

Perception towards plant growth regulators among vegetable growers in Junagadh district of Gujarat, India

ABSTRACT

Plant growth regulators (PGRs) are chemical substances that govern various aspects of development and growth in plants. The application of PGRs to crops can modify hormonal balance and growth, leading to increased yield, enhanced crop tolerance to abiotic stress, and improved physiological traits. This study examines farmers' perceptions of PGRs in vegetable cultivation. Using a multi-stage sampling technique, two talukas in the Junagadh district, namely Junagadh and Vanthali, were purposefully selected. From each taluka, 40 farmers were sampled, resulting in a total of 80 farmers. The weighted average index (WAI) was employed to analyze the results. The findings revealed that the majority of farmers in Junagadh held an overall positive perception of plant growth regulators (PGRs) in vegetable cultivation, particularly appreciating their impact on vegetable size, packaging convenience, and return on investment. However, concerns about cost, online availability and the perceived benefits related to disease resistance and sustainability highlight areas for improvement. Addressing these issues through improved education, cost management and better distribution could increase PGR adoption and overall satisfaction.

Keywords: Plant growth regulators, vegetable, perception and weighted average index

1. INTRODUCTION

Food security is a major concern worldwide due to the rapid growth of the human population. To meet up the demand for food of the growing population, it is necessary to increase the productivity of agriculture. Productivity growth in agriculture has been closely related to the increased use of chemical inputs, such as various types of fertilizers and agro-chemicals [1].

Plant growth regulators (PGRs) have long been a crucial element in horticulture, offering effective means for both quantitative and qualitative improvements in crop growth and development through the complex and coordinated action of endogenous hormones. In modern agricultural practices, particularly in vegetable cultivation, PGRs hold significant potential for optimizing crop production. Understanding the perceptions of local vegetable growers towards PGRs in the Junagadh district of Gujarat, where agriculture is a primary livelihood and the unique climatic and soil conditions present specific challenges, is essential for promoting more effective and sustainable farming practices. This study's

detailed analysis is valuable for policymakers and agricultural extension services, as it guides the development of targeted interventions that address regional concerns and needs, thereby enhancing the relevance and applicability of the findings. The exploration of these perceptions is of significant importance to the scientific community as it provides critical insights into how agricultural inputs are received and utilized in specific regional contexts, allowing for more tailored and effective recommendations. By examining factors such as effectiveness, environmental impact, and economic considerations from the perspective of local growers, this research contributes to a deeper understanding of PGRs' role in sustainable agriculture [2].

The adoption and use of plant growth regulators (PGRs) among vegetable growers is influenced by various factors, including changing agricultural needs and market demands. Understanding these perceptions is essential for ensuring that the products and techniques used align with the growers' expectations and preferences. Vegetable growers, spanning

different age groups, income levels, and regions, often have diverse experiences and perceptions regarding the use of PGRs. Identifying and understanding these differences is crucial for improving the effectiveness and acceptance of these agricultural inputs. This study aims to explore the perceptions of vegetable growers towards plant growth regulators, focusing on areas where growers may have reservations or negative views. Given the complexity of agricultural practices and the diverse nature of the growers' backgrounds, understanding their perceptions can be challenging. However, gaining insights into these perceptions is vital for the development and promotion of PGRs that meet the specific needs and expectations of vegetable growers, ultimately contributing to the growth and sustainability of the agricultural sector [3].

Plant growth regulators (PGRs) are a diverse group of chemicals that significantly influence the growth and development of plants. In the realm of vegetable cultivation, PGRs have gained considerable attention due to their potential to enhance crop yields, improve quality, and manage growth under varying environmental conditions. Plant hormones are defined as organic compounds which regulate plant physiological processes regardless of whether these compounds are naturally occurring and/or synthetic; stimulating and/or inhibitory; local activators, or substances that act at a distance from the place where they are formed [4]. Farmers and researchers alike are exploring the benefits of PGRs in optimizing plant growth, enhancing stress tolerance, and reducing the time to market for vegetables. The perception of PGRs among vegetable cultivators varies, often shaped by factors such as economic considerations, environmental impact, and the level of scientific understanding. The evolving attitudes toward PGRs reflect a broader trend in agriculture towards sustainable practices and technological innovations. The role of plant growth regulators including both growth promoters and retardants, in crop production is a well-known phenomenon [5].

