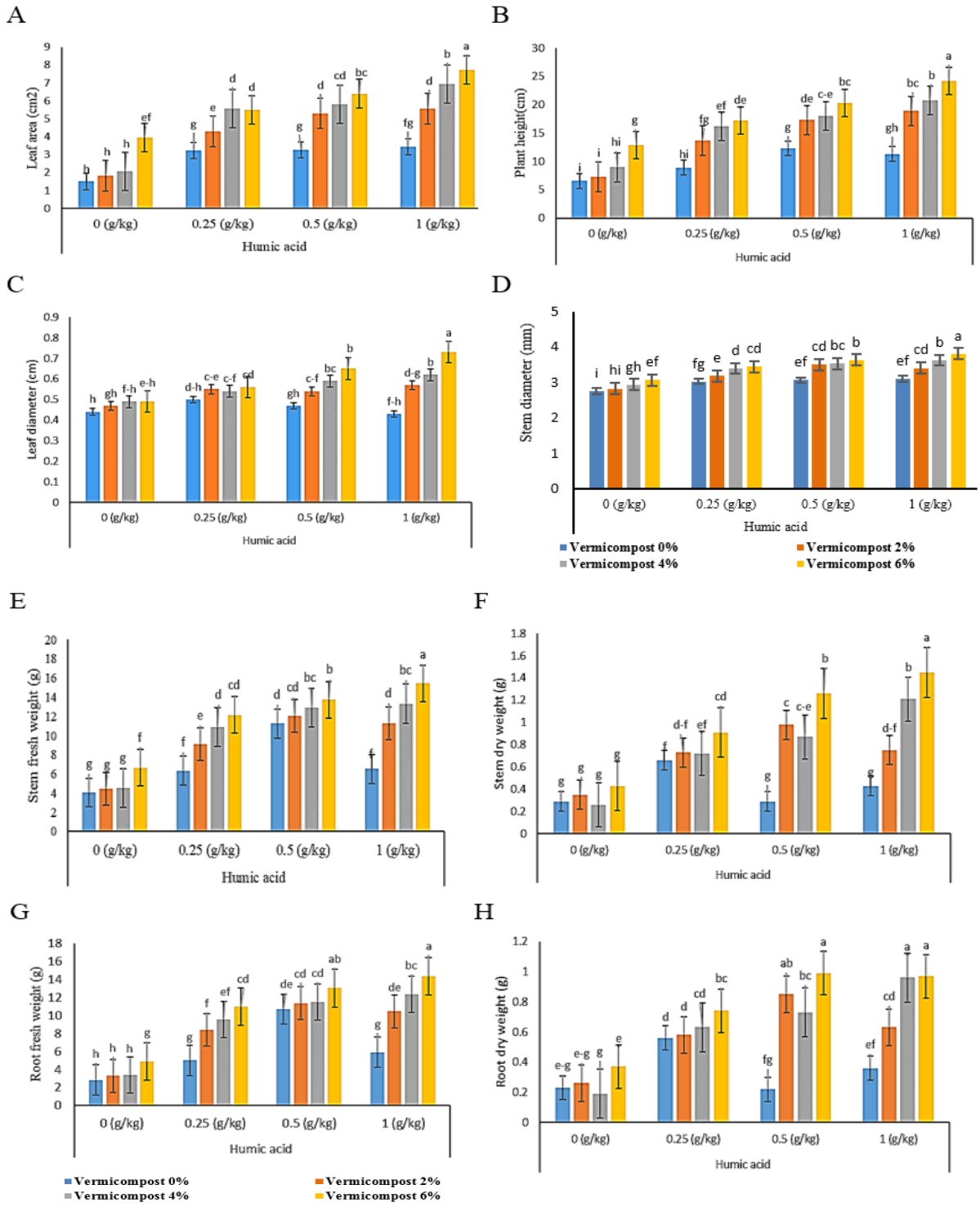

Fig. 1. The effect of humic acid and vermicompost on leaf area and diameter, plant height, stem diameter, fresh and dry weight, and Root fresh and dry weight.

Chlorophyll content and total soluble solids

Fertilization of *Gynura* plants with 1 g/kg humic acid doubled the chlorophyll a, b and total contents of leaves, compared with the control (Fig. 2). When humic acid was used in combination with vermicompost, the chlorophyll content was nearly tripled. The 0.5 g/kg humic acid in combination 4 % vermicompost improved the chlorophyll a, b and total contents by 3-fold amount (Fig. 2).

1 g/kg Humic acid increased the total soluble solids (147.36 %) of *Gynura* leaves, compared with the control (Fig. 2). When humic acid was used in combination with vermicompost, the total soluble solids content was greatly increased. Co-application of 1 g/kg humic acid with 4% vermicompost amplified the amount of total soluble solids contents by 236.84 % (Fig. 2).

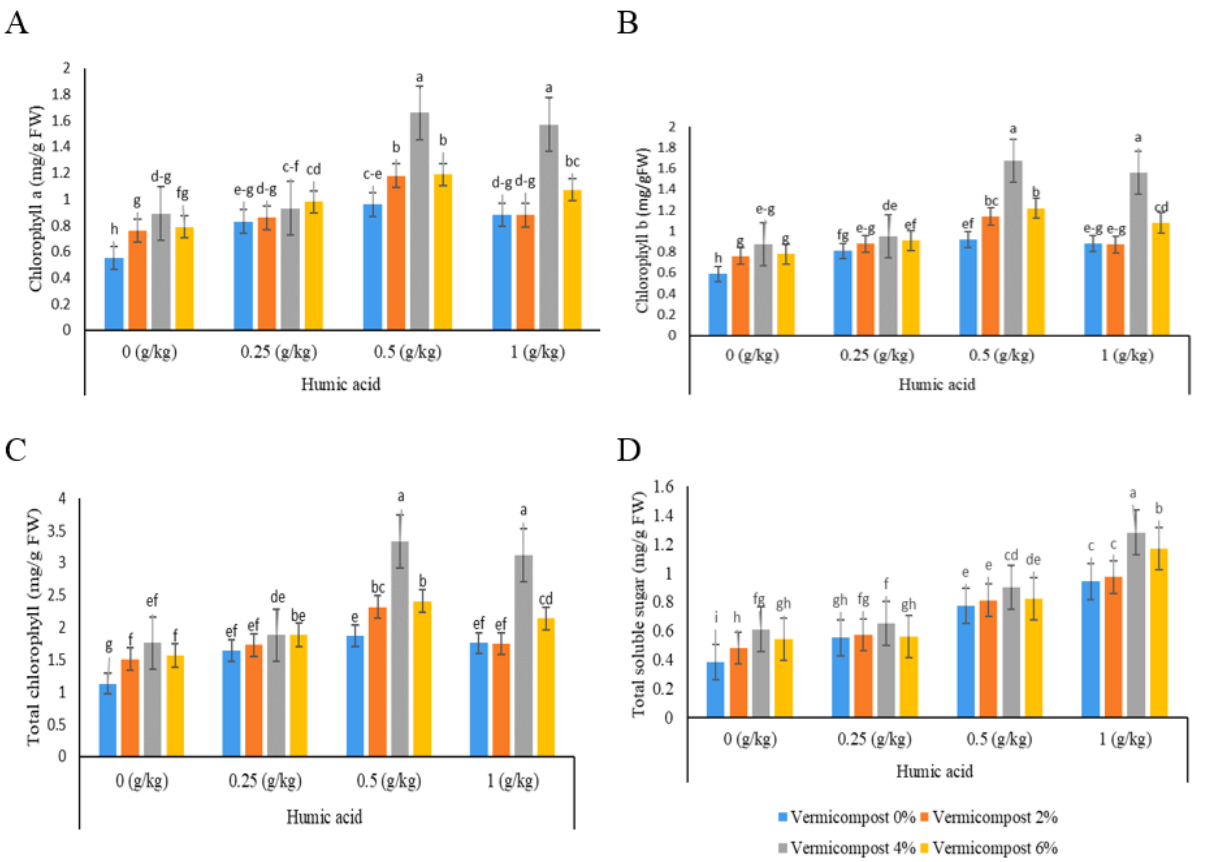

Fig. 2. The effect of humic acid and vermicompost on chlorophyll (a, b and total) and total soluble solids content of *Gynura* plants.

