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Performance and impact of JG-12, an improved variety of chickpea under rainfed conditions in a Kymore plateau and Satpura hills Agro-climatic zone of Madhya Pradesh

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Abstract
To study the comparative performance and impact of newly released chickpea variety JG 12, On Farm Trials (OFT) were conducted under rainfed conditions during rabi season of 2015-16 and 2016-17 at Krishi Vigyan Kendra, Seoni, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh – India. Seoni comes under the Kymore Plateau and Satpura Hills Agro-climatic zones of Madhya Pradesh. The OFTs were conducted at different five locations of KVK, Seoni to demonstrate production potential and economic benefits of improved technologies for chickpea crop. Chickpea (*cicer aeritinum*) is one of most important pulse crop which is grown in rabi season. Farmers practice kept as check for comparing the performance of chickpea yield and economic returns. Results of OFT revealed that chickpea variety JG 12 was equally good performers with respective average seed yield 16.35 q/ha under recommended practice while, minimum seed yield 11.02 q/ha was observed in farmers practice. Further, mean of the technology gap was 3.65 q/ha and mean extension gap was 5.34 q/ha. Whereas, technology index was observed 18.25 during the assessment period. The economic performance of chickpea cultivation were showed maximum B:C ratio 3.15 and 2.70 B:C under recommended practice while minimum B:C ratio 2.24 and 1.99 were noted in farmers practice during 2015-16 and 2016-17, respectively.

Keywords: Performance, technology gap, extension gap, JG-12, rainfed condition, B:C rato

Introduction
Chickpea (*Cicer arietinum* L.) is the most important pulse crop in India and it's belonging to family *Leguminosae* which is originated from north-west India. Chickpea is commonly known by Gram, Chana, and Bengal-gram. It is very important nutritious crop and its production in India is about 70 lakh tonnes. It is a good source of protein (18-22%), carbohydrate (52-70%), fat (4-10%), minerals (calcium, phosphorus, iron) and vitamins. Madhya Pradesh is the largest producer of chickpea in India which contributes about 39 per cent in production of gram followed by Maharashtra (14%) by Kumar *et al.* (2011) [8]. The pulses are suitable for intercropping and mixed cropping and hence having multidimensional scope in all type of climatic conditions of our country. Chickpea alone accounts about 50% of the total pulses production in India. The average productivity of chickpea in India is about 841 kg/ha against the average global productivity of 1023 kg/ha (Anonymous, 2017) [2].
The average yield productivity of chickpea in the country is very low when we compare it with the world's chickpea productivity. Varieties play an important role in the production and selection of proper variety for a set of agro-climatic conditions it is very important to achieve maximum yield potential. Chickpea varieties tolerant to drought stress with the highest yield potential have to be identified and developed to maximize the national average yield productivity of chickpea (Meena and Dudi, 2012) [10]. As of now many improved varieties of chickpea have been developed in India but their performance and yielding aptitude differ from location to location owing to specified varieties don't exhibit the same phenotypic characteristics. Variety of the crop decides its growth and yield potential under specific agro-climate along with efficient resource utilization. The yield potential of different chickpea varieties may differ under different agro-climatic conditions because of their inherent capacity. However, JG-12 is a Desi chickpea variety. It is an early (105-115 days) brown and medium seed, semi spreading profuse branching, suitable for both irrigated and rainfed conditions of Madhya Pradesh having yield potential of 20 q ha^{-1} (Anonymous, 2016) [1]. Thus, adoption of improved cultivar is an important tool, which has regulated chickpea production in many states of the country. Therefore, to generate more information on the performance of chickpea variety JG 12 for greater yields in a given agro-climatic conditions.

Materials and Methods

In order to assess the site-specific performance, production potential and profitability of recently released chickpea variety JG 12 at Krishi Vigyan Kendra, Seoni, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh – India. Seoni comes under the Kymore Plateau and Satpura Hills Agro-climatic zones of Madhya Pradesh (agro-climatic zone- III). Thus, five On Farm Trial (OFT) were conducted 12 under rainfed conditions during rabi season of 2015-16 and 2016-17.