The response with growth regulators depends upon the amount of particular compound absorbed by the seed or plant and ability of seed or plant to respond to the stimulus of the chemical applied. It is however, believed that the mechanism of action of a growth regulator in plant through same fundamental process involving the activities of the cell and the enzyme concerned in the process. Scientists

have given due attention to the idea of regulating plant growth as an important factor in improving the growth, yield and quality parameters with the application of plant growth regulators in various ways. Its use in crop promotes growth along the longitudinal area, increase number of branches, early flower initiation, fruit set, fruit quality and subsequently contributes towards higher production when applied at various concentrations. The use of plant growth regulators has gained a separate field of study besides varietal, manurial and cultural methods of vegetable improvement [6].

Sial (2016) conducted study on farmers perception about effects of pesticides use in vegetables in taluka of Jaffarabad district concluded that 86.10 per cent farmers had low to medium level of perception. Whereas only 13.90 per cent farmers had high perception on adverse effects of pesticide [7]. Shashidhara (2017) conducted research on a study on farmer's perception on ill effects of agro chemicals in north eastern part of Karnataka result showed that positive and highly significant relationship between mass media exposure of farmer and their perception regarding ill effects of agro chemicals [8]. Badekhan and Devi (2018) observed that cotton farmers were found to have medium perception level. Most of the cotton farmers in the study area were not aware of the health hazards caused by the pesticides and also the consequences of their improper handling [9]. Mehmood *et al.* (2020) in his study pesticide residues, health risks, and vegetable farmers' risks, and vegetable farmers' risk perceptions in Punjab, Pakistan observed that the relationship of an education was highly significant correlated with farmers risk perception [10]. Meshram (2020) concluded that land holding of the vegetable growers had shown positive and significant relationship with perception of environmental effect of pesticides use [11]. Bessah *et al.* (2021) indicated that there were several differences in how climate change was perceived and tackled by male and female genders. In the perception of male farmers, for example, they were found to be more vulnerable to increased temperature, and changes in rainfall and growing season, whereas female farmers on average were considered to be less resilient to floods and droughts for different reasons [12]. Mairura *et al.* (2021) observed that, regarding farmers perceptions of climate variability, most farmers perceived that climate had changed during the preceding 10 years (81.00%), while only 19.00 per cent of the farmers did not report variations in climatic parameters during the same period

[13]. Ogunjinmi (2022) observed that majority 70.80 per cent of male farmers had high level of perception and the rest (29.20%) had low level of perception. In case of female farmers, majority 58.30 percent had high level of perception and the rest (41.70%) had low level of perception [14]. Sujianto *et al.* (2022) used the Weighted Average Index (WAI) to assess farmers' perceptions, revealing that ORF farmers rated aspects like higher prices (0.82) and an organic lifestyle (0.83) more positively. In contrast, conventional rice farmers showed lower ratings on yield (0.63), risk aversion (0.70), and cash compensation (0.62) [15]. Islam *et al.* (2023) found that most of the respondents use chemical pesticides in vegetable cultivation and they have a positive perception of chemical pesticide use. They found that education, farming experience, extension media contact, and knowledge about insect pest management have positive impact with the farmers' perception [1].

2. METHODOLOGY

2.1 Sampling design

The current experiment employed a multistage sampling approach to select the final sample units. In the first stage, the Junagadh district of Gujarat was purposefully selected due to the company's interest in establishing a market presence there, making it a relevant location for examining perceptions towards plant growth regulators among vegetable growers. In the second stage, the talukas of Junagadh and Vanthali within the district were chosen, also purposefully, based on the company's market development strategy. The third stage involved selecting villages from these talukas, with 8 villages from Junagadh taluka and 8 villages from Vanthali taluka randomly chosen to ensure a representative sample. Finally, in the fourth stage, 5 vegetable growers from each selected village who use plant growth regulators were purposively chosen to participate in the study. This resulted in a total of 40 farmers from Junagadh taluka and 40 farmers from Vanthali taluka, comprising a sample of 80 farmers across the district.