Antioxidant enzymes activity

1 g/kg Humic acid increased the antioxidant enzymes activity of SOD (155.75 %), POD (620 %) and CAT (200 %) of *Gynura* plants, compared with the control (Fig. 3). When humic acid was used in combination with vermicompost, the antioxidant enzymes activity was strongly increased. The 1 g/kg humic acid in co-application with 6% vermicompost increased the antioxidant enzymes activity of POD and CAT by 920 % and 345.83 % respectively (Fig. 3). Treatment of plants by 1 g/kg humic acid in combination with 4% vermicompost increased the antioxidant enzymes activity of SOD by 228.25%, having no significant difference with 1 g/kg humic acid in combination with 6% vermicompost.

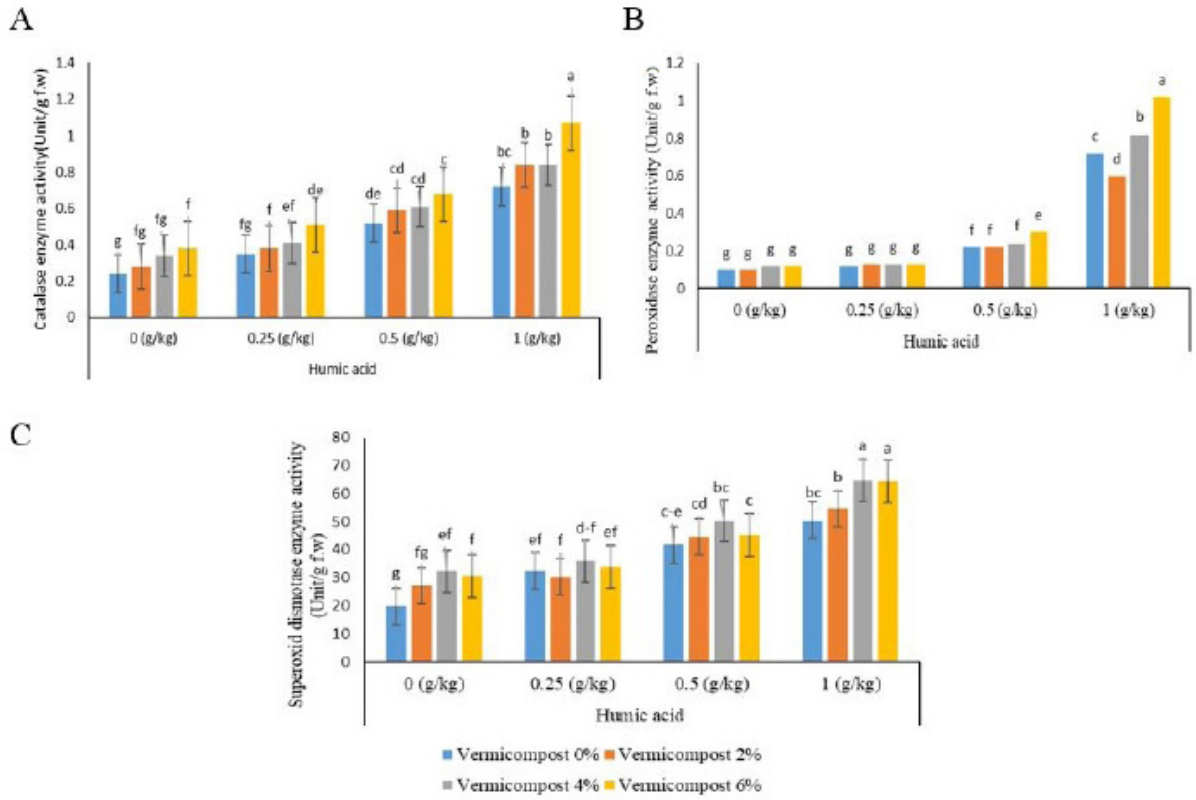

Fig. 3. Effect of different levels of vermicompost and humic acid on antioxidant enzymes activity of *Gynura* plants.

DISCUSSION

The current study showed that higher concentrations of humic acid and vermicompost improved root growth (fresh and dry weight), which was in accordance with Nikbakht *et al.* (2008), Boogar *et al.* (2014), and Joshi *et al*. (2015) findings. Root development is a result of enhanced nutrient absorption in the root, as well as the hormone-like effects of humic acid. Humic acid enhanced the number of lateral roots of gerbera flowers due to its increased nutrient intake and hormone-like characteristics (Boogar *et al.*, 2014). Vermicompost's hormone-like activity leads to an increase in root biomass, root initiation, and improved plant growth and development (Joshi *et al.,* 2015). Previous studies have shown that humic acid leading to support photosynthetic tissues, resulted in an increased total dry weight (Motaghi and Nejad., 2014). Water soluble bioactive compounds including phytohormones, humic, and fulvic acids, minerals, amino acids, or microbial metabolites found in vermicompost may stimulate the plant growth (shoot length, shoot diameter, leaf area and leaf diameter) (Chaichi *et al.*, 2018). It has been reported that vermicompost not only increases the availability of mineral elements required by plants, but also promotes optimal growth and nutrient availability by increasing the physical condition and functions of microorganisms (Anwar *et al.*, 2005). The increase in plant growth due to the mature vermicompost consumption can be attributed to its content of physiologically active plant growth affecting chemicals as well as nutritional factors (Hatamzadeh, 2011; Moghadam *et al.,* 2012). As perceived in this study, humic compounds have the largest impact on root nourishment, which leads to higher shoot development and shoot dry weight (Chaichi *et al.*, 2018). Given to the effects of humic acid and vermicompost on *Gynura* growth, one of the reasons for the increase of leaf area is the role of these elements in increasing photosynthetic

activity, which leads to the increased leaf area (Moghadam *et al.*, 2012; Ahmad *et al.*, 2013).

Based on results of this study, high content of chlorophyll resulted in high photosynthesis rate, which in turn high carbohydrate content should be respected. The chlorophyll content and contents of total soluble solids in the leaves of *Gynura* increased significantly after being treated with 1g/kg humic acid and 4% vermicompost fertilizers compared with those of the control. In previous study, humic acid fertilizer increased chlorophyll content and photosynthesis, resulting in an increased carbohydrate stimulation in cut chrysanthemum flowers, which had a direct impact on floral quality (Fan *et al.*, 2015). Furthermore, previously, the positive effect of vermicompost on higher content in carbohydrates and total soluble solids has been reported (Canellas *et al.,* 2015; Kim *et al.,* 2015). An increase in leaf chlorophyll concentration as a result of vermicompost treatment can be interpreted as a sign of better plant physiological health (Ievinsh *et al.,* 2017). This impact was found in both applications of humic and vermicompost in the current study. Moreover, many authors supported findings (Ahmad *et al*., 2013; Tina *et al.,* 2015; Ievinsh *et al*., 2017), implying that vermicompost components activate photosynthesis-related process.

SOD is the initial line of defense against superoxide anion radicals, converting them to O_2 and H_2O_2; CAT and APX then detoxify H_2O_2 to H_2O and O_2 due to peroxide's high cell integrity toxicity (Morozesk *et al*., 2017). The findings of this study showed that humic acid in combination with vermicompost stimulated SOD, POD, and CAT activity in *Gynura*, thereby enhancing plant antioxidant system and showing improvement in growth and development of these plants, which was in accordance with Garcia *et al.* (2016) findings. There has been observed the effect of application of vermicompost and humic acid in inducing antioxidant enzyme activity of aerial sections of *Tulbaghia ludwigiana* (Aremu *et al*., 2014) and rice (Hernández *et al*., 2012; Berbara and Garcia, 2014).

CONCLUSION

Our findings could advance the understanding of physiochemical responses and antioxidant enzyme activity in *Gynura* plants treated with soil application of humic acid and vermicompost. The present study demonstrated humic acid and vermicompost applications enhanced vegetative growth (leaf area, plant height, stem and leaf diameter) in *Gynura* plants. The increased antioxidant enzyme activity after humic acid and vermicompost applications evidenced the effects of these compounds on enhancing plant antioxidant systems. Thus, co application of humic acid and vermicompost increased the total soluble solids of *Gynura* plants. In general, the application of these substances can be aid to improve sustainable agriculture systems around the world, typically in areas were the application of are an economically restrictive factor.

