Future Agriculture e-magazine

E-ISSN: 3048-4553 (Online) https://futureagriculture.co.in/

Article Id: FA-26 **ISSUE- December, 2025 | Issue-3 pp. 88-92**

Hybrid Seeds and Hybrid Vigour Increasing Crop Yield and Quality

Neeraj Gupta*[1], Madhvendra Bahadur Singh[2], Hrishabh Knaujiya[1] and Vishal Sharma[1]

[1]*M.Sc. Students, Department of Horticulture, Deen Dayal Upadhyaya Gorakhpur University Gorakhpur, UP.*

[2] *Asst. Prof. Department of Horticulture, Deen Dayal Upadhyaya Gorakhpur University Gorakhpur, UP.*

***Corresponding Author Email:** neerajgupt058@gmail.com

Abstract

Hybrid vegetable crops constitute a cornerstone of modern horticulture by contributing significantly to food security, nutritional quality, farm income, and sustainable production systems. Hybrid seeds are developed by crossing genetically distinct parental lines to exploit heterosis, resulting in superior vigor, higher yield, uniform growth, and improved quality traits such as colour, taste, texture, and nutritional value. These crops exhibit enhanced resistance to biotic stresses including diseases, insect pests, and nematodes, along with greater tolerance to abiotic stresses such as drought, heat, and soil salinity. Improved root architecture, faster growth rate, and heterozygous advantage further strengthen productivity and adaptability under diverse environments. Hybrid seeds have enabled yield gains of 30–45% in several vegetable crops, aligning production with market demand and resource-use efficiency. Despite advantages, challenges persist in terms of higher seed cost, dependence on seed companies, limited seed saving, and erosion of genetic diversity. Balanced integration of hybrid technology remains critical for resilient vegetable farming systems.

Keywords: *Hybrid seeds; Heterosis; Vegetable crops; Stress resistance; Productivity*

1. Introduction

Hybrid vegetable crops play an important role in global agriculture, food security, nutrition and economic development. Hybrid seeds have increased vegetable crop production globally. Providing farmers with a chance to meet the market demand for high-quality produce improve flexibility and increased productivity and quality. Hybrid seeds play a vital role not only in enhancing food security but have also aligned vegetable production with sustainability. Hybrid seeds have become important in modern vegetable farming for best quality, higher productivity and resistance to biotic and abiotic stresses. By crossing two different parent lines, hybrid seeds combine the best traits of both parents resulting in crops that are more resilient and productive. Hybrid vigour, the growth rate and productivity of hybrid offspring, is a key factor in the success of hybrid crops / variety.

2. Characteristics of hybrid seed & vigour

1 Heterosis-

It refers to the increased performance of a hybrid (F1 generation) compared to its parents in terms of traits like disease resistance vigour and yield. It is also known as hybrid vigour.

2. Uniformity-

Hybrid seeds are known for their uniformity, meaning plants grown from them tend to be more consistent in size, shape and maturity compared to plants grown from open-pollinated

varieties in vegetables crops. Hybrid crops often exhibit more uniformity in growth and maturity, making them easier to manage and harvest.

3. Increased yield and better quality-

Hybrid seeds are bred to produce higher yields resulting in more abundant harvests. This is achieved by combining the genetic material of two different parent lines, each contributing desirable traits. Hybrid seeds can have improved quality traits such as better taste, texture, and nutritional content enhancing their value to consumers.

4. Resistant & tolerance to biotic and abiotic stress-

Mostly hybrid seeds are resistant and tolerant to various biotic & abiotic factors such as insect-pest, disease, droughts and soil salinity etc.

Biotic stress resistance-

Disease resistance- hybrid seeds can be bred to resist specific diseases, reducing crop losses and minimizing the use of fungicides and bactericides. Ex- tomato- Arka Samrat, A. Abhed & A. Rakshak are multiple disease resistant varieties.

5. Insect-pest and nematode resistance-

Hybrid seed can be engineered to produce proteins that are toxic to certain pest (*Bacillus thuringiensis* for lepidopteran order), reducing insecticides use and crop damage. Some hybrid seeds are resistant to nematodes, microscopic worms that can harm crops. Ex- Brinjal- Annamalai variety resistant to aphid, Punjab Sadabahar & Pusa Purple Round resistant to shoot & fruit borer insect, Tomato - Hisar Lalit & Arka Vardhan, are resistant to Root Knot Nematode.

6. Abiotic stresses tolerance-

Drought tolerance- Hybrid seeds can be bred to conserve water and thrive in dry conditions. Drought tolerance refers to a plants ability to survive and grow in conditions with limited water availability. Such plants often have mechanisms to conserve water, such as deep roots, small leaves or specialized photosynthetic pathways. Some hybrid seeds can be engineered to express genes that help them respond to drought stress. Ex Beetroot – Crimson Globe variety.

Heat tolerance- Some hybrids are designed to withstand high temperatures, reducing heat stress and crop loss. Hybrid seeds express genes that help plants respond to heat stress, and producing some stress-related proteins or molecules that protect plants from heat damage and maintaining efficient

photosynthetic pathways. Ex- tomato - Hybrid- 61.

7. Soil-Salinity tolerance-

Some hybrid seeds can grow well in soil with high salt levels, making them suitable for areas with poor soil conditions. hybrid seeds limiting the uptake of toxic ions (Na+, Cl-) from the soils. Ex- tomato varieties- Florida, Abhinav, & Rohini variety.