2.2 Analytical tools

2.2.1 Weighted Average Index (WAI)

The weighted average index (WAI) was employed to assess the farmers' perceptions

about plant growth regulators. The WAI formula is as follows

$$WAI = \sum SiFi/N$$

where the WAI is ($0 \leq WAI \leq 1$), S_i denotes the scale value assigned based on the response, F_i denotes the frequency of responses, and N denotes the total number of responses. The level of perception was measured on a five-point scale with varying weights. The degree was weighted as 1 for "Very Strong" (VS), 0.75 for "Strong" (S), 0.5 for "Medium" (M), 0.25 for "Weak" (W), and 0 for "Very Weak" (VW). Numerous studies have used this approach to examine farmers' perceptions and associated decision-making [16].

3. RESULT AND DISCUSSION

3.1 Weighted average index

The perception of farmers regarding plant growth regulators in vegetable cultivation was calculated by using weighted average index (WAI) as mentioned in the below Table 1.

In terms of quality, PGRs were perceived to significantly improve vegetable size (WAI: 0.81), indicating a strong belief in their positive impact on crop yield. Perceptions about disease resistance (WAI: 0.57) and taste enhancement (WAI: 0.54) were moderate, suggesting mixed views. The strong perception of shelf-life extension (WAI: 0.66) and color intensification (WAI: 0.72) highlights the role of PGRs in improving marketability. However, the moderate view on chemical usage reduction (WAI: 0.53) suggests that the sustainability benefits of PGRs are not fully recognized. PGRs often enhance vegetable growth by influencing hormone levels, which can lead to improved yield and quality traits, but their impact on reducing chemical usage depends on specific product formulations and farming practices.

For packaging, the durability (WAI: 0.71) and ease of dispensing (WAI: 0.69) were rated highly, indicating satisfaction with the product's usability. The very strong rating for convenient size (WAI: 0.87) suggests the packaging is well-suited for small-scale farmers. However, the moderate ratings for clear instructions (WAI: 0.55) and attractiveness (WAI: 0.57) point to areas where improvements could be made. Effective packaging is crucial for ensuring proper application and maintaining product efficacy, which can impact overall crop performance.

Regarding availability, PGRs were generally seen as readily available at local stores (WAI: 0.68) and consistently in stock during the growing season (WAI: 0.65). However, the weak perception of online availability (WAI: 0.38) highlights a gap in e-commerce infrastructure or awareness. The strong perception of difficulty in accessing PGRs in remote areas (WAI: 0.66) underscores a distribution challenge. Ensuring widespread availability and effective distribution channels is essential for maximizing the benefits of PGRs, particularly in underserved regions.

In the effectiveness category, PGRs were perceived to offer excellent returns on investment (WAI: 0.84) and facilitate efficient water usage (WAI: 0.70), indicating their economic and sustainability benefits. However, the moderate perception of cost (WAI: 0.47) and expense justification (WAI: 0.69) points to concerns about affordability and cost-effectiveness. Economically, PGRs can contribute to cost savings by enhancing crop productivity and resource use efficiency, but their perceived value can vary based on individual farming contexts and cost structures.

Under other factors, the perception of PGRs as environmentally friendly (WAI: 0.71) was strong, aligning with sustainable agriculture goals. However, the weak perception of PGRs enhancing marketability (WAI: 0.37) suggests that this benefit is not well recognized. The ease of use was rated strong (WAI: 0.68), indicating good user experience. Environmentally friendly PGRs can support sustainable farming practices by reducing the need for chemical inputs and promoting resource-efficient crop management.

The overall WAI of 0.64 indicates a strong perception of PGRs among vegetable growers in Junagadh. Key strengths include improvement in vegetable size, packaging convenience, return on investment, and environmental friendliness. However, there are moderate concerns about cost, accessibility in remote areas, and marketability enhancement. The weakest areas include the availability of online ordering and the perceived impact on marketability. The findings suggest a generally positive perception of PGRs, but addressing cost concerns, improving accessibility, and better communicating the benefits could enhance adoption and satisfaction. Additionally, further education on disease resistance and marketability benefits could improve perceptions and encourage broader use of PGRs.