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The Impact of Sales Promotion, Market Management, and Increased Market Share of Ornamental Plants on the Financial Performance of Producing Companies

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Abstract

Evaluating financial performance allows marketers to measure and assess their contribution to changes in a company›s value. Therefore, understanding how marketing affects the financial performance of ornamental plant producers is of great importance. The aim of this study is to investigate the impact of sales promotion, market management, and increased market share of ornamental plants on the financial performance of producing companies. This research is classified as applied research in terms of its purpose and is descriptive-survey in nature regarding data collection. Standard questionnaires were used for gathering information. The statistical population of this research includes all marketing managers, financial managers, and senior staff of ornamental plant-producing companies in 2024. Using the Klein and Jackson formula for structural equations, a sample of 125 individuals was randomly selected. Structural equations and Smart PLS 3 software were used to test the research hypotheses. The results of the hypothesis tests indicate that sales promotion, market management, and increased market share positively and significantly affect the financial performance of ornamental plant producers. Based on these results, it can be stated that in today›s complex, dynamic, and highly variable environment, ornamental plant producers need to design and adopt strategies that assist in continuously improving their performance. In other words, the outcomes of managers› decisions in such companies are reflected in financial performance metrics through strategies like sales promotion, market management, and increasing market share.

Keywords: Financial performance, Increased market share, Market Management, Ornamental plants, Sales promotion.

INTRODUCTION

Although, the commercial production of ornamental plants in Iran dates back approximately 90 years, it experienced slow growth before the Islamic Revolution. However, after the revolution, with the ban on imports of these goods, domestic producers were revitalized, leading to a production boom that continues today. Each year, the cultivation area for these products grows by more than 10%. For instance, the growth of greenhouse areas between 1996 and 2002 was around 200%, and in seven years, the production area for these products more than tripled. Such a growth rate is rare in other agricultural products. The outdoor cultivation area of ornamental plants has remained stable over the past seven years, indicating that greenhouse production, due to its higher performance and superior quality, is more popular despite the suitable climate for outdoor cultivation in many regions of Iran (Mirzadeh Vaghfi and Jalili, 2020).

On the other hand, a lack of understanding of the marketing system, inefficiencies in the marketing systems of some ornamental plant producers, and significant pressure to reduce costs prompt marketing executives to reassess their objectives, structure, and the efficiency of their marketing teams. Just as accounting is a tool for evaluating a company's financial operations, marketing can assess the opportunities in marketing activities, ensuring they align with set marketing strategies and programs and are effective. In response to increasing competitive pressures and financial constraints, measuring financial performance has become a key priority in the field of marketing (Apaolaza Perez de Eulate and Lizarralde Aiastui, 2021). Financial performance evaluation allows marketers to measure and assess their contribution to changes in a company's value (Aydin *et al*., 2023).

Thus, the issue of studying the effect of marketing on the financial outcomes of ornamental plant producers is considered to be important. As this subject is considered relevant, this research seeks to establish the impact of sales promotion, market management, and enhanced market share of ornamental plants on the financial performance of the producing firms.

The findings of this research can contribute to marketing literature and the ornamental plant production industry as follows:

It is the first study that examines the effect of sales promotion, management of markets, and market growth of ornamental plants on the financial returns of the producing companies. Therefore, the findings can considerably enhance the existing knowledge of the factors affecting the financial performance of ornamental plant producers, particularly in the context of Iran, a developing country.

The findings of this study will help policymakers and legislators implement the right incentives for ornamental plant producers to enhance their sales promotion, market management, and market share.

THEORETICAL FOUNDATIONS AND DEVELOPMENT OF HYPOTHESES

Sales promotion

Although, sales promotion is a popular concept in the field of management (Brodie *et al*., 2011; Hollebeek *et al*., 2014), it has not been explored much in academic contexts (Santos *et al*., 2022). Consumer sales promotions have become popular in product management, and this has led to a lot of discussions about their impact. Critics have long claimed that sales promotions are not effective because they make the consumer wait for promotions, which, in the long run, results in the loss of market share. The term "promotion" is a relative term, and its meaning varies depending on the context and the industry of practice. In this context, it is generally understood as an element of the "marketing mix." In one sense, it refers to any

technique designed to sell a product. Sales promotion is a process that persuades a prospective buyer to buy a product. It is supposed to be used as a short-term strategy, which will help to increase sales in the shortest possible time. However, it is not considered a method that is effective in building a long-term relationship with consumers. Sales promotion entails all the processes that are geared towards the successful completion, coordination, and improvement of the sales activities, advertisement, and marketing departments as well as the sellers with the intention of increasing sales and encouraging the consumers to be more proactive in their purchase (Garanti and Kissi, 2019).

Market management

Managers have defended that market management is a good practice, and acts as a signal to anticipate the future performance of businesses. While in some markets, market share is a critical determinant of a company's future profitability, this is not always so. General Motors was one of the biggest car manufacturing companies in the world before it went bankrupt in 2009. Hence, it is necessary to emphasize that comprehending the relationships expected in a specific market, between market share and profitability, is crucial. In some markets, size does matter; the most important notable example is markets that require economies of scale. Firms in such economies can lower the PCU by selling more, thus improving profitability (Aydin *et al*., 2023).

Increasing market share

Gains or losses in market share, depending on the industry conditions, can significantly impact a company's performance. Market share essentially refers to the percentage of total sales that a company captures in an industry. Changes in market share have a greater impact on the performance of companies in cyclical industries with low growth. In contrast, changes in market share have less effect on companies in growing industries. In such industries, the overall market is expanding, allowing companies to increase sales even if they are losing market share. For companies operating under these conditions, stock performance is more influenced by sales growth and margins than by other factors. In cyclical industries, competition for market share is fierce. Economic factors play a greater role in the variance of sales, profits, and margins than other factors. Margins are usually low, and operations are carried out with maximum efficiency due to competition. Since sales come at the expense of competitors' prices, companies invest heavily in marketing efforts or even employ loss leaders to attract sales (Hollebeek *et al*., 2014).

Financial performance

Financial performance generally refers to all outputs and efficiency in an organization's operations (Isaac *et al*., 2023). It can be measured regarding market share growth, revenue, return, competition, performance, and price manipulation, among other metrics Increasing sales is a goal for many companies in a competitive market environment, and sometimes, sales volume is used to gauge a company's market share within an industry (Apaolaza Perez de Eulate and Lizarralde Aiastui, 2021).

Sales promotion and financial performance

The widespread use of consumer sales promotions to boost sales has generated significant discussions regarding their effectiveness. Critics argue that sales promotions are ineffective because they condition consumers to expect discounts, leading to a long-term loss of market share. Meanwhile, the term "promotion" has different meanings depending on the context and

field in which it is used. In this context, it generally refers to an element of the "marketing mix." Essentially, it refers to any technique designed to sell a product (Ricky *et al*., 2015). From others' perspective, it refers to any effort by the seller to influence the buying decision. (Blanchard *et al*., 2019). The concept of "sales promotion" in marketing, similar to advertising, has been interpreted in various ways by researchers. Blanchard *et al*. (2019) also believe that sales promotion involves "a set of short-term promotional techniques that marketers use to stimulate immediate purchases". Thus, sales promotion can be described as offering added value, acting as a direct incentive for consumers or salespeople. The International Chamber of Commerce defines sales promotion as "marketing tools and techniques that are used to make products and services more attractive by offering some additional benefits, whether in cash or kind or the expectation of such benefits" (Aydin *et al*., 2023). Accordingly, the first research hypothesis is presented as follows:

Hypothesis 1. Sales promotion significantly impacts the financial performance of ornamental plant producers.

Market management and financial performance

Market management capability is a key and basic strategic approach companies can use to enhance their financial performance. Market management is defined as a holistic approach in which a firm uses physical and non-physical assets to decipher the dynamics of certain customer needs, attain a relative product differentiation for a competitive edge, and attain suitable brand quality (Hollebeek *et al.*, 2014). Market management is described as the utilization of organizational knowledge, skills, and resources to add value to goods and services, meet competitive demand, and satisfy market-related needs. The more recent approaches have mainly highlighted innovation and branding as the marketing capabilities. There are several ways through which researchers have defined processes to implement marketing capabilities, all of which can be used by the company to get to the target customers and create value for the goods and services (Ibrahim and Aljara, 2018).

