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Chickpea (*Cicer arietinum* l.) production enhancement through frontline demonstration

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Abstract
The management of fungal diseases in gram has relied heavily on chemical fungicides. However, concerns over environmental pollution, pesticide residues in food and the development of fungicide resistance in pathogens have prompted a shift towards sustainable and eco-friendly disease management strategies. In the present study, 60 frontline demonstrations (FLDs) on *Trichoderma* were conducted in an area of 14 ha during *Rabi* 2019-20, 2020-21 and 2022-23. The finding of the study show that extension gap that ranged from 01.89 to 01.09q ha^{-1} emphasizes that there is need to educate the farmers by many ways for adoption of improved production methods. The results revealed that due to front line demonstration on chickpea an average yield was observed 10.19q/ha as compared to farmers practice 08.60 q/ha during 2019-20. In 2020-21 an average yield was observed 11.16q/ha as compared to farmers practice 09.27 q/ha and in 2021-22 an average yield was observed 10.47q/ha as compared to farmers practice 09.38 q/ha.

Keywords: Chickpea, Extension gap, Frontline demonstration, fungal diseases, management strategies, Pathogen, pollution, *Trichoderma*, yield

Introduction
Gram (*Cicer arietinum* L.) commonly known as chickpea, is an important legume crop that holds significant economic, nutritional, and agricultural value worldwide. It ranks second in production among pulses globally, following only dry beans, and is cultivated predominantly in regions with semi-arid climates, including South Asia, the Middle East, and parts of Africa. Pulses are significant sources of protein, fatty and essential amino acids, minerals, fibres, high-quality carbohydrates in the human diet for the impoverished, as well as a vegetarian way of life in the country (Bairwa *et al.* 2020, Verma *et al.* 2021) [2, 10]. Apart from this, pulses are also good sources of the B-group vitamins apart from riboflavin, and are capable of alleviation of increasing protein hunger and malnutrition that is prevalent amongst the poorer section of society (Kumar *et al.* 2019) [4].

Beyond its nutritional benefits, gram plays a pivotal role in sustainable agriculture due to its ability to fix atmospheric nitrogen through symbiotic association with Rhizobium bacteria, thereby enriching soil fertility and reducing the need for nitrogen fertilizers. This nitrogen-fixing capacity not only supports the sustainability of cropping systems but also contributes to improved soil health and structure, making gram cultivation an integral part of crop rotations in many farming systems.

However, Chickepea productivity in dang district is far below as compared to potential yield 2500 kg/ha (Javiya *et al.* 2023) [3]. Gram production faces numerous challenges, including abiotic stresses such as drought, salinity, and heat stress, as well as biotic stresses from various pathogens. Among the most significant fungal diseases affecting gram are Fusarium wilt (caused by *Fusarium oxysporum*) and dry root rot (caused by *Rhizoctonia bataticola*). These diseases can cause substantial yield losses, reduce crop quality, and limit the economic viability of gram cultivation, especially in dang district where the crop is extensively grown.

Traditionally, the management of fungal diseases in gram has relied heavily on chemical fungicides. However, concerns over environmental pollution, pesticide residues in food, and the development of fungicide resistance in pathogens have prompted a shift towards sustainable and eco-friendly disease management strategies. Biological control methods, particularly the use of beneficial microorganisms, have gained attention as effective alternatives to synthetic chemicals for managing plant diseases. Our district also declares as organic/Natural farming district in Gujarat.

One promising group of biocontrol agents is the genus *Trichoderma*, a ubiquitous and versatile group of filamentous fungi known for their ability to colonize plant roots, stimulate growth, and suppress plant pathogens through various mechanisms. *Trichoderma* spp. produce a range of antifungal metabolites, lytic enzymes and volatile organic compounds that inhibit the growth and development of pathogenic fungi. Moreover, *Trichoderma* can enhance plant tolerance to abiotic stresses, improve nutrient uptake, and promote overall plant health, making them attractive candidates for integrated pest management (IPM) strategies in agriculture.

This research paper aims to address this gap by investigating the effect of frontline demonstrations of *Trichoderma* on gram yield and associated agronomic parameters. The study will evaluate the performance of gram plants treated with *Trichoderma* under field conditions.

Materials and Methods

The Front line demonstration on chickpea was conducted by Krishi Vigya Kendra, Dang (Gujarat) during 2020, 2021 and 2022 in four villages viz.,Uga, Dokpatal, Borpada and Bhadarpada of district Dang, Gujarat A total 60 farmers were associated under FLD programme. The components of demonstration of frontline technology for chickpea production were comprised of use of *Trichoderma@* of 20g/kg of seed as seed treatment and also soil treatment with FYM. Total 14.0 hectare area was covered in three consecutive years. In the demonstration, one control plot was also kept where farmers practices was carried out.