The research on the perception towards plant growth regulators (PGRs) among vegetable growers in Junagadh district of Gujarat highlights both strengths and areas for improvement. The high weighted average index (WAI) scores for aspects such as vegetable size improvement and packaging convenience indicate that growers perceive PGRs as valuable tools for enhancing crop characteristics and ease of use. This positive perception aligns with the observed benefits of PGRs in increasing vegetable size and improving the user experience. However, concerns about the cost of PGRs and their limited online availability reflect potential barriers to broader adoption. These concerns suggest a need for targeted strategies to address cost issues and improve access, especially in remote areas.

The moderate perception regarding PGRs' effectiveness in disease resistance and sustainability underscores a gap in growers' understanding of these regulators' full potential. While PGRs are recognized for their immediate benefits, such as improved size and color of vegetables, their role in long-term sustainability and disease management may not be fully appreciated. Educational efforts focused on demonstrating the comprehensive advantages of PGRs, including their environmental and health benefits, could enhance their perceived value. Furthermore, improving online availability and distribution channels could help overcome accessibility issues and support wider adoption of PGRs among vegetable growers.

The findings of this research underscore the critical role of plant growth regulators (PGRs) in advancing vegetable cultivation in Junagadh. PGRs are essential for optimizing plant growth by manipulating hormonal pathways, which can lead to significant improvements in yield, quality, and overall plant health. For instance, the application of auxins can enhance root development, resulting in better nutrient uptake and stronger plants. Gibberellins, on the other hand, are known to increase fruit size and uniformity, while cytokinin's can improve shoot growth and extend the productive life of plants. The future use of PGRs in vegetable farming in Junagadh should focus on leveraging their ability to address environmental stresses and improve resource use efficiency. By enhancing drought tolerance and optimizing water use, PGRs can help mitigate the effects of variable weather conditions, which are particularly relevant for growers in regions with inconsistent rainfall. Additionally, PGRs can reduce reliance

on chemical inputs by promoting plant health and resilience, aligning with the broader goals of sustainable agriculture.

For future prospects, it is recommended that efforts be focused on improving the affordability and accessibility of plant growth regulators (PGRs), especially in remote areas and through online platforms, to enhance availability. Strengthening educational programs to clearly communicate the benefits of PGRs, particularly regarding disease resistance and marketability, will help address existing concerns and encourage broader adoption. Additionally, investing in the development of more user-friendly packaging and providing clear, comprehensive instructions can improve overall user satisfaction. Finally, promoting sustainable practices and highlighting the environmental benefits of PGRs can further align with the growing emphasis on eco-friendly agriculture.

UNDER PEER REVIEW

Table 1 Weighted average index (WAI) of perception of farmers about plant growth regulator in vegetable cultivation

Sr. No.	Statement	The frequency of perception level						WAI index					Total	WAI	Category
		No. of respondents=80						1	0.75	0.5	0.25	0			
		VS	S	M	W	VW	Total								
A. Quality															
1	Plant growth regulator improves vegetable size noticeably	35	33	10	1	1	80	35	24.8	5	0.3	0	65	0.81	Very strong
2	Plant growth regulator boosts disease resistance in vegetable crops	9	22	35	9	5	80	9	16.5	17.5	2.3	0	45.25	0.57	Medium
3	Plant growth regulator extends shelf life of vegetables positively	15	32	25	6	2	80	15	24	12.5	1.5	0	53	0.66	Strong
4	Plant growth regulator intensifies vegetable color, making them more appealing	19	33	28	0	0	80	19	24.8	14	0	0	57.75	0.72	Strong
5	Plant growth regulator enhances taste and flavor of vegetables	10	16	35	16	3	80	10	12	17.5	4	0	43.5	0.54	Medium
6	Plant growth regulator promotes overall health of vegetable plants	21	42	10	6	1	80	21	31.5	5	1.5	0	59	0.74	Strong
7	Plant growth regulator reduces chemical usage and enhances sustainability in vegetable cultivation	5	20	41	9	5	80	5	15	20.5	2.3	0	42.75	0.53	Medium
B. Packaging															
1	The packaging of Plant growth regulator is very strong and durable	20	33	21	5	1	80	20	24.8	10.5	1.3	0	56.5	0.71	Strong
2	The packaging is attractive and easy to identify	11	21	32	10	6	80	11	15.8	16	2.5	0	45.25	0.57	Medium
3	The packaging adequately protects the product from damage during transport and storage	16	33	23	6	2	80	16	24.8	11.5	1.5	0	53.75	0.67	Strong
4	The packaging material is environmentally friendly	14	36	23	5	2	80	14	27	11.5	1.3	0	53.75	0.67	Strong
5	The packaging includes clear instructions for use	10	12	44	12	2	80	10	9	22	3	0	44	0.55	Medium
6	The packaging design makes it easy to dispense the product	22	34	10	12	2	80	22	25.5	5	3	0	55.5	0.69	Strong
7	The packaging size is convenient for small-scale farming operations	43	32	5	0	0	80	43	24	2.5	0	0	69.5	0.87	Very strong
C. Availability															