The first process is customer service, which is done in a manner that can suit the buyers and consumers in the market. Most marketing researchers believe that customer service can uniquely result in a competitive advantage. The second process is the effectiveness of promotional activities in attaining market share and sales. These activities are employed in the communication with target markets. The third process is having a strong distribution network to create suitable relationships with distributors. The fourth process is developing customer relations. This process is used to get the customers' opinions and interact with them. The fifth process is the use of marketing research to determine the stated and unstated needs of the customers and the goods and services provided by competitors. The last process is the company's capability to design a unique product in terms of quality, price, image, services, and the like. All these variables are positively associated with the company's performance, particularly in innovation, entrepreneurship, establishment of competitive advantage, and sales and market share (Apaolaza Perez de Eulate and Lizarralde Aiastui, 2021). Based on this, the second research hypothesis is proposed as follows:

Hypothesis 2. Market management significantly affects the financial performance of ornamental plant producers.

Market share and financial performance

Based on various sources, the relationship between market share and financial performance is likely one of the most extensively studied phenomena in management research (Mansourian and Taghi Nasab, 2023). Over the past three decades, a wealth of conceptual and empirical studies have examined the relationship between market share and financial performance. Researchers argue that market share reflects a company's current competitive position in the market, with companies holding a higher market share being perceived as better able to meet customer needs, thereby gaining a competitive advantage over smaller competitors. Since the first published study reported a positive correlation between market share and profitability, the nature of this relationship has continued to be a key topic for economic research. The ongoing debate about the basic relationship has been fueled by inconsistencies in the strength of the market share-financial performance link, its statistical significance, and the direction of the relationship reported in various studies and models. Therefore, the third research hypothesis is as follows:

Hypothesis 3. Market share significantly impacts the financial performance of ornamental plant producers.

Research background

In most research paradigms, a literature review is always done during the research process. However, it is worth mentioning that, up to the present, there are few attempts to investigate the factors influencing the financial performance of ornamental plant producers, and there are a limited number of published articles in this field of study in Iran and worldwide. This section briefly reviews these studies:

Yakubu *et al.* (2024) explored the impact of niche marketing strategy on the performance of small and medium-sized enterprises (SMEs) in Nasarawa State, Nigeria. The study aimed to assess how niche marketing strategy affects the performance of SMEs in this state. The total population included 400 registered SMEs with the Ministry of Commerce and Industries of Nasarawa State, Lafia. A sample of 200 was determined using Yamane's sample size formula from the total population of 200 registered SMEs. The research design employed was a survey research design. Questionnaires were developed and distributed to the registered SMEs in Nasarawa State with the data collected analyzed using a five-point Likert scale questionnaire. The findings revealed that marketing strategy significantly influences the performance of SMEs. It was established that the product positioning strategy of SMEs with an overall mean score of 2.74 (above the decision-making rule mean of 2.50) has a significant effect. However, it was indicated that the market segmentation strategy has no significant impact on the performance of SMEs, as reflected by an overall mean score of 2.01, which is lower than the decision-making rule mean of 2.50.

Aripin *et al.* (2024) investigated the influence of marketing duality on performance. This study aimed to examine the effects of marketing duality on company performance employing a response surface approach to address empirical challenges. The research utilized qualitative descriptive analysis to uncover the impacts of marketing duality and quantitative response surface analysis to model the relationship between marketing variables and company performance. The findings showed that the impact of marketing duality has a significant effect on company performance with interactions between marketing variables being complex and not always linear.

Ellitan (2023) explored how experiential marketing and customer satisfaction can

increase repurchase intention. Marketing activities are increasingly focusing on customer satisfaction. Identifying the factors that lead to customer satisfaction can enhance repurchase intention. This research work discusses how experiential marketing can serve as a strategy that restaurant marketers use to improve customer satisfaction and encourage repurchase intention. It is anticipated that this work will add valuable insights and become a reference for both the present and future particularly in the area of marketing management related to experiential marketing, customer satisfaction and repurchase intention. It can be concluded that a higher sense of experience leads to greater customer satisfaction as all businesses focusing on products and services aim to provide a pleasant experience for their customers. As customer satisfaction increases, the intention to repurchase also grows. Additionally, greater customer satisfaction correlates with a higher intention to repurchase.

Ho *et al*. (2023) examined the benefits of market orientation in the agricultural value chain of an emerging economy. Data from 190 actors in the cattle value chain in the central highlands of Vietnam were analyzed in this study to assess the relationship between market orientation and innovation. Results show that market orientation does not have a significant relationship with performance. However, customer orientation and inter-functional coordination positively correlate with innovation which in turn is positively associated with financial performance. The results offer insights into the relationships among market orientation, innovation and performance in agricultural value chains in developing economies.

Acosta *et al.* (2018) investigated the internationalization of SMEs to analyze the impact of international market orientation, network capabilities and international entrepreneurship approach on the international performance of these businesses. In particular, both direct influences of explanatory variables on international performance and the dependencies among them were examined. Results derived from a study of 161 Mexican SMEs utilizing SEM-PLS analysis demonstrate that network capabilities have a positive impact on the international performance of these companies and international entrepreneurship approach, but not by international market orientation. Similarly, there exist relationships and dependencies among the explanatory variables of international performance for SMEs, where a positive impact of the international entrepreneurship approach on network capabilities and international market orientation of SMEs is observed.

Bhattarai *et al.* (2018) investigated whether the access to certain business approaches such as market orientation and market agility contributes to both the economic and social performance of social enterprises. Their study, which drew on empirical data from 162 social enterprises in the UK, show that market orientation enhances both social and economic performance simultaneously. In contrast, market disruption capability improves only economic performance and not social performance. Nevertheless, they discovered a positive interaction between market disruption and market orientation regarding social performance, while the effect on economic performance was negative.

Mansourian and Taghi Nasab (2023) explored the link between marketing agility and economic performance in market turbulence. The study was applied in terms of its objective, survey-based in terms of method and descriptive in nature. The study's population included 35 companies listed on the Tehran Stock Exchange that operate in the automotive and parts manufacturing sectors. Using the Morgan-Krejcie table, a sample of 370 individuals was randomly selected. Data analysis was carried out with the assistance of SPSS and SMART PLS statistical software. The hypothesis test results indivated a significant positive correlation between marketing agility and economic performance, taking into account various levels of market turbulence. Marketing agility significantly and positively affects economic performance.

Additionally, there exists a significant positive correlation between marketing agility and innovation capability which in turn significantly influences economic performance. Market turbulence moderates the relationship between marketing agility and financial performance but does not moderate the relationship between marketing agility and innovation capability or the relationship between innovation capability and financial performance.

Afsharfar (2022) examined the impact of market orientation and marketing capabilities on financial performance, considering the moderating role of innovation. This study, in terms of purpose, is applied, and in terms of data collection, is a descriptive survey. A questionnaire was used as the data collection tool, developed through library and field studies. The statistical population consisted of 412 employees of Hekmat Bank, from which 200 were selected as the sample using Cochran's formula. The sampling method was stratified random sampling. In this research, market orientation and marketing capabilities were the independent variables, financial performance was the dependent variable, and innovation was the mediating variable. The questionnaire was standardized, and after confirming its validity (content) and reliability (Cronbach's alpha), it was distributed among the statistical population. The results from structural equation modeling in the LISREL software environment showed a significant positive impact of market orientation and marketing capabilities on the financial performance of Hekmat Bank. Additionally, innovation moderated the effect of market orientation on financial performance.

Dehdar (2022) examined the relationship between marketing performance and financial performance and marketing strategy in private medical clinics in Isfahan. The questionnaire was used to gather data, and the validity of the instrument was established by a Cronbach's alpha of 0. 85. The data was analyzed with the help of structural equation modeling and LISREL software to test the hypotheses and all the components of the research were measured on a five-point Likert scale. Since it is an applied study, this research was done using the descriptive survey research method. The statistical population included all the customers of private medical clinics in Isfahan in the spring of 2021. The sampling method adopted in the study was random and easy to access. The results of the research indicated that marketing performance and marketing strategy have a positive effect on financial performance.

Javidi and Broomand (2019) conducted a study titled "The relationship between international marketing strategies and international experience with export performance (Case study: Zohreh Tarshiz Tile Company)." They found a significant relationship between international marketing strategies, international experience, and export performance, confirming the main hypothesis of the research. The subsidiary hypotheses also showed that international marketing strategies and international experience are significantly related to export performance. Furthermore, the impact of international marketing strategies on export performance was found to be greater than that of international experience, with all three subsidiary hypotheses confirmed.