The FLD was conducted to study the technology gap between potential yield and demonstrated yield, extension gap between demonstrated yield and yield under existing practice. The yield data were collected from both the demonstration and farmers practice using random crop cutting method and analyzed. The technology gap, extension gap and technological index (Javiya *et al*., 2023) [3] were calculated by using following formula as given below:

$$\text{Per cent increase in yield} = \frac{\text{Demonstration yield} - \text{Farmers yield}}{\text{Farmers yield}} \times 100$$

Technology gap = Potential yield - Demonstrated yield

Extension gap = Demonstrated yield – Yield under existing practice

Technology index = Potential yield - Demonstrated yield/ Potential yield

Result and Discussion

Field level demonstration was laid out on chickpea to assess the yield and economics at farmers' field. The results indicate that use of trichoderma in chickpea enhancing the yield of chickpea over farmer. Different parameters were analysed for production of chickpea. Front line demonstration technology results obtained during three consecutive years (2019, 2020 and 2021) are presented in Table.

Chickpea Yield

The results revealed that due to front line demonstration on chickpea an average yield was observed 10.19q/ha as compared to farmers practice 08.60 q/ha. During 2019-20. In 2020-21 an average yield was observed 11.16q/ha as compared to farmers practice 09.27 q/ha and in 2021-22 an average yield was observed 10.47q/ha as compared to farmers practice 09.38 q/ha. This results clearly indicated that the higher average grain yield in demonstration plots over the years compare to local check due to knowledge and adoption of full package of practices viz., timely sowing, seed treatment with Trichoderma of seed, use of balanced dose of fertilizer (N and P) and need based plant protection system. The average yield of chickpea increased 18.48, 20.46 and 11.62 per cent in three year.

The better yield of chickpea was observed due to the adoption of trichoderma seed treatment and also apply trichoderma mixed with FYM effectively increased the chickpea yield compared to the yield observed under farmers practices. The lesser yield of chickpea at farmer's practices over FLD may be due to lack of awareness, not using any plant protection measures, Farmers followed broadcast method of sowing against the recommended line sowing and because of this, they applied higher seed rate than the recommended limit (Singh *et al*., 2014) [9].

Extension gap

The extension gap that ranged from 01.89 to 01.09q ha-1 emphasizes that there is need to educate the farmers by many ways for adoption of improved production methods. A descending trend of technology gap reflects the farmer's cooperation in carrying out such demonstrations with encouraging results in subsequent years.

Technology gap

The technology gap in the demonstration ranged from 14.81 to 13.84 q/ha yields over potential yield (Table 2). The technology gap observed may be attributed to the dissimilarity in soil fertility status and weather conditions etc. Hence, location specific recommendation appears to be necessary to minimize the technology gap for yield level in different situation.

Technology index

Technology index showed the feasibility of the evolved technology at the farmer's fields. However the lower value of technology index indicates that more is the feasibility of technology at farmers fields. As such fluctuation in technology index during the study period in certain regions may be attributed to the dissimilarity in Disease management. The frontline demonstration on chickpea was helpful for farmers to adopt the new technologies to increase in chickpea production.

Therefore, for enhancing the production of chickpea, strategy should be made for getting the more and more recommended technologies adopted by the farmers (Raj *et al*., 2013 and Sharma *et al.*, 2011) [6, 8]. The variation in per cent increase in the yield was found due to the lack of knowledge, and poor socioeconomic condition. The present study indicates that the OFTs and FLDs programmes were effective in chickpea production.

Table 1: Data of Frontline demonstration

Year	Crop	No. of farmers	Area (ha)	Demo Yield (q/ha)	Check (q/ha)	Increase %	Demo Gross cost (Rs./ha)	Demo Gross Return (Rs./ha)	Demo Net Return (Rs./ha)	BCR	Check Gross cost (Rs./ha)	Check Gross Return (Rs./ha)	Check Net Return (Rs./ha)	BCR
2019-20	Gram	10	04	10.19	08.60	18.48	14669	45451	30782	3.09	14331	35323	20992	02.46
2020-21	Gram	25	05	11.16	09.27	20.46	15000	50252.4	35252.4	3.50	14000	41727.6	27727.6	02.98
2021-22	Gram	25	05	10.47	09.38	11.62	15000	45046.8	30046.8	3.03	14000	40398.4	25868.4	02.78

Table 2: Effect of *Trichoderma* on average yield, extension gap, technology gap and technology index

Year	Crop	No. of farmers	Area (ha)	Demo Yield (q/ha)	Check (q/ha)	Increase %	Technology gap (q/ha)	Extension gap (q/ha)	Technology index (q/ha)
2019-20	Gram	10	04	10.19	08.60	18.48	14.81	1.59	59.00
2020-21	Gram	25	05	11.16	09.27	20.46	13.84	1.89	55.00
2021-22	Gram	25	05	10.47	09.38	11.62	14.53	1.09	58.00

Conclusion

Demonstration at field level provides an opportunity to display the productivity potential and profitability of the latest technology under the natural farming conditions. The under FLD over existing practices of chickpea cultivation created greater awareness and motivated the other farmers to adopt suitable production technology of chickpea.

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