1	Plant growth regulator is readily available at local agricultural stores	16	32	25	6	1	80	16	24	12.5	1.5	0	54	0.68	Strong
2	Always in stock during growing season	18	28	20	11	3	80	18	21	10	2.8	0	51.75	0.65	Strong
3	Availability is not affected by season changes	16	32	25	6	1	80	16	24	12.5	1.5	0	54	0.68	Strong
4	Plant growth regulator is available in different quantities to suit various farm sizes	12	10	31	25	2	80	12	7.5	15.5	6.3	0	41.25	0.52	Medium
5	I can order it online	8	6	17	36	13	80	8	4.5	8.5	9	0	30	0.38	Weak
6	Difficult to get in remote areas	18	24	31	5	2	80	18	18	15.5	1.3	0	52.75	0.66	Strong
7	Availability of the product is well-advertised through agricultural extension services	21	33	23	2	1	80	21	24.8	11.5	0.5	0	57.75	0.72	Strong
D. Effectiveness															
1	Investing in Plant growth regulator offers excellent returns on investment	41	29	8	2	0	80	41	21.8	4	0.5	0	67.25	0.84	Very strong
2	The cost of Plant growth regulator is prohibitively high for me	8	10	36	17	9	80	8	7.5	18	4.3	0	37.75	0.47	Medium
3	I find it difficult to justify the expense of using Plant growth regulator	20	30	22	7	1	80	20	22.5	11	1.8	0	55.25	0.69	Strong
4	Plant growth regulator facilitates efficient water usage, contributing to sustainable farming practices	18	35	23	2	2	80	18	26.3	11.5	0.5	0	56.25	0.70	Strong
5	Adoption of Plant growth regulator results in enhanced crop uniformity and consistency in yield	17	26	29	5	3	80	17	19.5	14.5	1.3	0	52.25	0.65	Strong
E. Others															
1	I believe Plant growth regulator is environmentally friendly	23	25	29	3	0	80	23	18.8	14.5	0.8	0	57	0.71	Strong
2	Using Plant growth regulator enhances the marketability of my vegetables	6	8	18	35	13	80	6	6	9	8.8	0	29.75	0.37	Weak
3	Applying Plant growth regulator is very easy and convenient	25	20	23	11	1	80	25	15	11.5	2.8	0	54.25	0.68	Strong
4	I make sure to follow all guidelines and regulations when using Plant growth regulator	12	15	39	11	3	80	12	11.3	19.5	2.8	0	45.5	0.57	Medium
Overall													51.18	0.64	Strong

(Source: Field Survey, 2024)

Note: *For perception level category, the fonts are to represent qualitative value, namely Very Strong (VS) = 0.8–1, Strong (S) = 0.6–0.79, Medium (M) = 0.4–0.59, Weak (W) = 0.2–0.39, and Very Weak (VW) = <0.2 from the value of WAI.

4. CONCLUSION

Plant growth regulators (PGRs) significantly enhance vegetable quality in the Junagadh district of Gujarat by improving size, color, and yield. They promote sustainable farming by reducing chemical usage and increasing resource efficiency. Farmers appreciate the convenient packaging, local availability, and effective promotion of PGRs. Despite some concerns about costs of PGRs, the benefits, including better return on investment, improved water efficiency, crop uniformity, and environmental friendliness, strongly support their use in vegetable cultivation.