Research methodology

In terms of its objective, this study is applied research and falls under the category of descriptive-correlational research in data collection. Additionally, it follows a deductive-inductive reasoning approach. Given that the data was gathered for a specific time frame, the analysis follows a cross-sectional method, and the data analysis method is based on path analysis. For this purpose, a questionnaire was used as the data collection tool. The analysis dimension is also descriptive-correlational, utilizing quantitative methods. Data collection was carried out in two ways. Initially, relevant information on the research variables (literature review) was extracted from reputable domestic and international databases such as Noormags,

Ganj, Civilica, SID, IranDoc, Emerald, Elsevier, Web of Science, etc., using note-taking techniques. In the field section, marketing data (sales promotion, market management, and market share) was collected through the standardized questionnaire of Santos *et al.* (2022), which contains 17 questions. Financial performance data was collected using the standardized financial performance questionnaire by Touni *et al.* (2020), which included 8 questions and was distributed to the sample population.

Statistical population, sampling method, and sample size

The statistical population includes all marketing managers, financial managers, and senior staff of ornamental plant-producing companies in 2024. The sample size will be calculated based on the Klein and Jackson (2011) formula. In confirmatory factor analysis (CFA), the sample size is determined based on the factors rather than the variables. If structural equation modeling (SEM) is used, about 20 samples are needed for each factor (latent variable). The recommended sample size for CFA is about 200 samples for ten factors. According to Klein's criteria, for each questionnaire item, at least 5 to 25 subjects are needed. Since the questionnaire contains 25 questions and 5 subjects are needed for each item, the sample size amounts to 125 individuals. The sampling method is simple random sampling.

RESEARCH FINDINGS

Descriptive statistics

In order to get acquainted with the characteristics of the statistical sample, the demographic data of the research participants are provided in table 1.

Table 1. Demographic characteristics of respondents.

Index	Frequency	Percentage
Gender		
Male	117	93.6%
Female	8	6.4%
Total	125	100%
Education		
Bachelor's degree	24	19.2%
Master's degree	97	77.6%
PhD and PhD student	4	3.2%
Total	125	100%
Work experience		
Up to 5 years	13	10.4%
6 to 10 years	18	14.4%
11 to 15 years	32	25.6%
Over 16 years	62	49.6%
Total	125	100%
Age		
Up to 30 years	15	12%
31 to 40 years	84	67.2%
Over 41 years	26	20.8%
Total	125	100%

The descriptive statistics on gender showed that 8 of the respondents were women while 117 were men, which means that the data collected mostly focused on men. With regards to education, 24 participants had a bachelor's degree, 97 had a master's degree, and 4 had a PhD, which indicates that the majority of the collected data was from participants with a master's degree. As for work experience, 13 participants had no more than 5 years of work experience, 18 had 6-10 years of work experience, 32 had 11-15 years, and 62 had more than 16 years of work experience. Concerning age, the study showed that 15 participants were below 30 years, 84 participants were between 31-40 years, and 26 participants were above 41 years.

Hypothesis testing

To assess the reliability of the measurement model, convergent validity and discriminant validity were examined using confirmatory factor analysis (CFA) and average variance extracted (AVE). The confirmatory approach evaluates the consistency of the data with a specific factor structure. In fact, CFA examines the validity of the items selected to represent the latent variable or construct. CFA is essentially an extension of traditional factor analysis and is a critical aspect of structural equation modeling (SEM), in which specific hypotheses about the structure of factor loadings are tested. According to Fornell and Larcker's (1981) criteria, factor loadings greater than 0.50 are considered to have acceptable validity. Moreover, the average variance extracted between constructs should be equal to or greater than 0.50. Based on the results of this study, all factor loadings are at least 0.70, thereby fully confirming the convergent validity of the data in this section. Additionally, the statistical t-values for all variables are above 1.96, indicating their significant influence on the corresponding constructs. As shown in table 2, the average variance extracted for all variables exceeds 0.50 and is within acceptable limits, thereby confirming the convergent validity of the constructs in this section as well. Moreover, the composite reliability and Cronbach's alpha coefficients obtained for all constructs indicate that the measurement models' internal consistency is satisfactory.

Table 2. Convergent validity and reliability.

Dimension	AVE	Composite reliability	Rho	Cronbach's alpha
Sales promotion	0.875	0.977	0.980	0.970
Market share	0.863	0.974	0.981	0.966
Financial performance	0.772	0.963	0.983	0.952
Market management	0.971	0.994	0.993	0.993

The present research assessed discriminant validity using the Fornell and Larcker (1981) procedure. In this method, discriminant validity is achieved if the square root of the AVE of each construct is greater than the correlation between that construct and other constructs. Table 3 presents the result of the average variance extracted test of the constructs. The diagonal values are the square root of the AVE values.

Table 4 shows the R2 value of the latent variables of the model that defines the impact of independent variables on the dependent variables. According to these findings, 7. It shows that sales promotion, market management, and increased market share contribute to 68.7% variations in financial performance.

Table 3. Average variance between constructs (discriminant validity test).

Constructs	Sales promotion	Market share	Financial performance	Market management
Sales promotion	0.936			
Market share	0.544	0.929		
Financial performance	0.667	0.480	0.879	
Market management	0.348	0.472	0.681	0.986

Table 4. R2 values for the research model.

Dimensions	R-squared	Adjusted R-squared
Financial performance	0.687	0.686

The examination of the values in table 5 shows that none of the Q2 values are negative, and the minimum required values for prediction have been met.

Table 5. Goodness-of-fit indices.

Dimensions	CV. communality (Q2)	CV. redundancy (Q2)
Sales promotion	0.772	.....
Market share	0.761	.....
Financial performance	0.671	0.701
Market management	0.869	.....

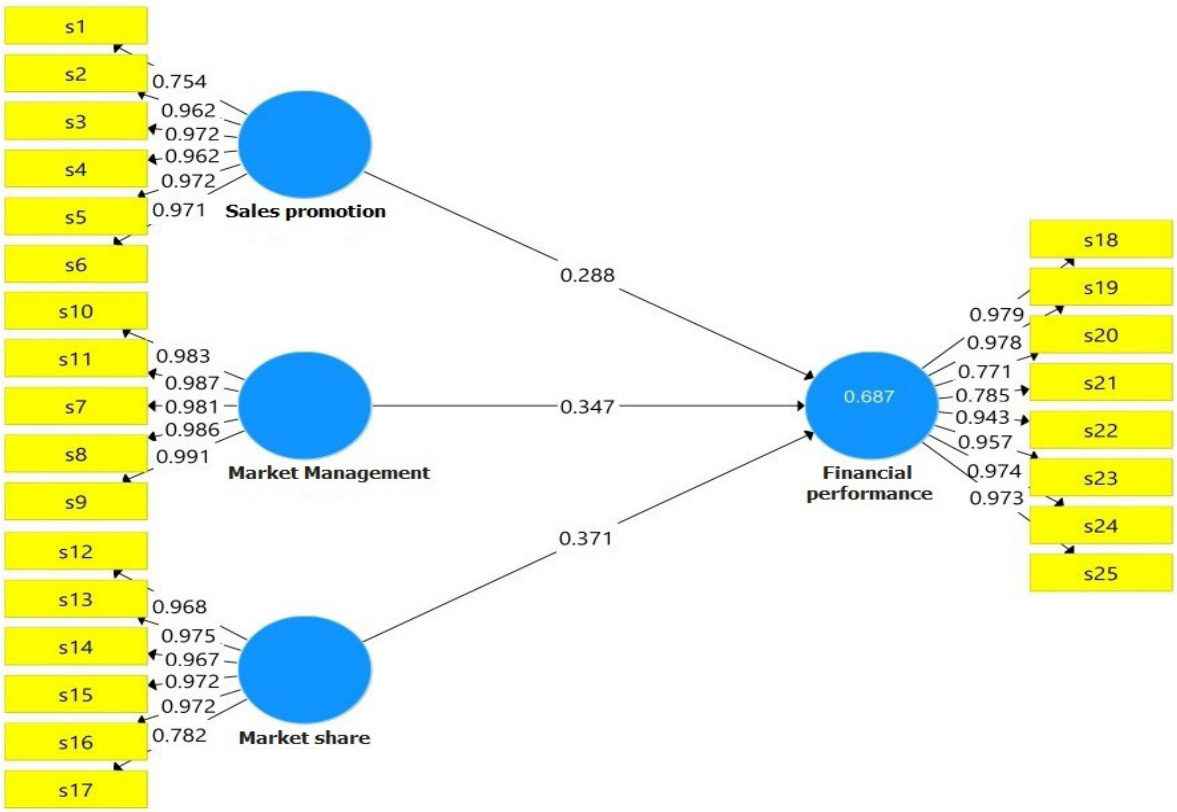

Fig. 1. Path coefficients in the research model.