The experimental field was prepared with the help of tractor-drawn implements. The stubbles of previous crops and weeds were cut into pieces by harrowing and later to provide coarse seedbed, a cross ploughing was done. The demonstrations were carried out on improved varieties of chickpea JG 12, with recommended seed rate of 80 kg/ha adopting line sowing by seed drill with keeping 30 cm apart distance between the rows and later plant to plant distance was maintained at an interval of 10 cm. Seed treatment was done with carbendazim 12% + mancozeb 63% WP @ 2 g/kg seed. Application of nutrients in the formed inorganic was done as per recommended dose of fertilizers 25 kg N: 60 kg P_2O_5: 20 kg K_2O per hectare were supplied as basal at time of sowing. The weeds particularly Bathua, Senji, Motha, Gajar Grass and Satyanasi *(Argemone maxicana)* were predominantly associated in the experimental field, though pre-emergent herbicides (Pendimethalin) were applied just after 1 day of sowing. The associated weeds were kept under control up to the stages of 25-30 DAS and 60 DAS by hand weeding/ hand hoe. Nipping, is the process of removal of the top portion of a young plant (Apex bud with 2-3 leaves), stops the apical growth and promotes lateral branching, thus the plants become more vigorous and produce more flowers and pods and yield per plant is increased. In this study, nipping was done between 30–35 DAS and that helped in getting profuse branching and foliar growth during its grand growth stages.

The yield data were collected from all demonstration units. The economics was calculated on the basis of prevailing market prices of different inputs and outputs. The data were collected from front line demonstration's fields as well as from control field (farmers practices) and finally the technology gap, extension gap and technological index were calculated by using following formula as given by Samui *et al.* (2000) [12].

- Technology Gap = Potential yield – Demonstration yield
- Extension Gap = Demonstration yield – Farmer's yield
- Technology index = [(Potential Yield – Demonstrated Yield)/Potential Yield] x 100

Results and Discussion

Technological Intervention

Krishi Vigyan Kendra, Seoni (M.P.) and Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) made efforts in collaborative manner for enhancing production and productivity of chickpea variety JG 12. The recommended packages of practices (RP) and Farmers practice (FP) were followed to conduct the OFTs at the Krishi Vigyan Kendra, Seoni (M.P.). The use of improved chickpea variety JG 12, seed treatment, line sowing, weeding, need based plant protection and balanced nutrient management practices as suggested by Chattopadhyay *et al*. (2003) [3] and Kushwaha *et al*., (2017) [9] were used as technological interventions. The difference between recommended practices (RP) and farmers practices (FP) is given in Table 1.

Table 1: Difference between recommended practices (RP) and farmers practices (FP).

Intervention	Recommended practices (RP)	Farmers practices (FP)
Seed rate	80 kg/ha	100 kg/ha
Spacing/ Depth	Row x Row = 45 cm Plant x Plant = 20 cm Depth: 8 – 10 cm	Row x Row = 30 cm Plant x Plant = 10 cm Depth: 6 – 8 cm
Farming situation	Irrigated/rainfed	Irrigated/rainfed
Crop variety	JG 12	JG 12
Seed treatment	Seed treatment done by Carbendazim 12% + Mancozeb 63% WP @ 2 g/kg seed	Seed treatment not done
Seed inoculation	Seed inoculation with *Rhizobium* and PSB biofertilizers @10 ml/kg seed	No seed inoculation
Method of sowing	Line sowing	Line sowing
Fertilizer doses	Balance dose of fertilizers = 20N: 60 P_2O_5: 20 K_2O kg/ha	Applied only N and P through 100 kg DAP fertilizer per hectare
Weed control	Two mechanical weeding	No weeding
Disease Management (Wilt)	*Trichoderma* 1% WP @ 4.0 kg/ha at the time of sowing	No use of bio agent
Incest pest management (pod borer)	Used scientific integrated pest management practices	Mix different pesticide to control pest

Yield of Chickpea

The seed yield data of chickpea (JG 12) are presented in Table 2 and indicated that the on farm trial (OFT) has given a good impact for the performance of chickpea variety JG 12 which is help to demonstrated new agricultural technologies in the farmers field of Seoni district comes under the Kymore Plateau and Satpura Hills Agro-climatic zones of Madhya Pradesh. Results of five OFTs indicated that the cultivation practices comprised under demonstration *viz.*, use of improved variety (JG-12), balanced application of fertilizers (N: P: K @ 20:60:0:20 kg NPK ha^{-1}, line sowing, timely weed management and control wilt and insect-pest management through integrated pest management practices, produced on an average 17.50 q/ha and 15.20 q/ha during 2015-16 and 2016-17, respectively under recommended practice plot. However, farmers practice plots produced minimum seed yield of chickpea crop 11.80 q/ha and 10.23 q/ha during 2015-16 and 2016-17, respectively. The yield of chickpea variety JG 12 increased by 48.31% and 48.58% during 2015-16 and 2016-17, respectively with an average increase of 48.45% over the farmers' practices. The yield enhancement under the technology demonstration was due to the need based use of improved and disease resistant varieties, balanced use of nutrients (Thakur and Sawarkar, 2009) [13], efficient weed management and insect pest management practices. The

results were in conformity with the findings of Khamparia *et al*., (2018) [6] and Meshram *et al*., (2018) [11].