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REFERENCES

- [1] Islam, S.; Sayadat, N. and Haider, S. 2023. Perceptions of chemical pesticide use among vegetable growers in Bangladesh: Implications for sustainable pest management. *South Asian Journal of Social Studies and Economics*. **20(2)**: 100-108.
- [2] Singh, S. K.; Thakur, N. and Sharma, Y. 2023. Plant growth regulators in fruit and vegetable crops. *International Journal of Agricultural Sciences*. **9(1)**: 433-437.
- [3] Kumar, N. R. 2019. A Study on Consumer's Perception on Fruits and Vegetables with Special Reference to Retail Outlets in Coimbatore City. *Journal of Business and Management*. **21(3)**: 23-26.
- [4] Van, O. J.; Conklin, M. E. and Blakeslee A. F. 1941. Factors in coconut milk essential for growth and development of datura embryos. *Science*. **94**: 350.
- [5] Aurovinda, and Rajjendra, P. 2003. Effect of plant growth regulators CCC and NAA on the growth and yield of summer mungbean. *Ann Agri Res*. **24(4)**: 874-879.
- [6] Maity, U.; Dutta, P. and Laye, B. 2016. Effect of plant growth regulators on growth, yield and quality of okra [*Abelmoschus esculentus* (L.) Moench]. *Journal of Agroecology and Natural Resource Management*. **3(3)**: 251-253.
- [7] Sial, A. Z. 2016. Farmers' perception about effects of pesticides uses in vegetables in taluka of Jaffarabad district, Balochistan. *Journal of Natural Science Research*. **5(1)**: 2224-3186.
- [8] Shashidhara, K. K. 2017. A study on farmer's perception on ill effects of agrochemicals in north eastern part of Karnataka. *Journal of Applied and Natural Science*. **9(4)**: 2158-2164.

- [9] Badekhan, A. and Devi, K. U. 2018. Perception of cotton farmers on the effects of pesticide use. *Asian Journal of Agricultural Extension, Economics and Sociology*. **23(1)**: 1-6.
- [10] Mehmood, Y.; Arshad, M.; Kaechele, H.; Mahmood, N. and Kong, R. 2020. Pesticide residues, health risks, and vegetable farmers' risks, and vegetable farmers' risk perceptions in Punjab, Pakistan. *Human and Ecological Risk Assessment: An International Journal*. **27(3)**: 846-864.
- [11] Meshram, P. M. 2020. Perception of vegetable growers towards environmental effect of pesticides use in Jabalpur district of Madhya Pradesh. M.Sc. (Agri.) Thesis (Unpublished), J.N.K.V.V., Jabalpur.
- [12] Bessah, E.; Raji, A. O.; Taiwo, O. J.; Agodzo, S. K.; Ololade, O. O.; Strapasson, A. and Donkor, E. 2021. Gender-based variations in the perception of climate change impact, vulnerability and adaptation strategies in the Pra River Basin of Ghana. *International Journal of Climate Change Strategies and Management*. **13**: 435-462.
- [13] Mairura, F. S.; Musafiri, C. M.; Kiboi, M. N.; Macharia, J. M.; Ng'etich, O. K.; Shisanya, C. A. and Ngetich, F. K. 2021. Determinants of farmers' perceptions of climate variability, mitigation and adaptation strategies in the central highlands of Kenya. *Weather and Climate Extremes*. **34**: 100374.
- [14] Ogunjinmi, K. O. 2022. Original Research Article Gender Dimensions of the Determinants of Climate Change Perception in Farming Communities of Southwest Nigeria. *The Faculty of Agriculture Delta State University*. **9(1)**: 67- 78.
- [15] Sujianto, Gunawan, E.; Saptana, Syahyuti, Darwis, V.; Ashari, Syukur, M.; Ariningsih, E.; Saliem, H. P.; Mardianto, S. and Marhendro, 2022. Farmers' perception, awareness, and constraints of organic rice farming in Indonesia. *Open Agriculture*. **7**: 284–299.
- [16] Petcho, W.; Szabo, S.; Kusakabe, K. and Yukongdi, V. 2019. Farmers' Perception and Drivers of Membership in Rice Production Community Enterprises: Evidence from the Central Region, Thailand. *sustainability*. **11**: 5445.