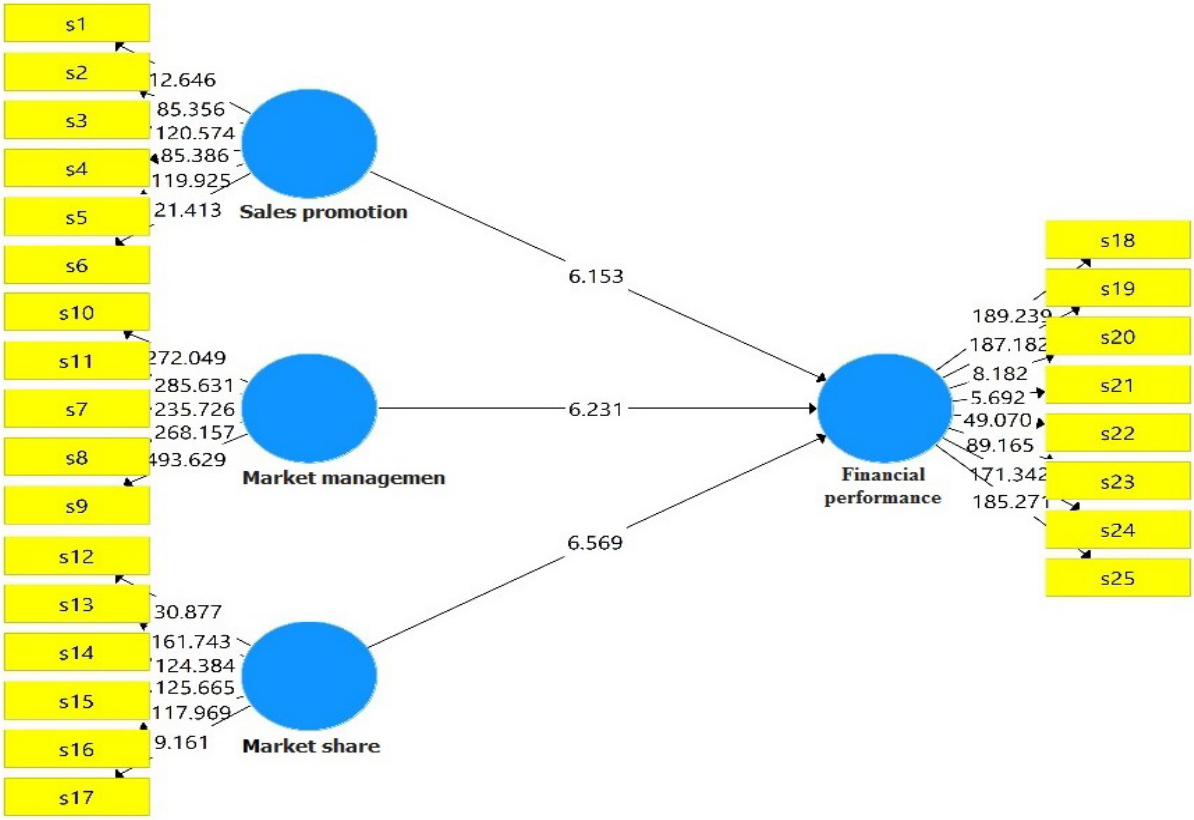

Fig. 2. T-statistics values of the model.

This section analyzes the research hypotheses using path coefficients and t-statistics. In other words, if the t-statistic of a given path is greater than 1.96, it means that the path is significant and the hypothesis is accepted at a 5 percent error level.

Table 6. Results of the hypothesis testing.

Hypothesis	Variable		Path coefficient	T-statistic	Significance level	Result
	Independent variable	Dependent variable				
1	Sales promotion	Financial performance	0.288	6.153	0.000	Confirmed
2	Market management	Financial performance	0.347	6.231	0.000	Confirmed
3	Market share	Financial performance	0.371	6.569	0.000	Confirmed

The results for the first hypothesis, which examines the effect of sales promotion on the financial performance of ornamental plant producers, show that the standardized path coefficient of the sales promotion – financial performance relationship is 0.288, t=6.153, and it is highly significant at 95% level of confidence. Therefore, it can be said that the use of sales promotion has a positive and significant impact on the financial performance of the ornamental plant producers.

Hypothesis 2: The findings for the second hypothesis that tests the relationship between market management and financial performance of the ornamental plant producers show that the standardized path coefficient for the market management to financial performance is 0.347, and the t-statistic is 6.231 which is relatively high and therefore the null hypothesis is rejected at 95% level of confidence. Therefore, the findings reveal market management as a significant and positive determinant of the financial performance of these producers.

Hypothesis 3: The results of the third hypothesis, which determines the connection between market share and the financial performance of the ornamental plant producers, show that the standardized path coefficient between the market share and the financial performance is equal to 0.371, whereas the t-statistic is 6.569 and thus the 95% level of confidence can be regarded as significant. Consequently, this research established that market share has a positive and significant relationship with the financial performance of the ornamental plant producers.

DISCUSSION AND CONCLUSION

The average income per country from the export of ornamental plants is estimated to be 60 billion dollars per year, while our country earns only 5 million dollars. On the other hand, India and Turkey, for example, make 5 billion and 3 billion dollars from the export of flowers and plants. It is only possible to achieve and sustain a competitive advantage in the current market environment through the application of contemporary marketing techniques. One of them is relationship marketing, which involves direct interaction with the customer to understand their needs and, thus, develop a competitive edge (Santos *et al*., 2022).

This study focused on the effect of sales promotion, market control, and market share of the ornamental plant producers on their financial outcomes. The findings of the study also indicated that the independent variables, namely sales promotion, market management, and increased market share, have a positive and significant relationship with the financial performance of the ornamental plant producers.

Financial performance is one of the key issues that managers of economic units are interested in. Managers want their companies to perform better, so they use new techniques. Many factors affect the financial position of the companies, and every company attempts to choose the right strategies to enhance the business. The degree of development of countries, the recognition of methods, the willingness of managers to use certain methods, and the availability of tools to support these methods in organizations are some of the factors that determine the advantage of a particular method (Garanti and Kissi, 2019).

Over the past few decades, management experts' main concerns have been identifying factors that influence financial performance and finding ways to improve it. Significant efforts have been made in this regard, resulting in valuable findings. Company managers and experts are particularly interested in financial performance data. They assess the company's position using financial ratios and make decisions based on this evaluation. Companies must adapt to the complexities of today's world to cope with environmental turbulence (Brodie *et al*., 2011; Hollebeek *et al*., 2014).

Today's organizations are required to use and adopt new management systems to be relevant in the market. One of the most important approaches is the improvement of their marketing skills. Marketing capability is a coordinated set of activities that apply organizational knowledge, skills, and resources to satisfy market demands and facilitate firms' value creation. Another definition states that marketing capabilities refer to certain organizational skills that enable a firm to offer a better market understanding of customer and channel management in global markets (Aydin *et al*., 2023).

Based on the above findings, it is suggested that marketing should be accepted as a strategy for the implementation of organizational programs. All companies should cultivate a strategic marketing plan according to the company's position and resources to enhance financial performance. Producers of ornamental plants are encouraged to gain deep insight into various market segments, analyze their market niche in certain periods, and adjust to the customers. Thus, they can improve their financial performance if they increase their market knowledge.

The marketing and sales managers of ornamental plant producers should increase their marketing capacity by advertising widely and stressing their competitive advantage. Managers of hotels are also urged to place emphasis on the quality of the services offered as a way of enhancing the market capacity of their organizations for the benefit of their firms' financial health.

This research's main weakness is using questionnaires in data collection. Perhaps the most severe drawback of a questionnaire is the respondents' comprehension, interpretation, and analysis of the subject. Further research could be done on the real-life application of each theory in an effort to increase the market share of ornamental plant producers. Further, the social, political, cultural, and geographical factors may affect the financial performance of these companies. Thus, it is recommended that these factors should be taken into account in further research.