Table 2: Seed yield of chickpea in recommended practices and farmers practices.

Year	Seed yield (q/ha)			% increase over farmers practice
	Recommended practices (RP)	Farmers practice (FP)	Additional over farmers practice	
2015-16	17.50	11.80	5.70	48.31
2016-17	15.20	10.23	4.97	48.58
Average	16.35	11.02	5.34	48.45

Technology gap

The technology gap in the demonstrations were 2.50 q/ha and 4.80 q/ha yields over potential yield of chickpea variety JG 12 (Table 3) during the 2015-16 and 2016-17, respectively. The technology gap observed may be attributed to the dissimilarity in soil fertility, erratic rainfall and other vagaries of weather conditions in the area. Hence, variety wise location specific recommendation appears to be necessary to minimize the technology gap for yield level in different situations (Khan *et al*., 2008 and Dwivedi *et al*., 2015) [7, 4].

Extension gap

The extension gaps under demonstration were 5.70 q/ha and 4.97 q/ha during 2015-16 and 2016-17, respectively (Table 3). The demonstration of technology emphasized the need to educate the farmers through various means for the adoption of improved agricultural production technologies to reverse this trend of wide extension gap. More and more use of latest production technologies with high yielding variety will subsequently change this alarming trend of galloping extension gap. The new technologies will eventually lead to the farmers to discontinue the old technology and to adopt new technology (Table 1). This finding is in corroboration with the findings of Hiremath and Nagaraju, (2010) [5].

Table 3: Technology gap, extension gap and technology index of chickpea as grown under OFT and existing package of practices.

Year	Technology Gap (q/ha)	Extension Gap (q/ha)	Technology index
2015-16	2.50	5.70	12.50
2016-17	4.80	4.97	24.00
Average	3.65	5.34	18.25

Technology index

The technology index shows the feasibility of the evolved technology at the farmer's fields and the lower the value of technology index more is the feasibility of the technology (Prajapati *et al.* 2019). The average technology index was 18.25%, while 24.00% maximum technology index was during 2015-16 but minimum 12.50% was during 2017-18 (Table 3).

Economic performance of chickpea cultivation

Data pertaining to cultivation costs incurred in recommended/demonstration and famers' practice, net return and benefit cost ratio is presented in Table 4. The economics of chickpea cultivation and its feasibility in demonstration was calculated considering the existing prices of inputs and production costs over farmers' practice. The cost of production with the improved variety JG 12 were Rs. 17750/ha in 2015-16 and Rs. 22600/ha in 2016-17 with an average cultivation cost of Rs. 20175/ha as compared to Rs. 18650/ha under farmers practice. The average additional cost incurred with JG 12 was Rs.1525/ha over farmer practice. The additional cost incurred in the demonstration practice was mainly due to cost involved in fertilizers for balanced nutrient application and herbicide for weed management. The average value of net return in chickpea cultivation was noticed to be remarkably higher under demonstration practice in variety JG 12 was Rs. 38425/ha as compared to farmers practice Rs.20600/ha with the additional of Rs. 17825/ha. The results were in agreement with the findings of Meena and Dudi, (2012) [10]. Further, results revealed that higher benefit cost ratio of JG 12 under recommended practice over the farmers practice. An average incremental B: C ratio of 0.81 was noticed over the farmers practice.

Table 4: Economics of chickpea cultivation in recommended and farmers practices.

Year	Cost of cultivation (Rs/ha)		Gross Return (Rs/ha)		Net Return (Rs/ha)		B:C ratio	
	RP	FP	RP	FP	RP	FP	RP	FP
2015-16	17750	16800	56000	37760	38250	20960	3.15	2.24
2016-17	22600	20500	61200	40290	38600	20240	2.70	1.99
Average	20175	18650	58600	39025	38425	20600	2.93	2.12

Conclusion

It may be concluded that the results of OFTs helped to understand that chickpea variety JG 12 is performing well under rainfed condition of Madhya Pradesh. The existing farmers' practice was compared against recommended practice for chickpea managed with balanced nutrient use and integrated crop management practices. The study revealed that an average chickpea yield of demonstration plots increased by 48.45% over farmers' practice.

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