8. Characteristics of hybrid vigour-

A Increased growth rate and enhanced productivity

Hybrid vigour leads to faster growth and development in hybrid plants, allowing them to reach maturity more quickly. Hybrid seeds often exhibit higher productivity due to the combination of beneficial traits from parent lines, resulting in more abundant yields.

B Robustness Crops with hybrid vigour tend to be more robust and adaptable to varying conditions, making them more resilient to environmental challenges.

C Heterozygous advantage

Hybrid vigour is a result of the heterozygous condition, where the hybrid offspring outperforms both parents due to the combination of genetic material**.**

D Improved root system

Hybrid crops often develop deeper root system, allowing them to absorb nutrients and water more efficiently; where higher root density enhance nutrient uptake, promoting healthy plant growth. Deeper and more extensive root systems can help hybrid crops tolerate drought conditions**.**

9. Role of hybrid seeds

1. Increasing yield

Hybrid seeds have increased vegetable crops yield broadly. Some vegetables such as cucumber, chilli, & tomatoes show 35-45% increased yields than traditional cultivars of vegetable crops.

2. Enhanced quality of produce

Hybrid seed & vigour enhanced quality of vegetable crops include shape, size, colour and nutritive value like as some tomato hybrid variety red and attractive colour, round shape, keeping quality and lycopene content are high to high demand in market**.**

3. Resistance to biotic and abiotic stress

Hybrid seeds are mostly show the resistance to common insect-pest and disease like as tomato varieties Arka Samrat, A. Abhedh. and A. Rakshak are multiple disease resistance varieties. Mainly hybrid seeds are show the tolerancey of abiotic stresses like as drought, temperature fluctuation, rainfall fluctuation, soil salinity and acidity**.**

4. Economically benefits for farmers

Hybrid seeds produce high quality and better quality of products according to the market demand and enhanced our income. Hybrid seeds are resistance to biotic and abiotic stress, that's produce higher yield for unit area; nearabout 30-40% increased crop yield than traditional variety of vegetable crop (FAO 2018).

10. Limitations of hybrid seeds

1. Seed saving-

The seeds from hybrid crops may not produce the same uniform characteristics in the next generations, So it is not typically recommended to save seeds from hybrids. Hybrid seeds must be exchanged for sowing every year for cultivation.

2. Higher cost

Hybrid seeds are often more expensive to produce due to the complex breeding process involved. The higher cost of hybrid seeds can be a significant burden for small-scale farmers, potentially reducing their profit margins.

3. Loss of genetic diversity

Adoption of hybrid seeds can lead to a reduction in crop diversity, making agricultural systems more vulnerable to disease outbreaks and environmental stress. Hybrid seeds become more popular, traditional crop varieties may be lost, taking with them valuable genetic traits.

4. Dependence on seed companies

Farmers who use hybrid seeds may have to rely on seed companies for new seeds each season, reducing their ability to save and replant seeds. Hybrid seeds are often patented, which can restrict farmers rights to save and exchange seeds.

5. Limited gene pool

The gene pool of hybrid seeds is limited, which can restrict the potential for further improvement. Breeders may be limited to working with existing genetic material, which can limit the development of new traits due to dependence on existing genetic materials**.**

Conclusion

Hybrid seeds have significantly influenced vegetable crop production by offering solutions to the challenges of increasing yield, enhance flexibility and improve quality; Although they are widely used, it is important to address the socio-economic and environmental concerns associated the hybrid seeds. Future innovation should focus on making hybrid seeds; more affordable and common while preserving traditional varieties. Hybrid seeds, resulting from the cross between two genetically distinct parents, often exhibit hybrid vigor (heterosis), leading to improved performance in yield, growth rate, and stress resistance compared to inbred lines. This phenomenon is widely utilized in agriculture to boost crop productivity and quality. Hybrid seeds, leveraging hybrid vigor, play a critical role in improving crop yield; quality, and resilience. While challenges like seed cost and genetic diversity exist, ongoing research and breeding innovations are likely to expand their impact on global agriculture.

References

1. **Chaudhary, SA. Hassan M. and Alam S.** (2021). hybrid seeds in protected cultivation system. A review, greenhouse horticulture journal (12) 4, 34-47

2. **Dhillon, N. P. S., Prasanna, B. M., Singh, J. P., &Saxena, R. K**. (2014).Breeding hybrid vegetables: Progress and challenges. Horticultural Reviews, 42, 103–160

3. **Food and Agriculture Organization of the United Nations (FAO). (2018).** Hybrid seed production and use in vegetable crops: A global perspective. FAO Agriculture Bulletin.

4. **Jha, A., Verma, P., & Roy, S**. (2020). Challenges in hybrid seed production: Socioeconomic perspectives. Agricultural Review, 41(2), 89–97

5. **Kumar S. and Singh PK.** (2004). Mechanism of hybrid development in Vegetables. In hybrid vegetable development **(Eds. Singh PK. Dasgupta SK. and Tripathi SK. Eds)** Food Products Press an imprint of the Howarth Pros, Inc. pp 381-407-

6. **Patel, J., Sharma, N., &Rathod, S.** (2022). Climate-resilient hybrid vegetables for sustainable agriculture. Advances in Crop Science, 15(1), 56–71.

7. **Patra, R., Das, A., & Gupta, T.** (2023). Integrating farmer participation in hybrid seed development. Sustainable Agriculture Research, 8(2), 76–88.

8. **Singh B. and Tomar BS**. (2015). Vegetable seed production under protected and open field Conditions in India. A review,

Indian journal of Agricultural science 85(10):3-11.

9. Singh, P. and Reddy R (2019). Enhancing vegetable crop resilience through hybrid technology. Journal of Vegetable science 10(3) 45-62