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بررسی تأثیر ارتقای فروش، مدیریت بازار و افزایش سهم بازار گیاهان زینتی بر عملکرد مالی شرکت‌های تولیدکننده

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چکیده

ارزیابی عملکرد مالی به بازاریابان اجازه می‌دهد میزان سهم خود را در تغییرات ارزش شرکت مورد اندازه‌گیری و ارزیابی قرار دهند؛ بنابراین بررسی چگونگی اثرگذاری بازاریابی بر عملکرد مالی تولید کنندگان گیاهان زینتی، مسأله‌ای حائز اهمیت می‌باشد. هدف از پژوهش حاضر، بررسی تأثیر ارتقای فروش، مدیریت بازار و افزایش سهم بازار گیاهان زینتی بر عملکرد مالی شرکت‌های تولید کننده بود. تحقیق حاضر از نظر هدف یکی از تحقیقات کاربردی بوده و از نظر جمع‌آوری داده‌ها توصیفی و از نوع پیمایشی است. برای جمع‌آوری اطلاعات از پرسشنامه‌های استاندارد استفاده شد. جامعه آماری تحقیق حاضر کلیه مدیران بازاریابی، مدیران مالی و کارکنان ارشد شرکت‌های تولید کننده گیاهان زینتی در سال ۱۴۰۳بودند. با استفاده از فرمول کلاین و جکسون برای معادلات ساختاری، نمونه آماری تحقیق تعداد ۱۲۵نفر به صورت تصادفی ساده انتخاب شد. با استفاده از معادلات ساختاری و نرم‌افزار Smart PLS3 فرضیه‌های تحقیق مورد آزمایش قرار گرفت و نتایج آزمون فرضیه‌ها نشان داد ارتقای فروش، مدیریت بازار و افزایش سهم بازار بر عملکرد مالی تولید کنندگان گیاهان زینتی تأثیر مثبت و معنی‌داری دارد. بر اساس این نتایج می‌توان بیان داشت در محیط پیچیده، پویا و بسیار متغیر امروزی، تولیدکنندگان گیاهان زینتی نیازمند طراحی و اتخاذ استراتژی‌هایی هستند که بتوانند آن‌ها را در بهبود روز افزون عملکردشان یاری رساند و به‌عبارت دیگر، مدیران این شرکت‌ها حاصل تصمیم‌گیری‌های خود را در قالب انتخاب استراتژی‌هایی همچون ارتقای فروش، مدیریت بازار و افزایش سهم بازار، در آیینه معیارهای عملکرد مالی مشاهده خواهند نمود.

کلید واژه‌ها: عملکرد مالی، افزایش سهم بازار، مدیریت بازار، گیاهان زینتی، ارتقای فروش.

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پاسخ مورفوفیزیولوژیکی گیاه ژینورا (*Gynura aurantiaca*) به کاربرد اسید هیومیک و ورمی‌کمپوست

لی لی فاتح نژاد*[1] و ابوالفضل جوکار[1]

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چکیده

این مطالعه به بررسی تأثیر اسید هیومیک و ورمی‌کمپوست به‌عنوان کودهای طبیعی خاک بر ویژگی‌های مورفوفیزیولوژیکی گیاه *G. aurantiaca* می‌پردازد. برای تعیین تأثیر این مواد در دوزهای مختلف بر رشد و فعالیت آنزیم آنتی‌اکسیدانی ژینورا، از ورمی‌کمپوست (۰، ۲، ٤ و ٦ درصد) و اسید هیومیک (۰، ۰/۲۵، ۰/۵، ۱ گرم بر کیلوگرم) در خاک استفاده شد. خصوصیات مورفولوژیکی *G. aurantiaca* شامل طول ساقه، سطح برگ، قطر ساقه، وزن ریشه‌ها و اندام هوایی تازه و خشک و خصوصیات فیزیولوژیکی و بیوشیمیایی آن شامل میزان کلروفیل a، b و کل مواد جامد محلول و فعالیت آنزیم‌های آنتی‌اکسیدانی مورد مطالعه قرار گرفت. آزمایش به‌صورت فاکتوریل در قالب طرح کاملاً تصادفی با سه تکرار در گلخانه تحقیقاتی دانشگاه شیراز در سال ۱۳۹۸ انجام شد. گیاهان تیمار شده با اسید هیومیک ۰/۵ گرم بر کیلوگرم در ترکیب با ورمی‌کمپوست ٦ درصد باعث افزایش وزن خشک ریشه شدند. ۱ گرم در کیلوگرم اسید هیومیک به همراه ٦ درصد ورمی‌کمپوست باعث افزایش سطح برگ، قطر ساقه، قطر برگ، ارتفاع بوته، وزن تر ریشه، وزن تر اندام هوایی، وزن خشک اندام هوایی و همچنین فعالیت آنزیم‌های آنتی‌اکسیدانی پراکسیداز و کاتالاز شد. میزان کلروفیل a، b و کل بهبود یافته در گیاهان تیمار شده با ۰/۵ گرم بر کیلوگرم اسید هیومیک در ترکیب ٤ درصد ورمی‌کمپوست مشاهده شد. این نتایج نشان می‌دهد که مصرف همزمان اسید هیومیک و ورمی‌کمپوست برای بهبود رشد گیاهان ژینورا قابل توصیه است.

کلید واژه‌ها: فعالیت آنزیم آنتی‌اکسیدانی، کود زیستی، میزان کلروفیل، کشاورزی پایدار.

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رشد و ویژگی‌های کیفی هجده گیاه پوششی زینتی در شرایط اقلیمی گرگان، ایران

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چکیده

با توجه به کمبود منابع آبی در بسیاری از شهرهای ایران و استفاده قابل توجه از آب توسط چمن، بررسی امکان‌سنجی کاهش سطح چمن و گسترش فضای سبز با کاشت گیاهان پوششی، رویکردی منطقی برای دستیابی به فضای سبز پایدار است. گیاهان پوششی جذابیت بصری متنوع و طبیعی‌تری نسبت به علف‌ها ارائه می‌دهند. یک نکته ضروری در طراحی فضای سبز، انتخاب گیاهانی است که به خوبی به تغییرات فصلی در اقلیم‌های مختلف پاسخ می‌دهند. مطالعه حاضر با هدف ارزیابی ۱۸ گیاه پوششی در شرایط اقلیمی گرگان ایران در طول یک سال (چهار فصل) انجام شد. صفات اندازه‌گیری شده شامل کیفیت ظاهری، کلروفیل b ،a و کل، محتوای کاروتنوئید و درصد رشد گیاه بود. مقایسه میانگین داده‌ها نشان داد که بیشترین و کمترین میزان رشد در طول چهار فصل به‌ترتیب در ناز دم عقربی (*Carpobrotus acinaciformis*) و فستوکا (*Festuca ovina*) مشاهده شد. ناز دم عقربی بالاترین سطوح کلروفیل a، b و کل را نشان داد. عود قرمز (*Alternanthera bettzickiana*) بالاترین محتوای کاروتنوئید را در برگ‌های خود نشان داد و پس از آن *Frankenia thymifolia* قرار داشت. بهترین کیفیت بصری برای مینا آفریقایی (*Osteospermum ecklonis*) در بهار بود و به دنبال آن فرانکنیا (*Frankenia thymifolia*)، پلکرانتوس (*Plectranthus australis*) و چمن طلایی (*Lysimachia nummularia*) قرار گرفتند. این تحقیق نشان داد که از ۱۸ گیاه پوششی مورد بررسی، مناسب‌ترین گونه‌ها برای فضاهای سبز شهری گرگان در زیر نور کامل خورشید و بدون سایه عبارتند از: فرانکنیا، مینا آفریقایی، لیریوپ (*Liriope muscari*)، سدوم (*Sedum reflexum*)، اطلسی مکزیکی (*Ruellia tweediana*)، ناز دم عقربی و عود قرمز. علاوه بر این، گیاهانی مانند برف تابستانه (*Cerastium tomentosum*)، فالاریس (*Phalaris arundinacea*) و چمن طلایی که به دلیل نور شدید تابستان در تابستان، زردی و کاهش رشد و کیفیت ظاهری را از خود نشان می‌دهند، اگر در مناطق سایه‌دار کشت شوند، احتمالاً در فضای سبز شهری گرگان رشد می‌کنند.

کلید واژه‌ها: اقلیم، گیاهان پوششی، فضای سبز، منظر.

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تأثیر سطوح مختلف اکسین، سیتوکینین و جیبرلین بر رشد، ترکیبات فنلی و فعالیت آنزیم‌های آنتی‌اکسیدانی گیاه اپونتیا سیلندریکا

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چکیده

کاکتوس‌ها یکی از مهم‌ترین و متنوع‌ترین خانواده گیاهی هستند که در سراسر دنیا برای اهداف مختلفی از جمله خوراکی، دارویی، آرایشی و زینتی کشت می‌شوند. تحقیق حاضر به‌منظور بررسی رشد و تغییرات فیزیولوژیکی کاکتوس اپونتیا سیلندریکا تحت تیمار هورمون‌های اکسین، سیتوکینین و جیبرلین در غلظت‌های ۲۵۰، ۵۰۰ و ۱۰۰۰ میلی‌گرم بر لیتر به‌صورت طرح کاملا تصادفی در سال ۱۳۹۹ در گلخانه دانشگاه آزاد اسلامی واحد گرگان انجام شد. تیمار اکسین نه تنها تغییر معنی‌داری بر وزن تر و ارتفاع قلمه‌های کاکتوس ایجاد نکرد، تاثیر معنی‌داری بر میزان رنگدانه‌ها، قند و پروتئین محلول، ترکیبات فنولیک به استثنا فلاونوئیدها و فعالیت آنزیم‌های فنیل آلانین‌آمونیالیاز و سوپراکسیددیسموتاز نیز نداشته است. اما تیمار کاکتوس با سیتوکینین باعث افزایش معنی‌دار وزن تر، میزان پروتئین محلول، ترکیبات فنولیک (فنل کل و فلاونوئیدها) و همچنین فعالیت آنزیم‌های فنیل‌آلانین‌آمونیالیاز، سوپراکسیددیسموتاز و پراکسیداز شد. تیمار جیبرلین باعث کاهش وزن تر به میزان ۱۴ و ۲۳ درصد و کاهش چشمگیر میزان رنگدانه کلروفیل a به میزان ۳۱ و ۷۰ درصد و کلروفیل b به میزان ۳۷ و ۶۸ درصد و فعالیت آنزیم پراکسیداز به میزان ۶۰ و ۵۰ درصد به‌ترتیب در غلظت‌های ۵۰۰ و ۱۰۰۰ میلی‌گرم بر لیتر شد. درحالیکه میزان ترکیبات فنولیک و فعالیت آنزیم‌های فنیل‌آلانین‌آمونیالیاز و سوپراکسیددیسموتاز افزایش معنی‌داری یافت. به‌نظر می‌رسد که سیتوکینین در غلظت‌های ۵۰۰ و ۱۰۰۰ میلی‌گرم بر لیتر به‌عنوان بهترین غلظت باعث تقویت رشد کاکتوس اپونتیا سیلندریکا با ظرفیت فنلی و آنتی‌اکسیدانی بالا شد. در مقابل کاهش وزن تر و میزان کلروفیل‌ها در قلمه‌های کاکتوس تیمار شده با جیبرلین حکایت از وجود استرس در گیاه داشت که افزایش میزان ترکیبات فنولیک و فعالیت آنزیم‌های آنتی‌اکسیدانی مخصوصا در غلظت‌های ۵۰۰ و ۱۰۰۰ میلی‌گرم بر لیتر احتمالا باعث تعدیل استرس شد.

کلید واژه‌ها: سیستم‌های آنتی‌اکسیدانی، رشد، هورمون، اپونتیا سیلندریکا، پارامترهای فیزیولوژیک.

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بررسی ادراک زیبایی‌شناختی شهروندان در طراحی فضای سبز شهری: بررسی پراکندگی درختان و درختچه‌های زینتی در بوشهر، ایران

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چکیده

گسترش و احیای فضاهای سبز شهری نشان‌دهنده یک تقاضای اجتماعی رو به رشد در میان شهروندان کشورهای در حال توسعه است. اگرچه، در ایران این تلاش‌ها با چالش‌های قابل‌توجهی به‌دلیل مناطق خشک کشور و افزایش انتظارات مردم از کیفیت بصری و محیطی مواجه است. انتخاب گونه‌های درختی در طراحی منظر شهری نقش مهمی در شکل‌دهی جنبه‌های زیبایی‌شناختی، احساسی و محیطی مناطق شهری دارد. برای ارزیابی تأثیر درختان و درختچه‌های زینتی در فضای شهری بوشهر، نظرسنجی مبتنی بر پرسشنامه با نمونه آماری ۲۰۰ شهروند بوشهری با تمرکز بر پنج گونه *Bougainvillea* sp., *Ficus elastica*, *Conocarpus erectus*, *Clerodendrum inerme* و *Dodonea viscosa* انجام شد. تجزیه و تحلیل نشان داد که "احساس عاطفی" و "زیبایی محیطی درک شده" ۹/۷۰ درصد از تنوع ادراک زیبایی‌شناختی جامعه را تشکیل می‌دهند. علاوه بر این، آزمون ناپارامتریک فریدمن تفاوت‌های قابل‌توجهی را در درک زیبایی‌شناختی جامعه از درختان مورد مطالعه، با پاسخ‌دهندگان به زیبایی‌شناختی بالاتر در *Bougainvillea* sp. و *F. elastica* نشان داد. انتخاب مؤثر گونه‌های گیاهی برای فضاهای سبز شهری نه تنها جذابیت بصری را افزایش می‌دهد، بلکه تأثیر مثبتی بر رفاه عاطفی افراد نیز دارد. این امر مستلزم بررسی کامل عوامل محیطی و واکنش‌های احساسی است. با ادغام این مفاهیم در طراحی، همراه با افزایش آگاهی از گونه‌های مناطق خشک، می‌توان تا حدی رضایت از فضاهای شهری را افزایش داد.

کلید واژه‌ها: زیبایی‌شناختی، درختچه‌ها، درختان، فضای سبز شهری.

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تبیین عملکرد اقتصادی تولیدکنندگان گیاهان زینتی با توجه به مدیریت برند و پویایی بازار

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چکیده

عدم قطعیت و پویایی در بازارهای رقابتی، تولیدکنندگان گیاهان زینتی را مجبور می‌کند نسبت به رویکردهای خود جهت بهبود عملکرد اقتصادی شرکت تجدید نظر کنند. کلید دستیابی و حفظ عملکرد اقتصادی در اختیار داشتن و توسعه منابع منحصر به فرد است که تقلید از آن توسط سایر شرکت‌های دیگر دشوار باشد. هدف از پژوهش حاضر، تبیین عملکرد اقتصادی تولیدکنندگان گیاهان زینتی با توجه به مدیریت برند و پویایی بازار بود. تحقیق حاضر از نظر هدف یکی از تحقیقات کاربردی بوده و از نظر جمع‌آوری داده‌ها توصیفی و از نوع پیمایشی است. برای جمع‌آوری اطلاعات از پرسش‌نامه‌های استاندارد استفاده شد. جامعه آماری تحقیق حاضر کلیه مدیران بازاریابی، مدیران مالی و کارکنان ارشد شرکت‌های تولید کننده گیاهان زینتی در سال ۱۴۰۳ بودند. با استفاده از فرمول کلاین و جکسون برای معادلات ساختاری، نمونه آماری تحقیق به تعداد ۱۲۵ نفر به‌صورت تصادفی ساده انتخاب شد. با استفاده از معادلات ساختاری و نرم‌افزار Smart PLS3 فرضیه‌های تحقیق مورد آزمایش قرار گرفت و نتایج آزمون فرضیه‌ها نشان داد مدیریت برند و پویایی بازار بر عملکرد اقتصادی تولید کنندگان گیاهان زینتی تأثیر مثبت و معنی‌داری دارد. بر اساس این نتایج می‌توان بیان داشت مدیران شرکت‌ها حاصل تصمیم‌گیری‌های خود را در قالب انتخاب استراتژی، در آینه معیارهای عملکردی مشاهده خواهند نمود. تجزیه وتحلیل و مقایسه عملکرد مشاهده شده با روند گذشته، رقبا و یا متوسط صنعت بازخورد مناسبی را جهت تصمیم‌گیری و انجام فعالیت‌های آتی فراهم می‌آورد. به همین دلیل یکی از مهمترین اهداف تمامی شرکت‌ها در طول زمان، بهبود مستمر عملکرد بوده است. علاوه بر آن شرکت‌ها باید نسبت به رقبا در ایجاد هماهنگی بین اعضای زنجیره و تجزیه وتحلیل بازار و پاسخ به نیازهای آن پیش دستی کنند و این مهم را می‌توانند با توسل به استراتژی‌های بازاریابی و قابلیت‌های آن انجام دهند.

کلید واژه‌ها: مدیریت برند، پویایی بازار، عملکرد اقتصادی، گیاهان زینتی، تقاضا.

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